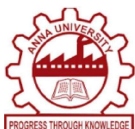




# Meenakshi Sundararajan Engineering College

(An Autonomous Institution)

Managed by I.I.E.T Society, Approved by AICTE, New Delhi,  
Affiliated to Anna University, Chennai,  
Accredited by NAAC with 'A' grade and NBA for programs applied,  
Recognized by UGC with 2(f) & 12(B) status



## 4<sup>th</sup> BOARD OF STUDIES (BoS) MEETING

Department of Electrical and Electronics Engineering

Powered by



363, Arcot Road, Kodambakkam, Chennai - 600 024.  
[www.msec.edu.in](http://www.msec.edu.in)



# Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University, Chennai)

**Prof. K. R. Sundararajan**, a well-known educationalist, established the Indian Institute of Engineering Technology (I.I.E.T) society in the year 1947 in Chennai. The total area of 14 acres was purchased with enormous hardship and was donated to the IIET Society for the cause of education. The society's main objective is to provide quality education and it has been ensured since 1951.

## The IIET Society has the following to its credit :-

- An uninterrupted and continuous education since 1951 in its premises
- All Colleges run by the institution are ranked among the top 5 – top 10 programs in Tamil Nadu
- 350 KW Solar Power Plant Generating upto 70% of its electricity needs
- Significant portion of the students are first generation learners
- Campus holds approximately 7000 plus students from the ages of 4 to 35 plus.
- Large Green Campus in the heart of the city of Chennai, Tamil Nadu
- In existence since 1947 – Completed 75 years
- Targeting to be Carbon Neutral from the end of the year 2025

## The society currently has the following institutions :-

- **Meenakshi Sundararajan Engineering College(MSEC)** - established in 2001 & affiliated to Anna University offering engineering programs with about 2000 plus students.
- **Meenakshi Sundararajan School of Management(MSSM)** - established in 2000 & affiliated to University of Madras offering MBA programs with about 100 plus students.
- **The NEST School (TNS)**- established in 2022 offering IB (International Baccalaureate) & CAIE (Cambridge) boards.

All of the institutions have earned an enviable name and are rated as one among Top 10 colleges in the Tamil Nadu state in their respective programs. Efforts are on to make the campus carbon neutral in 2 years (end of 2025) by using our community of staff and students.

**Meenakshi Sundararajan Engineering College (MSEC)** was established by the IIET Society in 2001. MSEC is defined by two keywords “**Industry Ready**” & “**Vibrancy**”. Creating a new generation of self- actualized learners is our **raison d'etre**. If children are our future, then education is the key to their future. When education is shaped around them, and not the other way around, we are laying the foundation for a future/world where creativity, diversity and caring, independent-thinkers thrive. Our curricula thrive on continuous learning while interacting with and incorporating real-world situations and challenges.

## **MSEC's Hallmark of Quality**

- Affiliated to Anna University, Chennai
- Approved by AICTE, New Delhi
- Accredited by NBA for programs in:
  - Civil Engineering
  - Computer Science and Engineering
  - Electronics and Communication Engineering
  - Mechanical Engineering
  - Electrical and Electronics Engineering
  - Information Technology
- Accredited by NAAC with a prestigious "A" grade
- Declared under Section 2(f) and 12(B) of the UGC Act
- Conferred with Autonomous status for 10 years ( 2024-25 to 2033-34 ) by the University Grants Commission (UGC) on February 1, 2024
- Meenakshi Sundararajan Innovation and Incubation Centre ( MSIIC )
- Meenakshi Sundararajan Career Development Cell ( MSCDC )
- MSEC Research Centre ( MSEC RC )
- Center of Excellence – Industry Tie Up in Specialized Labs
- Industry MOU's – 200 Plus

## **Vision of the Institute**

To impart state-of-the-art technical education, including sterling values and shining character, producing engineers who contribute to nation building thereby achieving our ultimate objective of sustained development of an unparalleled society, nation and world at large.

## **Mission of the Institute**

Meenakshi Sundararajan Engineering college, Chennai constantly strives to be a Centre of Excellence with the singular aim of producing students of outstanding academic excellence and sterling character to benefit the society, our nation and the world at large.

To achieve this, the college ensures

- Continuous upgradation of its teaching faculty to ensure a high standard of quality education and to meet the ever-changing needs of the society
- Constant interaction with its stakeholders
- Linkage with other educational institutions and industries at the national and international level for mutual benefit
- Provision of research facilities and infrastructure in line with global trends
- Adequate opportunities and exposure to the students through suitable programs, to mould their character and to develop their personality with an emphasis on professional ethics and moral values.

### **We offer following courses:**

| <b>S.No</b>                                   | <b>Course</b>                                   | <b>Intake</b> |
|-----------------------------------------------|-------------------------------------------------|---------------|
| <b>Undergraduate courses in B.E / B. Tech</b> |                                                 |               |
| 01                                            | B.E Civil Engineering                           | 60            |
| 02                                            | B.E Computer Science and Engineering            | 120           |
| 03                                            | B.E Electronics and Communication Engineering   | 120           |
| 04                                            | B.E Electrical & Electronics Engineering        | 60            |
| 05                                            | B.E Mechanical Engineering                      | 60            |
| 06                                            | B. Tech Information Technology                  | 120           |
| 07                                            | B. Tech Artificial Intelligence & Data Sciences | 120           |
| <b>Postgraduate courses in M.E / M. Tech</b>  |                                                 |               |
| 08                                            | M.E. Construction Engineering and Management    | 18            |
| 09                                            | M.E. Computer Science and Engineering           | 18            |
| 10                                            | M.E. Embedded System Technologies               | 18            |
| 11                                            | M.E Energy Engineering                          | 18            |

### **DEPARTMENT OF HUMANITIES AND SCIENCE**

The H&S Department stands out for its commitment to providing a well-rounded academic experience for first-year students. Covering key subjects like Physics, Chemistry, Mathematics, English, and Tamil. The department boasts a high pass percentage in semester exams, a testament to the hard work and dedication of the faculty. This year, the department enhanced offerings with industry and alumni talks, foreign language courses, engaging games, and specialized coaching for AEP and ICS. Additionally, the department introduced an industry-oriented and department-specific syllabus to better prepare students for future challenges and opportunities

### **DEPARTMENT OF CIVIL ENGINEERING**

The Civil Engineering Department at our college, established in 2002, is a beacon of academic excellence and research innovation. Offering both undergraduate program and postgraduate program in M.E. Construction Engineering and Management, the department is committed to integrating advanced technologies and sustainable practices into its curriculum. The department boasts state-of-the-art laboratories and strong industry collaborations. Graduates of the department have made significant contributions to civil engineering, both nationally and internationally, and continue to shape the future of the discipline through unwavering commitment to excellence.



## **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**

The Department of Computer Science and Engineering was established in 2001. It has its mission to inculcate innovative thinking and analytical abilities in addition to imparting quality education in the theory and application of Computer Science and Engineering. The department offers UG and PG programmes with State-of-the-art Computer laboratories equipped with high end hardware and software packages provided with high-speed leased line connectivity. The department takes pride in its academic excellence and outstanding placement records. It has consistently produced 68 university rank holders till 2023 batch and accredited by National Board of Accreditation.

## **DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

The Electrical and Electronics Engineering Department, established in 2003, is expanding its offerings to M.E. program in Embedded System Technologies from the 2024-25 academic year. With a focus on knowledge - based training, the department faculty empowers students with a deep understanding of concepts and industry - ready skills. The department forged partnerships with 22 companies through MOUs, facilitating collaboration and knowledge exchange.

The Electrical Technocrats Association (ETA) is a vibrant platform for technical activities, including the publication and showcasing of newsletters by staff and students every fortnight. Our mission is to drive technological advancements, foster research, and address industry needs.

## **DEPARTMENT OF MECHANICAL ENGINEERING**

Meenakshi Sundararajan Engineering College inaugurated the Department of Mechanical Engineering in the academic year 2011-12. The department has well qualified faculties with excellent teaching, training and industrial experience. It has state-of-the-art laboratories which include VMC, CNC Wire Cut, Spark Erosion, 3D CMM etc catering to academic, consultancy and research requirements. The department's endeavor is to develop its students to be industry ready when they graduate. Students of mechanical engineering department gain industrial exposure and are prepared to face future challenges by carrying out their Final Year Project work in various PSU/Private sectors as per their field of interest relevant to their program. The department has a memorandum of understanding with various Institutions, Industries and Research organizations for collaborative research and development work. There is a huge potential in the department for Consultancy as well as Technology and Product incubation.

## **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**

The Department of Electronics and Communication Engineering, established in 2001, has grown significantly increasing its sanctioned intake from 60 to 120 in 2010. With NBA accreditation, the department is committed to delivering quality education, producing graduates who excel technically, socially, and professionally. Its state-of-the-art infrastructure, featuring ICT-enabled classrooms and advanced laboratories with cutting-edge tools like Cortex M4, Spartan 6, IoT kits, MATLAB, Cadence and PSPICE that supports academic excellence.

The Department's industry linkages with renowned organizations including ISRO, DRDO, NLTVC, and Ericson enhance students' technical skills through interactive events.

The Department's achievements include academic excellence, impressive placement records, and students' accomplishments in sports, arts, and culture, with alumni globally represented in top companies like Intel, Yahoo, and Apple.

## **DEPARTMENT OF INFORMATION TECHNOLOGY**

The department of Information Technology was started in the year 2001 with an intake of 60 students focusing on the area. The department has won laurels to to the college. The department constantly strives with the singular aim of producing students with outstanding academic excellence and sterling character to benefit the society, our nation and the world at large. The department's commitment to high academic standards and successful student placements. It has consistently produced 65 university rank holders till 2023 batch and accredited by National Board of accreditation. Campus Agreement has been signed with leading software and hardware giants like Microsoft, IBM, Adobe and HP. The department has received a certificate partnership as a "Center of Excellence" with Virtusa Technology.

## **DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

The Department of Artificial Intelligence & Data Science was established in 2021 with an initial intake of 60 students, which was subsequently increased to 120 in 2024. Our department boasts a team of highly qualified, experienced, and competent faculty members and features spacious infrastructure with modern amenities, including six well-equipped computer laboratories with backup and internet facilities. We emphasize continuous knowledge enrichment through seminars, guest lectures, workshops, and skill enhancement programs for both students and faculty, and engage in meticulous academic planning to ensure a well-structured approach to each semester. Additionally, our student-driven club, serves as an incubation center, nurturing innovative ideas and fostering creativity.

## **INTERNAL QUALITY ASSURANCE CELL (IQAC)**

MSEC established the Internal Quality Assurance Cell (IQAC) in 2016 to develop and implement quality standards and benchmarks in key performance areas. In alignment with the National Education Policy (NEP) 2020 and subsequent reforms, the IQAC has been further strengthened to ensure compliance with the new policy directives.

Through IQAC, the institute strive to:

- Maintain and enhance the quality of education and services
- Align with our institution's vision and mission
- Foster a culture of continuous improvement and excellence
- Ensure accountability and transparency in institutional functioning
- Promote innovative practices in teaching, learning, and research
- Develop and implement effective quality benchmarks and parameters
- Facilitate student-centered learning and feedback mechanisms
- Enhance faculty development and capacity building
- Strengthen industry-academia partnerships and collaborations
- Ensure efficient governance and administrative processes
- Promote a culture of sustainability and social responsibility
- Facilitate accreditation and ranking processes
- Identify and mitigate quality assurance risks

## **CONTROLLER OF EXAMINATION**

The institution, granted autonomous status by UGC and Anna University from the academic year 2024-2025, has established the Controller of Examinations (COE) office to oversee assessment processes with confidentiality, ensuring quality and standards. The COE conducts fair examinations, declares results, and manages examination activities for Internal Assessment Tests (IATs) and Semester End Examinations (SEE). Their yearly schedule includes planning, coordinating, conducting, evaluating, and reviewing exams, as well as issuing certificates and transcripts. The COE ensures smooth conduct, maintains exam integrity, and coordinates with stakeholders, adapting to the institution's specific needs and exam cycle.

## **MEENAKSHI SUNDARARAJAN RESEARCH CENTRE (MSRC)**

The MSEC Research Centre has a steadfast commitment to fostering a strong research culture. It empowers students and faculties in their intellectual exploration and discovery. The center aims to advance knowledge, drive neoteric innovation, and contribute to the broader academic and industrial fraternity ultimately aimed at uplifting humankind.

## **THE MEENAKSHI SUNDARARAJAN CAREER DEVELOPMENT COMMITTEE (MSCDC)**

The Meenakshi Sundararajan Career Development Committee (MSCDC) is a strategic group dedicated to fostering students' professional growth and development. Our mission is to support students in achieving their career goals, fostering a culture of professional growth and development.

The MSCDC plays a vital role in aligning individual career goals through various initiatives, including:

1. Career Pathways
2. Specialised Expert Talk & Guidance on Different Career Pathways
3. Higher Education – Awareness Sessions on various Geographical Locations
4. University Fairs
5. Training / Coaching Programs for different Competitive Exams
6. Repository / Text Books for various Competitive Exams

By providing a career pathway, we help students understand the opportunities available to them and what is required to achieve their career goals. We encourage students as they navigate their professional journey, providing them with the tools, knowledge, and opportunities needed for successful career development.

## **OFFICE OF STUDENTS AFFAIRS**

Our mission is to create a supportive and inclusive educational environment that empowers students to succeed in their academic, personal, and professional lives. We achieve this by:

- Providing individualized support and responding to student needs
- Fostering a culture of academic integrity and excellence
- Promoting personal hygiene, cleanliness, discipline and sprucing
- Encouraging a moral code of conduct and respect for others
- Cultivating a sense of campus decency and decorum
- Modeling exemplary behavior and attitudes

By fulfilling these responsibilities, the institution aims to inspire students to become responsible, successful, and compassionate individuals who make a positive impact in their communities.

## **COLLEGE COUNSELING SERVICES**

College counseling services are essential in supporting students' overall well-being and academic success. These services often encompass various areas, including healthy mind well-being, career guidance, and academic counseling. Here's a breakdown of the typical counseling services available for college students in the institution:



**Individual Counseling:** One-on-one sessions with RCI registered counselors or psychologists to address personal issues such as stress, anxiety, depression, relationship problems, and any other psychological concerns.

**Group Counseling:** Support groups where students with similar issues can share experiences and strategies for coping in a safe and supportive environment.

**Crisis Intervention:** Immediate support for students in distress, trauma response, and any emergency psychological concerns.

## **TRAINING AND PLACEMENT CELL**

Meenakshi Sundararajan Engineering College training and placement cell is committed to providing exceptional placement opportunities for its students. The Placement Cell takes meticulous efforts to ensure that students are recruited by top-notch companies in the industry.

The training pathway is established starting from the first semester with 180 Hours of Placement training which includes Communications Skills, Aptitude Training, Specialised Programming, Guidance on Certifications, Projects, Competitions, Grooming, Etiquette, Group Discussion and Mock Interviews.

The Placement Cell functions under the leadership of Placement Officer, Faculty representatives and Coordinators from each department. The Cell's ultimate aim is to achieve 100% placement. Its Other Functions include

1. Implementation of the training pathway at appropriate semesters
2. Industry Talks
3. Alumni Talks
4. Arranging Internships & Projects
5. Centers of Excellence with Industry
6. Industry Specialised training & guidance

This comprehensive training empowers students to face the campus interviews with confidence through enhancing their employability skills for a successful future.

## **DEPARTMENT OF PHYSICAL EDUCATION**

Our college campus boasts an array of sports facilities, including

- Basketball Court
- Badminton Court
- Pickle Ball Court
- Volleyball
- Cricket / Foot Ball / Athletics Ground
- Tennis Court
- Kho Kho

The institution is much dedicated in nurturing the talent through specific college sports teams :

- Expert coaching and mentorship
- Formation of new sports teams
- Dedicated Sports Hour (1 hour/week)
- Regular Sports Day events - that are meticulously planned for maximum student participation.

## **DEPARTMENT OF SAFETY AND SECURITY**

MSEC's Safety Department include the Chief Security Officer (Retd. Lt. Col), Trained & Certified Safety Officers (18) and Chief Safety Officer.

The department ensures a secure and hazard-free environment within the campus through:

- Monitoring all areas of the campus to ensure a secure environment
- Conducting daily reviews and maintaining a register to track and address any safety issues
- Performing maintenance tasks such as securing compound walls, replacing damaged fencing, and ensuring proper drainage
- Educating the community through regular safety awareness programs and training sessions
- Organizing fire drills and evacuation procedures to prepare for emergencies
- Identifying and mitigating potential hazards to prevent accidents
- Developing and implementing comprehensive safety policies to guide the community
- Continuously monitoring CCTV cameras to quickly respond to any security incidents

The department's proactive approach helps to prevent accidents, minimizes risks, and fosters a culture of safety among students, staff, and faculty members.

## **MEENAKSHI SUNDARARAJAN INNOVATION AND INCUBATION CENTRE (MSIIC)**

Meenakshi Sundararajan Innovation and Incubation Centre (MSIIC) is a dynamic and forward-thinking organization dedicated to fostering innovation, entrepreneurship, and skill development etc. Our center serves as a catalyst for a transformative change - providing aspiring entrepreneurs with the resources, mentorship, and support that is needed to turn their ideas into successful ventures. MSIIC is dedicated to promoting entrepreneurship and an innovative mindset among students and entrepreneurs at institutions. Through mentorship MSIIC helps to develop talents and support their initiatives, provide knowledge on market access and funding, and empower individuals to identify opportunities, take risks, and create positive change. The institution solely believes in entrepreneurship as a catalyst for innovation and societal impact, providing resources and a supportive environment for individuals to thrive and make a difference in their communities and beyond. Its activities include

1. Managing the 100 Seat Innovation & Incubation Center
2. Guidance to both Internal & External Start-ups from Ideation to Funding
3. Competitions – Identification & Mentoring
4. Conducting Competitions :- 30 Hour Hackathons, All India Hackathons etc.
5. Managing Student Clubs
6. Art & Music Festival
7. Skill Development / Value Added Courses
8. Societal Beneficial Projects

## **MSEC STUDENTS CLUBS**

MSEC Students Clubs were initiated with the objective to provide a platform for students to discover, showcase and improve their interests, strengths and passion. There are 7 clubs in our college namely, AI Epoch Club, Eco Design Club, Adyant Coding Club, Renewables Club, Nodenova IOT Club, Dev Dynasty Web App Development Club and Product Development Club. Clubs foster vibrant student community in the campus by conducting variety of events and activities which include workshops, seminars, technical and non-technical events, campus benefit projects, long term projects such as SAE Baja etc that cater to diverse interests. Clubs help the students to collaborate with different disciplines and exchange knowledge with peer groups.





**Meenakshi Sundararajan Engineering College**  
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Department: Electrical and Electronics Engineering, R2024, CBCS

Curriculum for I to VIII Semesters

**SEMESTER I**

| S. NO.                            | COURSE CODE | COURSE TITLE                                                | CATEGORY | TCP        | PERIODS PER WEEK |          |           | CREDITS     |
|-----------------------------------|-------------|-------------------------------------------------------------|----------|------------|------------------|----------|-----------|-------------|
|                                   |             |                                                             |          |            | L                | T        | P         |             |
|                                   | U24IP101    | Induction Program- Universal Human values                   |          |            |                  |          |           |             |
| <b>THEORY</b>                     |             |                                                             |          |            |                  |          |           |             |
| 1                                 | U24EN101    | Technical English                                           | HSMC     | 30         | 2                | 0        | 0         | 2           |
| 2                                 | U24MA101    | Mathematical Foundation for Engineers                       | BSC      | 60         | 3                | 1        | 0         | 4           |
| 3                                 | U24PH104    | Physics for Electrical Engineering - I                      | BSC      | 45         | 3                | 0        | 0         | 3           |
| 4                                 | U24CY103    | Chemistry for Electrical and Electronics Engineering        | BSC      | 45         | 3                | 0        | 0         | 3           |
| 5                                 | U24TA101    | தமிழர் மரபு / Heritage of Tamils                            | HSMC     | 15         | 1                | 0        | 0         | 1           |
| 6                                 | U24ME104    | Basic Civil and Mechanical Engineering                      | ESC      | 45         | 3                | 0        | 0         | 3           |
| <b>THEORY CUM PRACTICAL (TCP)</b> |             |                                                             |          |            |                  |          |           |             |
| 7                                 | U24CS101    | Programming in C                                            | ESC      | 90         | 2                | 0        | 4         | 4           |
| <b>PRACTICAL</b>                  |             |                                                             |          |            |                  |          |           |             |
| 9                                 | U24BS101    | Physics and Chemistry Laboratory                            | BSC      | 60         | 0                | 0        | 4         | 2           |
| 10                                | U24TP110    | Communication Skills Laboratory-I                           | HSMC     | 30         | 0                | 0        | 2         | 1           |
| 11                                | U24ED111    | Design Thinking - Building Innovation & Solutioning Mindset | EDIC     | 15         | 0                | 0        | 1         | 0.5         |
| <b>TOTAL</b>                      |             |                                                             |          | <b>435</b> | <b>17</b>        | <b>1</b> | <b>11</b> | <b>23.5</b> |





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**SEMESTER II**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                                    | CATEGORY | TCP        | PERIODS PER WEEK |          |           | CREDITS   |
|-----------------------------|-------------|-----------------------------------------------------------------|----------|------------|------------------|----------|-----------|-----------|
|                             |             |                                                                 |          |            | L                | T        | P         |           |
|                             | U24IP201    | Value Added Course – II<br>(Biology for Engineers)              | VAC      | 30         |                  |          |           |           |
| <b>THEORY</b>               |             |                                                                 |          |            |                  |          |           |           |
| 1                           | U24EN201    | Professional English                                            | HSMC     | 30         | 2                | 0        | 0         | 2         |
| 2                           | U24MA204    | Mathematics for Electrical Engineering                          | BSC      | 60         | 3                | 1        | 0         | 4         |
| 3                           | U24TA201    | தமிழரும் தொழில்நுட்பமும்<br>Tamil and Technology                | HSMC     | 15         | 1                | 0        | 0         | 1         |
| 4                           | U24PH204    | Physics for Electrical Engineering -II                          | BSC      | 45         | 3                | 0        | 0         | 3         |
| 5                           | U24CY201    | Green and Sustainable Chemistry                                 | BSC      | 30         | 2                | 0        | 0         | 2         |
| <b>THEORY CUM PRACTICAL</b> |             |                                                                 |          |            |                  |          |           |           |
| 6                           | U24CS201    | Python Programming                                              | ESC      | 90         | 3                | 0        | 3         | 4.5       |
| 7                           | U24CE204    | Engineering Graphics for Electrical and Electronics Engineering | ESC      | 75         | 3                | 0        | 2         | 4         |
| <b>PRACTICAL</b>            |             |                                                                 |          |            |                  |          |           |           |
| 8                           | U24ME101    | Engineering Practices Laboratory                                | ESC      | 60         | 0                | 0        | 4         | 2         |
| 9                           | U24TP210    | Communication Skills Laboratory-II                              | HSMC     | 30         | 0                | 0        | 2         | 1         |
| 10                          | U24ED211    | Design Thinking - Decoding Innovation Opportunity               | EDIC     | 15         | 0                | 0        | 1         | 0.5       |
| <b>TOTAL</b>                |             |                                                                 |          | <b>450</b> | <b>17</b>        | <b>1</b> | <b>12</b> | <b>24</b> |



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**SEMESTER III**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                  | CATEGORY | TCP        | PERIODS PER WEEK |          |           | CREDITS     |
|-----------------------------|-------------|-----------------------------------------------|----------|------------|------------------|----------|-----------|-------------|
|                             |             |                                               |          |            | L                | T        | P         |             |
|                             |             | VAC                                           |          | 30         |                  |          |           |             |
| <b>THEORY</b>               |             |                                               |          |            |                  |          |           |             |
| 1                           | U24MA304    | Transforms and Partial Differential Equations | BSC      | 60         | 3                | 1        | 0         | 4           |
| 2                           | U24EE301    | Electrical Machines -I                        | PCC      | 45         | 3                | 0        | 0         | 3           |
| 3                           | U24MC313    | Foreign Language (Japanese/French)            | MC#      | 30         | 2                | 0        | 0         | 0           |
| <b>THEORY CUM PRACTICAL</b> |             |                                               |          |            |                  |          |           |             |
| 4                           | U24EE302    | Electron Devices and Circuit                  | PCC      | 90         | 3                | 0        | 3         | 4.5         |
| 5                           | U24CS308    | Data Structure                                | PCC      | 75         | 3                | 0        | 2         | 4           |
| 6                           | U24EE303    | Circuit Analysis                              | PCC      | 90         | 3                | 0        | 3         | 4.5         |
| <b>PRACTICAL</b>            |             |                                               |          |            |                  |          |           |             |
| 7                           | U24EE304    | Electrical Machines -I Laboratory             | PCC      | 45         | 0                | 0        | 3         | 1.5         |
| 8                           | U24TP310    | General Aptitude & Logical Reasoning          | EEC      | 30         | 0                | 0        | 2         | 1           |
| 9                           | U24ED311    | Innovation Tool Kits                          | EDIC     | 15         | 0                | 0        | 1         | 0.5         |
| 10                          | U24RM312    | Introduction to Problem Solving               | RMC      | 15         | 0                | 0        | 1         | 0.5         |
| <b>TOTAL</b>                |             |                                               |          | <b>480</b> | <b>17</b>        | <b>1</b> | <b>15</b> | <b>23.5</b> |

#Mandatory Course is a Non-credit Course.



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**SEMESTER IV**

| SL. NO.                     | COURSE CODE | COURSE TITLE                          | CATEGORY | TCP | PERIODS PER WEEK |   |    | CREDITS |
|-----------------------------|-------------|---------------------------------------|----------|-----|------------------|---|----|---------|
|                             |             |                                       |          |     | L                | T | P  |         |
|                             |             | VAC                                   |          | 30  |                  |   |    |         |
| <b>THEORY</b>               |             |                                       |          |     |                  |   |    |         |
| 1                           | U24MA402    | Linear Algebra and Numerical Methods  | PCC      | 60  | 3                | 1 | 0  | 4       |
| 2                           | U24EE401    | Electromagnetic Theory                | PCC      | 45  | 3                | 0 | 0  | 3       |
| 3                           | U24EE402    | Digital Logic Circuits                | PCC      | 45  | 3                | 0 | 0  | 3       |
| 4                           | U24EE403    | Electrical Machines - II              | PCC      | 45  | 3                | 0 | 0  | 3       |
| 5                           | U24MC413    | Indological studies                   | MC#      | 30  | 2                | 0 | 0  | 0       |
| <b>THEORY CUM PRACTICAL</b> |             |                                       |          |     |                  |   |    |         |
| 6                           | U24EE404    | Integrated Circuits                   | PCC      | 90  | 3                | 0 | 3  | 4.5     |
| <b>PRACTICAL</b>            |             |                                       |          |     |                  |   |    |         |
| 7                           | U24EE405    | Electrical Machines - II laboratory   | PCC      | 45  | 0                | 0 | 3  | 1.5     |
| 8                           | U24TP410    | Critical and Creative Thinking Skills | EEC      | 30  | 0                | 0 | 2  | 1       |
| 9                           | U24ED411    | Idea and Simulation Lab               | EDIC     | 15  | 0                | 0 | 1  | 0.5     |
| 10                          | U24RM412    | Hypothesis                            | RMC      | 15  | 0                | 0 | 1  | 0.5     |
| <b>TOTAL</b>                |             |                                       |          | 420 | 17               | 1 | 10 | 21      |

#Mandatory Course is a Non-credit Course.



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**SEMESTER V**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                        | CATEGORY | TCP        | PERIODS PER WEEK |          |           | CREDITS     |
|-----------------------------|-------------|-----------------------------------------------------|----------|------------|------------------|----------|-----------|-------------|
|                             |             |                                                     |          |            | L                | T        | P         |             |
|                             |             | VAC                                                 |          | 30         |                  |          |           |             |
| <b>THEORY</b>               |             |                                                     |          |            |                  |          |           |             |
| 1                           | U24EE501    | Transmission and Distribution                       | PCC      | 45         | 3                | 0        | 0         | 3           |
| 2                           | U24EE502    | Measurements and Instrumentation                    | PCC      | 45         | 3                | 0        | 0         | 3           |
| 3                           |             | Professional Elective I                             | PEC      | 45         | 3                | 0        | 0         | 3           |
| 4                           |             | Professional Elective II                            | PEC      | 45         | 3                | 0        | 0         | 3           |
| <b>THEORY CUM PRACTICAL</b> |             |                                                     |          |            |                  |          |           |             |
| 5                           | U24EE503    | Microprocessor and Microcontroller                  | PCC      | 75         | 3                | 0        | 2         | 4           |
| 6                           | U24EE504    | Control Systems                                     | PCC      | 75         | 3                | 0        | 2         | 4           |
| <b>PRACTICAL</b>            |             |                                                     |          |            |                  |          |           |             |
| 7                           | U24TP510    | Analytical and Logical Thinking Skills              | EEC      | 30         | 0                | 0        | 2         | 1           |
| 8                           | U24EE505    | Summer Internship*                                  | EEC      |            |                  |          |           | 1           |
| 9                           | U24RM512    | Domain Specific Experiments /Methodology/Algorithms | RMC      | 30         | 0                | 0        | 2         | 1           |
| 10                          | U24MC513    | Fitness for Life-Yoga, Food nutrition               | MC#      | 30         | 0                | 0        | 2         | 0           |
| 11                          | U24ED511    | Prototype & Market Validation                       | EDIC     | 15         | 0                | 0        | 1         | 0.5         |
| <b>TOTAL</b>                |             |                                                     |          | <b>435</b> | <b>18</b>        | <b>0</b> | <b>11</b> | <b>23.5</b> |

\*Two weeks Summer Internship carries one credit and it will be done during IV semester summer vacation and same will be evaluated in V semester.

#Mandatory Course is a Non-credit Course.





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**SEMESTER VI**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                        | CATEGORY | TCP        | PERIODS PER WEEK |          |          | CREDITS   |
|-----------------------------|-------------|-----------------------------------------------------|----------|------------|------------------|----------|----------|-----------|
|                             |             |                                                     |          |            | L                | T        | P        |           |
|                             |             | VAC                                                 |          | 30         |                  |          |          |           |
| <b>THEORY</b>               |             |                                                     |          |            |                  |          |          |           |
| 1                           | U24EE601    | Power System Analysis                               | PCC      | 45         | 3                | 0        | 0        | 3         |
| 2                           | U24EE602    | Discrete Time System and Signal Processing          | PCC      | 45         | 3                | 0        | 0        | 3         |
| 3                           |             | Open Elective I                                     | OEC      | 45         | 3                | 0        | 0        | 3         |
| 4                           |             | Professional Elective III                           | PEC      | 45         | 3                | 0        | 0        | 3         |
| 5                           |             | Professional Elective IV                            | PEC      | 45         | 3                | 0        | 0        | 3         |
| 6                           | U24MC613    | Integrated Disaster Management                      | MC#      | 30         | 2                | 0        | 0        | 0         |
| <b>THEORY CUM PRACTICAL</b> |             |                                                     |          |            |                  |          |          |           |
| 7                           | U24EE603    | Power Electronics                                   | PCC      | 75         | 3                | 0        | 2        | 4         |
| <b>PRACTICAL</b>            |             |                                                     |          |            |                  |          |          |           |
| 8                           | U24RM612    | Data Collection, Analysis And Interpretation        | RMC      | 15         | 0                | 0        | 1        | 0.5       |
| 9                           | U24TP610    | Employability Skills & Problem Solving Techniques   | EEC      | 30         | 0                | 0        | 2        | 1         |
| 10                          | U24ED611    | Business Management-Go to Market & Start-up Journey | EDIC     | 15         | 0                | 0        | 1        | 0.5       |
| <b>TOTAL</b>                |             |                                                     |          | <b>405</b> | <b>20</b>        | <b>0</b> | <b>6</b> | <b>21</b> |

#Mandatory Course is a Non-credit Course.



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**SEMESTER VII**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                 | CATEGORY | TCP        | PERIODS PER WEEK |          |          | CREDITS     |
|-----------------------------|-------------|----------------------------------------------|----------|------------|------------------|----------|----------|-------------|
|                             |             |                                              |          |            | L                | T        | P        |             |
|                             |             | VAC                                          |          | 30         |                  |          |          |             |
| <b>THEORY</b>               |             |                                              |          |            |                  |          |          |             |
| 1                           | U24MG701    | Engineering Economics and Finance Management | HSMC     | 45         | 3                | 0        | 0        | 3           |
| 2                           |             | Open Elective II                             | OEC      | 45         | 3                | 0        | 0        | 3           |
| 3                           |             | Open Elective III                            | OEC      | 45         | 3                | 0        | 0        | 3           |
| 4                           |             | Professional Elective V                      | PEC      | 45         | 3                | 0        | 0        | 3           |
| 5                           |             | Professional Elective VI                     | PEC      | 45         | 3                | 0        | 0        | 3           |
| 6                           | U24MC713    | Constitution Of India                        | MC       | 30         | 2                | 0        | 0        | 0           |
| <b>THEORY CUM PRACTICAL</b> |             |                                              |          |            |                  |          |          |             |
| 7                           | U24EE701    | Renewable Energy Systems                     | PCC      | 75         | 3                | 0        | 2        | 4           |
| 8                           | U24EE702    | Power System Operation and Control           | PCC      | 75         | 3                | 0        | 2        | 4           |
| <b>PRACTICAL</b>            |             |                                              |          |            |                  |          |          |             |
| 9                           | U24EE703    | Summer Internship*                           | EEC      |            |                  |          |          | 1           |
| 10                          | U24RM712    | Testing                                      | RMC      | 15         | 0                | 0        | 1        | 0.5         |
| <b>TOTAL</b>                |             |                                              |          | <b>420</b> | <b>23</b>        | <b>0</b> | <b>5</b> | <b>24.5</b> |

**\*Two weeks Summer Internship carries one credit and it will be done during VI semester summer vacation and same will be evaluated in VII semester.**



| SL. NO.       | COURSE CODE | COURSE TITLE | CATEGORY | TCP | PERIODS PER WEEK |   |    | CREDITS |
|---------------|-------------|--------------|----------|-----|------------------|---|----|---------|
|               |             |              |          |     | L                | T | P  |         |
|               |             | VAC          |          | 30  |                  |   |    |         |
| PRACTICAL     |             |              |          |     |                  |   |    |         |
| 1             | U24EE801    | Project Work | EEC      | 240 | 0                | 0 | 16 | 8       |
| TOTAL         |             |              |          | 240 | 0                | 0 | 16 | 8       |
| OVERALL TOTAL |             |              |          |     |                  |   |    | 169     |



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**PROFESSIONAL EELCTIVE COURSES : VERTICALS**

**VERTICAL I : POWER ENGINEERING**

| SI. NO. | COURSE CODE | COURSE TITLE                                  | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|-----------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                               |          |     | L                | T | P |         |
| 1       | U24EEP11    | UTILISATION & CONVERSION OF ELECTRICAL ENERGY | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP12    | HVDC & FACTS                                  | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP13    | APPLICATION OF AI TECHNIQUES TO POWER SYSTEMS | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP14    | POWER QUALITY                                 | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP15    | SMART GRID                                    | PEC      | 3   | 3                | 0 | 0 | 3       |
| 6       | U24EEP16    | POWER SYSTEM TRANSIENTS                       | PEC      | 3   | 3                | 0 | 0 | 3       |



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**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

**VERTICAL II : CONVERTERS AND DRIVES**

| SI. NO. | COURSE CODE | COURSE TITLE                                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                |          |     | L                | T | P |         |
| 1       | U24EEP21    | ANALYSIS OF ELECTRICAL MACHINES                | PEC      | 4   | 2                | 0 | 2 | 3       |
| 2       | U24EEP22    | SPECIAL ELECTRICAL MACHINES                    | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP23    | MULTILEVEL POWER CONVERTER CIRCUITS            | PEC      | 4   | 2                | 0 | 2 | 3       |
| 4       | U24EEP24    | ELECTRICAL DRIVES                              | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP25    | POWER ELECTRONICS FOR RENEWABLE ENERGY SOURCES | PEC      | 4   | 2                | 0 | 2 | 3       |
| 6       | U24EEP26    | CONTROL OF POWER ELECTRONIC CIRCUITS           | PEC      | 4   | 2                | 0 | 2 | 3       |





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**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

**VERTICAL III : EMBEDDED SYSTEMS**

| SI. NO. | COURSE CODE | COURSE TITLE                                | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|---------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                             |          |     | L                | T | P |         |
| 1       | U24EEP31    | EMBEDDED SYSTEM DESIGN                      | PEC      | 4   | 2                | 0 | 2 | 3       |
| 2       | U24EEP32    | EMBEDDED C PROGRAMMING                      | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP33    | EMBEDDED PROCESSORS                         | PEC      | 4   | 2                | 0 | 2 | 3       |
| 4       | U24EEP34    | EMBEDDED CONTROL FOR ELECTRIC DRIVES        | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP35    | SMART SYSTEM AUTOMATION                     | PEC      | 4   | 2                | 0 | 2 | 3       |
| 6       | U24EEP36    | EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS | PEC      | 4   | 2                | 0 | 2 | 3       |



**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY**

| SI. NO. | COURSE CODE | COURSE TITLE                                             | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|----------------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                          |          |     | L                | T | P |         |
| 1       | U24EEP41    | Electric Vehicle Architecture                            | PEC      | 3   | 2                | 0 | 2 | 3       |
| 2       | U24EEP42    | Electric Vehicle Design, Mechanics & Control             | PEC      | 3   | 2                | 0 | 2 | 3       |
| 3       | U24EEP43    | Design Of Electric Vehicle Charging System               | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP44    | Testing Of Electric Vehicle                              | PEC      | 3   | 2                | 0 | 2 | 3       |
| 5       | U24EEP45    | Grid Integration of Electric Vehicles                    | PEC      | 3   | 3                | 0 | 0 | 3       |
| 6       | U24EEP46    | Design Of Motor & Power Converters for Electric Vehicles | PEC      | 3   | 2                | 0 | 2 | 3       |
| 7       | U24EEP47    | Electric & Hybrid Vehicles                               | PEC      | 3   | 3                | 0 | 0 | 3       |



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**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL V: ADVANCED CONTROL & INDUSTRIAL AUTOMATION**

| Sl. NO. | COURSE CODE | COURSE TITLE                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|--------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                |          |     | L                | T | P |         |
| 1       | U24EEP51    | Process Modelling & Simulation | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP52    | Computer Control of Processes  | PEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EEP53    | System Identification          | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP54    | Model Based Control            | PEC      | 3   | 3                | 0 | 0 | 3       |
| 5       | U24EEP55    | PLC Programming                | PEC      | 3   | 2                | 0 | 2 | 3       |
| 6       | U24EEP56    | Adaptive Control               | PEC      | 3   | 3                | 0 | 0 | 3       |
| 7       | U24EEP57    | Robotics & Automation          | PEC      | 3   | 3                | 0 | 0 | 3       |



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**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL VI: ENERGY ENGINEERING**

| Sl. NO. | COURSE CODE | COURSE TITLE                                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                |          |     | L                | T | P |         |
| 1       | U24EEP61    | Energy Storage Systems                         | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP62    | Hybrid Energy Technology                       | PEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EEP63    | Design & Modelling of Renewable Energy Systems | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP64    | Grid integrating Techniques & Challenges       | PEC      | 3   | 2                | 0 | 2 | 3       |
| 5       | U24EEP65    | Battery Management System                      | PEC      | 3   | 3                | 0 | 0 | 3       |
| 6       | U24EEP66    | Energy Management & Auditing                   | PEC      | 3   | 3                | 0 | 0 | 3       |



# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

## OPEN ELECTIVE COURSES

| SI. NO. | COURSE CODE | COURSE TITLE                       | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                    |          |     | L                | T | P |         |
| 1       | U24EE011    | INTRODUCTION TO CONTROL SYSTEMS    | OEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EE012    | INTRODUCTION TO PLC PROGRAMMING    | OEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EE021    | ENERGY CONSERVATION AND MANAGEMENT | OEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EE022    | ELECTRIC VEHICLE TECHNOLOGY        | OEC      | 3   | 3                | 0 | 0 | 3       |
| 5       | U24EE031    | ENERGY AUDITING & CONSERVATION     | OEC      | 3   | 3                | 0 | 0 | 3       |



**Meenakshi Sundararajan Engineering College**  
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**EDIC – Entrepreneurial Development and Innovation Courses**

| SL. No. | COURSE CODE | COURSE TITLE                                                  | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|---------------------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                               |          |     | L                | T | P |         |
| 1       | U24ED111    | Design Thinking - Building Innovation and Solutioning Mindset | EDIC     | 15  | 0                | 0 | 1 | 0.5     |
| 2       | U24ED211    | Design Thinking - Decoding Innovation Opportunity             | EDIC     | 15  | 0                | 0 | 1 | 0.5     |
| 3       | U24ED311    | Innovation tool kits                                          | EDIC     | 15  | 0                | 0 | 1 | 0.5     |
| 4       | U24ED411    | Idea & simulation lab                                         | EDIC     | 15  | 0                | 0 | 1 | 0.5     |
| 5       | U24ED511    | Prototype and Market Validation                               | EDIC     | 15  | 0                | 0 | 1 | 0.5     |
| 6       | U24ED611    | Business Management - Go To Market & Start-up Journey         | EDIC     | 15  | 0                | 0 | 1 | 0.5     |

**Placement Training by EduTech**

| SL. No. | COURSE CODE | COURSE TITLE                                      | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|---------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                   |          |     | L                | T | P |         |
| 1       | U24TP110    | Communication Skills Laboratory-II Laboratory-I   | HSMC     | 30  | 0                | 0 | 2 | 1       |
| 2       | U24TP210    | Communication Skills Laboratory-II                | HSMC     | 30  | 0                | 0 | 2 | 1       |
| 3       | U24TP310    | General Aptitude & Logical Reasoning              | EEC      | 30  | 0                | 0 | 2 | 1       |
| 4       | U24TP410    | Critical and Creative Thinking Skills             | EEC      | 30  | 0                | 0 | 2 | 1       |
| 5       | U24TP510    | Analytical and Logical Thinking Skills            | EEC      | 30  | 0                | 0 | 2 | 1       |
| 6       | U24TP610    | Employability Skills & Problem Solving Techniques | EEC      | 30  | 0                | 0 | 2 | 1       |





**Meenakshi Sundararajan Engineering College**  
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**RMC – Research Methodology Courses**

| SL. No. | COURSE CODE | COURSE TITLE                                        | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|-----------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                     |          |     | L                | T | P |         |
| 1       | U24RM312    | Introduction to Problem Solving                     | RMC      | 15  | 0                | 0 | 1 | 0.5     |
| 2       | U24RM412    | Hypothesis                                          | RMC      | 15  | 0                | 0 | 1 | 0.5     |
| 3       | U24RM512    | Domain Specific Experiments/ Methodology/Algorithms | RMC      | 30  | 0                | 0 | 2 | 1       |
| 4       | U24RM612    | Data Collection, Analysis and Interpretation        | RMC      | 15  | 0                | 0 | 1 | 0.5     |
| 5       | U24RM712    | Technical Writing and Research Ethics               | RMC      | 15  | 0                | 0 | 1 | 0.5     |



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**CATEGORY OF COURSES AND CREDIT DISTRIBUTION**

| S. No.       | Subject Area | Credits per Semester |      |      |     |     |      |      |   | Total Credits |
|--------------|--------------|----------------------|------|------|-----|-----|------|------|---|---------------|
|              |              | 1                    | 2    | 3    | 4   | 5   | 6    | 7    | 8 |               |
| 1            | HSMC         | 4                    | 4    | 0    | 0   | 0   | 0    | 3    | 0 | 11            |
| 2            | BSC          | 12                   | 9    | 4    | 0   | 0   | 0    | 0    | 0 | 25            |
| 3            | ESC          | 7                    | 10.5 | 0    | 0   | 0   | 0    | 0    | 0 | 17.5          |
| 4            | PCC          | 0                    | 0    | 17.5 | 19  | 14  | 10   | 8    | 0 | 68.5          |
| 5            | PEC          | 0                    | 0    | 0    | 0   | 6   | 6    | 6    | 0 | 18            |
| 6            | OEC          | 0                    | 0    | 0    | 0   | 0   | 3    | 6    | 0 | 9             |
| 7            | EEC          | 0                    | 0    | 1    | 1   | 2   | 1    | 1    | 8 | 14            |
| 8            | MC           |                      |      | √    | √   | √   | √    | √    |   | 0             |
| 9            | EDIC         | 0.5                  | 0.5  | 0.5  | 0.5 | 0.5 | 0.5  |      |   | 3             |
| 10           | RMC          |                      |      | 0.5  | 0.5 | 0.5 | 1    | 0.5  |   | 3             |
| <b>Total</b> |              | 23.5                 | 24   | 23.5 | 21  | 23  | 21.5 | 24.5 | 8 | <b>169</b>    |

**HSMC** - Humanities, Social Sciences and Management Courses

**BSC** - Basic Sciences Courses

**ESC** - Engineering Sciences Courses

**PCC** - Professional Core Courses

**PEC** - Professional Elective Courses

**OEC** - Open Elective Courses

**EEC** - Employability Enhancement Courses

**MC** - Mandatory Courses / Non-Credit

**EDIC** - Entrepreneurial Development and Innovation Courses

**RMC** - Research Methodology Courses



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|                                                                                                                                                                                                                                                                                                                                                                  |                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>U24IP101</b>                                                                                                                                                                                                                                                                                                                                                  | <b>INDUCTION PROGRAMME</b>                                  |
| <b>Modules</b>                                                                                                                                                                                                                                                                                                                                                   |                                                             |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Universal Human Values I (UHV I)</b>                     |
| To help the student to see the need for developing a holistic perspective of life.                                                                                                                                                                                                                                                                               |                                                             |
| To sensitize the student about the scope of life – individual, family (interpersonal relationship), society and nature/existence.                                                                                                                                                                                                                                |                                                             |
| Strengthening self-reflection.                                                                                                                                                                                                                                                                                                                                   |                                                             |
| To develop more confidence and commitment to understand, learn and act accordingly.                                                                                                                                                                                                                                                                              |                                                             |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Physical Health and Related Activities</b>               |
| To understand the basic principles to remain healthy and fit.                                                                                                                                                                                                                                                                                                    |                                                             |
| To practice them through exercise, games etc.                                                                                                                                                                                                                                                                                                                    |                                                             |
| Involving health center, staff, sports coaches, faculty, staff, students sports team etc.                                                                                                                                                                                                                                                                        |                                                             |
| <b>3</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Familiarization of Department/ Branch and Innovation</b> |
| To get a broad perspective about goals of institution, department/branch in the context of the world, the nation, the state, and region.                                                                                                                                                                                                                         |                                                             |
| To get an idea of how the institution operates to fulfill its goals through various disciplines of education, research, development, and practice.                                                                                                                                                                                                               |                                                             |
| To get an idea of how students can connect /participate in it.                                                                                                                                                                                                                                                                                                   |                                                             |
| <b>4</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Visit to a Local Area</b>                                |
| For a student to relate to the social environment of the educational institution as well as the surroundings, a place wherein their most significant years students will scribble some indelible memories, an absolute necessity is generated for city visits to let students understand the environment through interaction with the people, place and history. |                                                             |
| <b>5</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Lectures by Eminent People</b>                           |
| Guest lectures are a great way to help the students gain a perspective on many different things in the world. Eminent personalities in different fields of expertise like academics, sports, industry, business etc. can share their story and talk about important subjects like career, entrepreneurship, government policies and technology                   |                                                             |
| <b>6</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Proficiency Modules</b>                                  |
| This module is to help fill the gaps in basic competency required for further inputs to be absorbed. It includes efforts to make the student proficient in interpersonal communication and expression.                                                                                                                                                           |                                                             |
| <b>7</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Literature / Literary Activities</b>                     |
| To develop the clarity of humanistic culture and its expression through literature, students may be exposed to local, regional, national, or international literature. It will help them in understanding traditional and contemporary values and thought.                                                                                                       |                                                             |
| <b>8</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Creative Practices</b>                                   |
| This module is to help develop the clarity of humanistic culture and its creative, joyful expression. The students can choose one skill related to visual arts or performing arts.                                                                                                                                                                               |                                                             |
| <b>9</b>                                                                                                                                                                                                                                                                                                                                                         | <b>Extra-Curricular Activities</b>                          |
| Wellness Sessions                                                                                                                                                                                                                                                                                                                                                |                                                             |
| <b>10</b>                                                                                                                                                                                                                                                                                                                                                        | <b>Extra Activities</b>                                     |
| Anti-Ragging Briefing                                                                                                                                                                                                                                                                                                                                            |                                                             |
| Informal Interactions                                                                                                                                                                                                                                                                                                                                            |                                                             |
| Club / Council / Committee/ Scholarship Briefings                                                                                                                                                                                                                                                                                                                |                                                             |



**Meenakshi Sundararajan Engineering College**  
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 Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EN101                                                                                                                                                                                                                                                               | TECHNICAL ENGLISH                                                                               | L | T | P  | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                        |                                                                                                 | 2 | 0 | 0  | 2 |
| Course Objectives                                                                                                                                                                                                                                                      |                                                                                                 |   |   |    |   |
| 1                                                                                                                                                                                                                                                                      | Demonstrate communicative competence in academic and professional contexts.                     |   |   |    |   |
| 2                                                                                                                                                                                                                                                                      | Develop the basic reading and writing skills of first year engineering and technology students. |   |   |    |   |
| 3                                                                                                                                                                                                                                                                      | Apply key grammar concepts in reading and writing tasks.                                        |   |   |    |   |
| 4                                                                                                                                                                                                                                                                      | Produce effective language for professional contexts.                                           |   |   |    |   |
| 5                                                                                                                                                                                                                                                                      | Construct clear, concise, and coherent language for a variety of contexts.                      |   |   |    |   |
| UNIT 1 EFFECTIVE READING AND WRITING COMMUNICATION                                                                                                                                                                                                                     |                                                                                                 |   |   | 6  |   |
| Reading: Comprehension of short technical texts – Skimming and scanning<br>Writing: Precis Writing, Email Writing<br>Grammar: Tenses, Question types: Wh/ Yes or No<br>Vocabulary development: Root words – Prefixes & Suffixes, Standard Abbreviations & Acronyms     |                                                                                                 |   |   |    |   |
| UNIT 2 NARRATION AND SUMMATION                                                                                                                                                                                                                                         |                                                                                                 |   |   | 6  |   |
| Reading: Reading biographies, travelogues, newspaper reports<br>Writing: Paraphrasing, Formal and informal Letter<br>Grammar: Prepositions, Subject-verb Agreement<br>Vocabulary development: One-word substitution                                                    |                                                                                                 |   |   |    |   |
| UNIT 3 LANGUAGE DEVELOPMENT                                                                                                                                                                                                                                            |                                                                                                 |   |   | 6  |   |
| Reading: Reading reviews, advertisements<br>Writing: Writing Instructions, Report writing (Industrial report, Survey report & Accident report)<br>Grammar: Discourse Markers, Degrees of comparison<br>Vocabulary development: Compound nouns, Homophones and homonyms |                                                                                                 |   |   |    |   |
| UNIT 4 RECOMMENDATIONS AND TRANSCODING                                                                                                                                                                                                                                 |                                                                                                 |   |   | 6  |   |
| Reading: Non-verbal communication (tables, pie charts etc.)<br>Writing: Writing recommendations, Transferring information (chart, graph etc.)<br>Grammar: Error corrections<br>Vocabulary development: Fixed and semi fixed expressions                                |                                                                                                 |   |   |    |   |
| UNIT 5 LANGUAGE FOR WORKPLACE                                                                                                                                                                                                                                          |                                                                                                 |   |   | 6  |   |
| Reading: Reading Editorial columns<br>Writing: Writing minutes of meeting<br>Grammar: Simple, compound and complex sentences<br>Vocabulary development: Verbal analogies                                                                                               |                                                                                                 |   |   |    |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                          |                                                                                                 |   |   | 30 |   |
| Course Outcomes                                                                                                                                                                                                                                                        |                                                                                                 |   |   |    |   |
| At the end of the course, the student will be able to                                                                                                                                                                                                                  |                                                                                                 |   |   |    |   |
| CO1                                                                                                                                                                                                                                                                    | To use appropriate words in a professional context                                              |   |   |    |   |
| CO2                                                                                                                                                                                                                                                                    | To gain understanding of basic grammatical structures and use them in the right context.        |   |   |    |   |
| CO3                                                                                                                                                                                                                                                                    | To read and infer the denotative and connotative meanings of technical texts                    |   |   |    |   |
| CO4                                                                                                                                                                                                                                                                    | To write definitions, descriptions, narrations and essays on various topics                     |   |   |    |   |
| CO5                                                                                                                                                                                                                                                                    | To expand vocabulary and technical language competency                                          |   |   |    |   |
| TEXT BOOKS                                                                                                                                                                                                                                                             |                                                                                                 |   |   |    |   |



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Department: Electrical and Electronics Engineering, R2024, CBCS

English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)

English for Science & Technology Cambridge University Press, 2021.

English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

## REFERENCES

Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.

A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.

English For Technical Communication (With CD) By AyshaViswamohan, McGraw Hill Education, ISBN: 0070264244.

Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

### CO-PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | -   | -   | -   | -   | 0   | 0   | 1   | 3   | 3   | 1    | 2    | 2    | 2    | -    |
| CO2   | -   | -   | -   | -   | 1   | 0   | 1   | 2   | 3   | 2    | 2    | 2    | 2    | -    |
| CO3   | -   | -   | -   | -   | 0   | 0   | 1   | 1   | 2   | 1    | 1    | 2    | 2    | -    |
| CO4   | -   | -   | -   | -   | 1   | 0   | 2   | 3   | 3   | 3    | 2    | 1    | 1    | -    |
| CO5   | -   | -   | -   | -   | 1   | 0   | 2   | 2   | 3   | 3    | 2    | 2    | 2    | -    |
| AVG   | -   | -   | -   | -   | 0.6 | -   | 1.4 | 2.2 | 2.8 | 2.0  | 1.8  | 1.8  | 1.8  | -    |



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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24MA101                                                                                                                                                                                                                                                                                                                                                                                | MATHEMATICAL FOUNDATION FOR ENGINEERS                                                                           | L | T | P | C   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 | 3 | 1 | 0 | 4   |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                 |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                       | To develop the use of matrix algebra techniques that is needed by engineers for practical applications.         |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                       | To familiarize the students with differential calculus.                                                         |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                       | To familiarize the student with functions of several variables. This is needed in many branches of engineering. |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                       | To make the students understand various techniques of integration.                                              |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                       | To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications. |   |   |   |     |
| UNIT 1 MATRICES                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                 |   |   |   | 9+3 |
| Introduction - characteristic equation - Eigenvalues and Eigenvectors of a real matrix –Properties of Eigenvalues and Eigenvectors (without proof) – Cayley - Hamilton theorem (statement and applications only) – Diagonalization of matrices by orthogonal transformation –Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms . |                                                                                                                 |   |   |   |     |
| Experiential Learning : MATLAB : Activity - To find Matrix operations addition, multiplication, Transpose, inverse of matrix and also to find eigen values and corresponding eigen vectors                                                                                                                                                                                              |                                                                                                                 |   |   |   |     |
| Industrial Application : The CT image is a digital image and consists of a square matrix of elements (pixel), each of which represents a voxel (volume element) of the tissue of the patient. The typical CT image is composed of 512 rows, each of 512 pixels, i.e., a square matrix of 512 x 512 = 262,144 pixels (one for each voxel).                                               |                                                                                                                 |   |   |   |     |
| Content Beyond Syllabus : Finding Principal directions and corresponding factors of extension or contraction of an elastic membrane                                                                                                                                                                                                                                                     |                                                                                                                 |   |   |   |     |
| UNIT 2 DIFFERENTIAL CALCULUS                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                 |   |   |   | 9+3 |
| Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum,product, quotient, chain rules) - The equations of tangent line and normal line, velocity and acceleration - Interval of increasing and decreasing functions-Maxima and Minima of functions of one variable - Intervals of concavity and convexity.                           |                                                                                                                 |   |   |   |     |
| Experiential Learning : MATLAB : Activity - Determination of maxima and minima for one variable.                                                                                                                                                                                                                                                                                        |                                                                                                                 |   |   |   |     |
| Industrial Application : Peak Deduction : In signal analysis, maxima are used to detect peaks in signals, such as identifying the peak amplitude in an audio signal or the peak voltage in a communication signal.                                                                                                                                                                      |                                                                                                                 |   |   |   |     |
| Content Beyond Syllabus : Finding evolute and envelope of different curves like parabola, ellipse, hyperbola.                                                                                                                                                                                                                                                                           |                                                                                                                 |   |   |   |     |
| UNIT 3 FUNCTIONS OF SEVERAL VARIABLES                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                 |   |   |   | 9+3 |
| Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Maxima and minima of functions of two variables - Lagrange’s method of undetermined multipliers.                                                            |                                                                                                                 |   |   |   |     |
| Experiential Learning : MATLAB : Activity - Determination of maxima and minima for two variables.                                                                                                                                                                                                                                                                                       |                                                                                                                 |   |   |   |     |
| Industrial Application : Image Rejection: In receivers, engineers might need to optimize the image rejection ratio, which depends on the local oscillator frequency and the filter characteristics. Engineers use maxima and minima to balance these variables for improved signal reception.                                                                                           |                                                                                                                 |   |   |   |     |
| Content Beyond Syllabus : To determine the highest and lowest temperature on the surface when the temperature at any point is given.                                                                                                                                                                                                                                                    |                                                                                                                 |   |   |   |     |
| UNIT 4 INTEGRAL CALCULUS                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                 |   |   |   | 9+3 |



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Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

**Experiential Learning** : MATLAB : Activity - Estimation of area using single integral.

**Industrial Application** : Capacitor Energy Calculation : For a capacitor with varying dielectric properties, engineers use integrals to calculate the total energy stored in the capacitor as a function of its electric field and charge distribution. This helps in designing capacitors with desired energy storage capabilities.

**Content Beyond Syllabus** : Finding moments and centre of mass of the system of an object that have different masses at the different points and also to find the centroid of the region bounded by the curves.

|                                  |            |
|----------------------------------|------------|
| <b>UNIT 5 MULTIPLE INTEGRALS</b> | <b>9+3</b> |
|----------------------------------|------------|

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – change of variables from Cartesian to polar in double integrals - Triple integrals – Volume of solids .

**Experiential Learning** : MATLAB : Activity - Estimation of area and volume using double and triple integral.

**Industrial Application** : Antenna Gain: The gain of an antenna can be found by integrating the antenna's radiation pattern over the entire sphere to get the total radiated power and compare it to an isotropic radiator.

**Content Beyond Syllabus** : Finding the mass and centre of mass of the Lamina that occupies the region with the given density function.

|                      |           |
|----------------------|-----------|
| <b>TOTAL PERIODS</b> | <b>60</b> |
|----------------------|-----------|

## Course Outcomes

At the end of the course, the student will be able to

|            |                                                                                      |
|------------|--------------------------------------------------------------------------------------|
| <b>CO1</b> | Use the matrix algebra methods for solving practical problems                        |
| <b>CO2</b> | Apply differential calculus tools in solving various application problems.           |
| <b>CO3</b> | Able to use differential calculus ideas on several variable functions.               |
| <b>CO4</b> | Apply different methods of integration in solving practical problems                 |
| <b>CO5</b> | Apply multiple integral ideas in solving areas, volumes and other practical problems |

## TEXT BOOKS

|    |                                                                                                                                                          |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Veerarajan.T,"Engineering Mathematics,for semester I and II", Updated second Edition,Tata Mcgraw Hill Education , private Limited ,2019.                 |
| 2. | Grewal B.S and Grewel J.S ."Higher Engineering Mathematics", Khanna Publishers, New Delhi, 45th Edition, 2020.                                           |
| 3. | Won Y.Yang,Young K.Choi,Jaekwon Kim,Man Cheol Kim, H.Jin Kim,Taeho Im, "Engineering Mathematics with MATLAB" CRC Press Publishers , I st Edition , 2017. |
| 4. | Engineering Mathematics: First year.Calculus and analytical geometry,volume 2,M.K.Venketaraman,National Publishing company,1965.                         |

## REFERENCES

|    |                                                                                                                                                 |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.                                        |
| 2. | Kandasamy.P.,Thilagavathy.K and Gunavathy.K.,"Engineering Mathematics For First Year B.E/B.Tech,Seventh Edition 2008 S.Chand and Co.,New Delhi. |
| 3. | Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics,semester-I", ninth Edition, Laxmi Publications Pvt. Ltd, 2016.               |





| <b>CO-PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                        | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| <b>CO1</b>                                                                                                                                                             | 3   | 3   | 3   | 1   | 1   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| <b>CO2</b>                                                                                                                                                             | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| <b>CO3</b>                                                                                                                                                             | 3   | 3   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| <b>CO4</b>                                                                                                                                                             | 3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| <b>CO5</b>                                                                                                                                                             | 3   | 3   | 3   | 1   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| <b>AVG</b>                                                                                                                                                             | 3   | 2.6 | 2.6 | 1   | 1   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |



**Meenakshi Sundararajan Engineering College**  
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| U24PH104                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | PHYSICS FOR ELECTRICAL ENGINEERING                                                                                                                                                | L | T | P  | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                   | 3 | 0 | 0  | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                   |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To introduce the fundamental concepts of electromagnetism, including Maxwell's equations and the properties of electromagnetic waves.                                             |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To introduce the concept of lasers and their applications in various fields, including telecommunications, manufacturing, and medicine.                                           |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To establish a sound grasp of knowledge on different optical properties of materials, and how they can be engineered for specific applications.                                   |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Learn how transistors are used as amplifiers, switches, and building blocks in electronic circuits, and analyze transistor circuits through mathematical modeling and simulation. |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To make the students to understand the basics of dielectric materials and insulation.                                                                                             |   |   |    |   |
| UNIT 1 ELECTROMAGNETIC WAVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                   |   |   | 9  |   |
| The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception- Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence                                                                |                                                                                                                                                                                   |   |   |    |   |
| UNIT 2 ELECTRICAL PROPERTIES OF MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                   |   |   | 9  |   |
| Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory : Fermi- Dirac statistics – Density of energy states – Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode -Electron in periodic potential – Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. |                                                                                                                                                                                   |   |   |    |   |
| UNIT 3 SEMICONDUCTORS AND TRANSPORT PHYSICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                   |   |   | 9  |   |
| Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode.                                                                                                                                                            |                                                                                                                                                                                   |   |   |    |   |
| UNIT 4 TRANSISTORS AND POWER DEVICES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                   |   |   | 9  |   |
| PN diode, Zener diode, Transistor-CE,CC,CB amplifiers,JFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- MOSFET- Characteristics- Threshold voltage - Channel length modulation MOSFET Characteristics – Comparison of MOSFET with JFET. Power Devices-UJT, SCR, Diac, Triac.                                                                                                                                                                                                                                                         |                                                                                                                                                                                   |   |   |    |   |
| UNIT 5 DIELECTRICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                   |   |   | 9  |   |
| Electrical susceptibility – Dielectric constant – Electronic, ionic, orientation and space charge polarization – Frequency and temperature dependence of polarization – Internal field – Clausius – Mosotti relation (derivation) – Physical significance of Maxwell's equations - Dielectric loss – Dielectric breakdown – Uses of dielectric materials in capacitor and transformer- Dielectric materials and its applications.                                                                                                                                                        |                                                                                                                                                                                   |   |   |    |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                   |   |   | 45 |   |



**At the end of the course, the student will be able to**

## TEXT BOOKS

- ## REFERENCES

- ## CO/PO, PSO Mapping

[illegible]



**Meenakshi Sundararajan Engineering College**  
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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24CY103                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                           | CHEMISTRY FOR ELECTRICAL AND ELECTRONICS ENGINEERING |  | L | T | P  | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|--|---|---|----|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                           |                                                      |  | 3 | 0 | 0  | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand the characteristics of water and apply suitable external and internal treatment methods by analyzing hardness, alkalinity, and boiler problems for industrial applications. |                                                      |  |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To apply thermodynamic laws, entropy, and free-energy concepts to analyze chemical processes, and to evaluate the working and performance of various energy resources.                    |                                                      |  |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To analyze phase diagrams and explain the synthesis, properties, and applications of nanomaterials for scientific and industrial use.                                                     |                                                      |  |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To apply electrode potential and Nernst equation to analyze electrochemical cells and understand reference electrodes and various titration methods.                                      |                                                      |  |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand and apply the working principles of sensors and basic spectroscopic techniques for chemical, environmental, and industrial monitoring.                                      |                                                      |  |   |   |    |   |
| UNIT 1 WATER TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                           |                                                      |  |   |   | 9  |   |
| Introduction-characteristics of water – Hardness – Types of hardness - Estimation by EDTA (problems on hardness) – Alkalinity – Determination (problems on alkalinity) – Boiler feed water – Requirements – Priming and foaming, Scales and sludges Caustic embrittlement and Boiler corrosion – Application - External conditioning (Ionexchange,zeolite) – Internal conditioning (Carbonate,phosphate,calgon,sodiumaluminate conditioning) — Brackish water treatment - Reverse osmosis.                                                                                                                                                                                                                                                            |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| UNIT 2 CHEMICAL THERMODYNAMICS AND ENERGY STORAGE DEVICES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                           |                                                      |  |   |   | 9  |   |
| Introduction - Thermodynamic process (isothermic, isobaric, isochoric and adiabatic processes) - Internal energy – first law of thermodynamics (Mathematical statement& limitation) - Enthalpy - Second law of thermodynamics - Entropy - Entropy change of an ideal gas & problems - Free energy - work function – Gibbs Helmholtz equation-Van't Hoff isotherm-derivation, applications. Batteries – Types of batteries – Characteristics-Definition of Electricity storage density and power discharge rate--Principle, working and applications of lead-acid battery, Ni–Cd and lithium ion batteries – Fuel cell.                                                                                                                                |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| UNIT 3 PHASE RULE AND NANOMATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                           |                                                      |  |   |   | 9  |   |
| Phase rule - Introduction, definition of terms - phase, components and degree of freedom - phase diagram- one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system.<br>Nanomaterials-Classification-Properties and uses-. Synthesis–Top down method (Ball milling)and Bottom up methods –Laser Evoparation method -chemical vapour deposition, - Applications of nanomaterials - A Case Study – Medicine,Agriculture,Industry and Electronics.                                                                                                                                                                                                                      |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| UNIT 4 ELECTROCHEMISTRY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                           |                                                      |  |   |   | 9  |   |
| Introduction-Electrodes-Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf – Single electrode potential – Nernst equation (problem) – reference electrodes –Standard Hydrogen electrode -Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series – significance – potentiometer titrations (redox - Fe <sup>2+</sup> + vs dichromate and precipitation – Ag + vs Cl - titrations) and conduct metric titrations (acid-base – HCl vs, NaOH) titrations,                                                                                                                                                                                                         |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| UNIT 5 SENSORS AND SPECTROSCOPY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                           |                                                      |  |   |   | 9  |   |
| Sensors, types of sensors. Chemical Sensors – characteristics and elements - Carbon dioxide, glucose detector, Mosquito, and Pregnancy test. Electrochemical sensors – potentiometric sensors, amperometric sensors, polarization techniques - Working Principles and Applications.Integrated and Smart sensors,Definitions and applications of various smart sensors-types- , Humidity sensor, UV sensor and Ultra Sonic Sensors.<br>Introduction-importance of spectroscopy-types of spectroscopy-Spectrum-Electromagnetic radiation-Electromagnetic spectrum-Absorption of Electromagnetic radiation-Types of energy present in molecules-Molecular spectra-Energy level diagram-Ultraviolet (UV) and visible spectroscopy-Infra red spectroscopy. |                                                                                                                                                                                           |                                                      |  |   |   |    |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                           |                                                      |  |   |   | 45 |   |



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**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Determine water hardness and alkalinity, analyze boiler water problems, and select appropriate treatment methods for industrial applications.            |
| <b>CO2</b> | Calculate thermodynamic parameters, predict feasibility of reactions, and compare different energy storage devices for various engineering applications. |
| <b>CO3</b> | Interpret phase diagrams, perform thermal analysis, and evaluate nanomaterial synthesis methods for real-world applications.                             |
| <b>CO4</b> | Measure electrode potentials, apply Nernst equation in calculations, and select suitable electrochemical methods for analytical and industrial use.      |
| <b>CO5</b> | Apply the principles of sensors and spectroscopic techniques to detect and monitor chemical and environmental parameters.                                |

**TEXT BOOKS**

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. H.K. Chopra, A. Parmer, "Chemistry for Engineers", Narosa Publishing House, New Delhi, 110 002, 2016
3. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4. Annalisa Bonfiglio and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
5. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013
6. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals,
7. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks Technology, Implementation applications, Pan Stanford Publishing Pte. Ltd, Singapore, 2012

**REFERENCES**

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Hagen Klauk, "Organic Electronics: Materials, Manufacturing and Applications", Wiley-VCH, 2006.
4. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.
5. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013
6. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO1</b> | 3          | 2          | 2          | 1          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |
| <b>CO2</b> | 3          | 2          | 2          | -          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |
| <b>CO3</b> | 3          | 2          | 2          | -          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |
| <b>CO4</b> | 3          | 2          | 2          | 1          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |
| <b>CO5</b> | 3          | 2          | 2          | -          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |
| <b>AVG</b> | 3          | 2          | 2          | 1          | 2          | 1          | 1          | 1          | -          | 1           | 2           | -           | -           | -           |



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| U24TA101                                                                                                                                                                                                                                                                                                                                                                                                                                             | தமிழர்மரபு<br>HERITAGE OF TAMILS | L<br>1                                                                                                                                                                                                                                                                                                                                                                                                                                                               | T<br>0 | P<br>0 | C<br>1 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|--------|
| <b>அலகு I மொழி மற்றும் இலக்கியம்</b><br><b>UNIT I LANGUAGE AND LITERATURE</b>                                                                                                                                                                                                                                                                                                                                                                        |                                  | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |
| இந்தியமொழிக்குடும்பங்கள் - திரொவிடமொழிகள் - தமிழ்ஒருசெம்மொழி - தமிழ்செல்விலக்கியங்கள் - சங்கஇலக்கியத்தின் சமயசார்பற்றதன்மை - சங்கஇலக்கியத்தில் பகிர்தல்அறம் - திருக்குறளில் மேலாண்மைகருத்துக்கள் - தமிழ்க்காப்பியங்கள், தமிழகத்தில் - சமணபௌத்தசமயங்களின்தாக்கம் - பக்திஇலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீனஇலக்கியத்தின்வளர்ச்சி - தமிழ்இளகியவளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு |                                  | Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan |        |        |        |
| <b>அலகு II மரபு - பாறைஓவியங்கள் முதல் நவீனஓவியங்கள்வரை -</b><br><b>சிற்பக்கலை</b><br><b>UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART - SCULPTURE</b>                                                                                                                                                                                                                                                                                          |                                  | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |
| நடுகல்முதல்நவீனசிற்பங்கள்வரை - ஐம்பொன்சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள்தயாரிக்கும் கைவினைப்பொருட்கள், பொம்பைகள் - தேர்செய்யும்கலை - சுடுமண்சிற்பங்கள் - நாட்டுப்புறதெய்வங்கள் - குமரிமுனையில்திருவள்ளுவர்சிலை - இசைக்கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூகபொருளாதாரவாழ்வில் கோவில்களின்பங்கு                                                                                                                    |                                  | Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils                                                                                                                               |        |        |        |
| <b>அலகு III நாட்டுப்புறக்கலைகள் மற்றும் வீரவிளையாட்டுகள்</b><br><b>UNIT III FOLK AND MARTIAL ARTS</b>                                                                                                                                                                                                                                                                                                                                                |                                  | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |
| தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான்கூத்து, ஓயிலாட்டம், தோல்பாவைக்கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின்விளையாட்டுகள்                                                                                                                                                                                                                                                                                                      |                                  | Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.                                                                                                                                                                                                                                                                                                                      |        |        |        |
| <b>அலகு IV தமிழர்களின் திணைக்கோட்பாடுகள்</b><br><b>UNIT IV THINAI CONCEPT OF TAMILS</b>                                                                                                                                                                                                                                                                                                                                                              |                                  | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                             |        |        |        |
| தமிழகத்தின்தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்கஇலக்கியத்தில் அகம்மற்றும் புறக்கோட்பாடுகள் - தமிழர்கள்போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில்தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககாலநகரங்களும் துறைமுகங்களும் - சங்ககாலத்தில் ஏற்றுமதிமற்றும் இறக்குமதி - கடல்கடந்தநாடுகளில் சோழர்களின்வெற்றி                                                                                                                                    |                                  | Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas                                                                                                                                                                                          |        |        |        |





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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <p>அலகு V இந்தியதேசியஇயக்கம் மற்றும்<br/>இந்தியபண்பாட்டிற்குத்தமிழர்களின்பங்களிப்பு<br/>UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN<br/>CULTURE</p>                                                                                                                                                                                                                                                                                                                                                                   | <p>3</p>  |
| <p>இந்தியவிடுதலைப்போரில்தமிழர்களின்பங்கு – இந்தியாவின் பிறபகுதிகளில்<br/>தமிழ்பண்பாட்டின்தாக்கம் - சுயமரியாதைஇயக்கம் - இந்தியமருத்துவத்தில்,<br/>சித்தமருத்துவத்தின்பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிக்கள் - தமிழ்புத்தகங்களின்<br/>அச்சுவரலாறு</p> <p>Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of<br/>India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions<br/>&amp; Manuscripts – Print History of Tamil Books.</p> |           |
| <p>TOTAL PERIODS</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>15</p> |
| <p>TEXT BOOK CUM REFERENCE BOOKS</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |
| <p>1. தமிழகவரலாறு - மக்களும்பண்பாடும் - கேகேபிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல்<br/>மற்றும் கல்வியியல்பணிகள்கழகம்)</p>                                                                                                                                                                                                                                                                                                                                                                                                                          |           |
| <p>2.கணிணித்தமிழ் - முனைவர்இல. சுந்தரம் (விகடன்பிரசுரம்)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |
| <p>3.Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB &amp; ESC and RMRL – (in print)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |
| <p>4.Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of<br/>Tamil Studies)</p>                                                                                                                                                                                                                                                                                                                                                                                                      |           |
| <p>5.Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by:<br/>International Institute of Tamil Studies)</p>                                                                                                                                                                                                                                                                                                                                                                                        |           |
| <p>6.The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute<br/>of Tamil Studies)</p>                                                                                                                                                                                                                                                                                                                                                                                                      |           |
| <p>7.Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by:Department of<br/>Archaeology&amp; Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)</p>                                                                                                                                                                                                                                                                                                                                     |           |
| <p>8.Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The<br/>Author)</p>                                                                                                                                                                                                                                                                                                                                                                                                                   |           |
| <p>9.Porunai Civilization (Jointly Published by: Department of Archaeology &amp; Tamil Nadu Text Book and<br/>Educational Services Corporation, Tamil Nadu)</p>                                                                                                                                                                                                                                                                                                                                                                                |           |
| <p>10. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |





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| U24ME104                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | BASIC CIVIL AND MECHANICAL ENGINEERING                                                                                                           | L | T | P  | C |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                  | 3 | 0 | 0  | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                  |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs. |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To help students acquire knowledge in the basics of surveying and the materials used for construction.                                           |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To provide an insight to the essentials of components of a building and the infrastructure facilities.                                           |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To explain the component of power plant units and detailed explanation to IC engines their working principles.                                   |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To explain the Refrigeration & Air-conditioning system.                                                                                          |   |   |    |   |
| UNIT: 1 PART A: OVERVIEW OF CIVIL ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                  |   |   | 9  |   |
| Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering – National building code – terminologists: Plinth area, Carpet area, Floor area, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.                                                                                                                                                                                                                                                                 |                                                                                                                                                  |   |   |    |   |
| UNIT: 1 PART B:OVERVIEW OF MECHANICAL ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                  |   |   |    |   |
| Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering – Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                  |   |   |    |   |
| UNIT: 2 SURVEYING AND CIVIL ENGINEERING MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                  |   |   | 9  |   |
| Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours. Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber - Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)                                                                                                                                                                                                                                             |                                                                                                                                                  |   |   |    |   |
| UNIT: 3 BUILDING COMPONENTS AND INFRASTRUCTURE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                  |   |   | 9  |   |
| Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering. Types of Bridges and Dams – Water Supply Network - Rain Water Harvesting – Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.                                                                                                                                                                                                                                                                             |                                                                                                                                                  |   |   |    |   |
| UNIT: 4 INTRODUCTION TO THERMODYNAMICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                  |   |   | 9  |   |
| Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work. First law of thermodynamics – application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments (only description and no problems). Second law of thermodynamics – Kelvin-Planck’s and Clausius statements of second law. Reversibility and irreversibility. Carnot cycle, reversed carnot cycle, efficiency, Performance and applications (only description and no problems). |                                                                                                                                                  |   |   |    |   |
| UNIT: 5 INTERNAL COMBUSTION ENGINES AND POWER PLANTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                  |   |   | 9  |   |
| Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Four stroke and two stroke Engines – Working principle of Petrol and Diesel Engines – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps – Comparison Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps.                                                                                                                                          |                                                                                                                                                  |   |   |    |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                  |   |   | 45 |   |



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| Course Outcomes                                                                                                     |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| At the end of the course, the student will be able to                                                               |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO1                                                                                                                 | Understanding profession of Civil and Mechanical engineering.                                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO2                                                                                                                 | Summarize the planning of building, infrastructure and working of Machineries.                                                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO3                                                                                                                 | Apply the knowledge gained in respective discipline                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO4                                                                                                                 | Illustrate the ideas of Civil and Mechanical Engineering applications.                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO5                                                                                                                 | Appraise the material, Structures, machines and energy.                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| TEXT BOOKS                                                                                                          |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018 |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2. B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain,Basic Civil Engineering, Lakshmi Publication, First edition, 2004 |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3. R K Rajput,Basic Mechanical Engineering, Lakshmi Publication, Fourth edition, 2007                               |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| REFERENCES                                                                                                          |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.                                            |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2. Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd, 2013.                              |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3. Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.                                              |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4. Shantha Kumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.                  |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                     | <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                     | PO1                                                                                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                 | 2                                                                                                                                                                      | 2   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |
| CO2                                                                                                                 | 2                                                                                                                                                                      | 2   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |
| CO3                                                                                                                 | 2                                                                                                                                                                      | 1   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |
| CO4                                                                                                                 | 2                                                                                                                                                                      | 2   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |
| CO5                                                                                                                 | 2                                                                                                                                                                      | 2   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |
| AVG                                                                                                                 | 2                                                                                                                                                                      | 2   | 1   | -   | -   | -   | 1   | -   | -   | -    | 2    | -    | -    | -    |  |



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| U24CS101                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | PROGRAMMING IN C                                                                                  | L | T | P    | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|---|---|------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                   | 2 | 0 | 4    | 4 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                   |   |   |      |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand the structure and syntax of C Language                                              |   |   |      |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop C programs using arrays and strings                                                    |   |   |      |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop modular applications in C using functions                                              |   |   |      |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop applications in C and apply the concept code reusability using pointers and structures |   |   |      |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To do input/output and understand the basics of file handling mechanisms in C .                   |   |   |      |   |
| UNIT 1 BASICS OF C PROGRAMMING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                   |   |   | 6+12 |   |
| Introduction to Problem Solving: Algorithm, Flowchart, Pseudocode. Programming Basics: Applications of C Language-Structure of C program -Identifiers-Data Types – Variables-Constants – Keywords – Operators – Input/output statements, Decision making statements - Looping statements - Expressions-Precedence and Associativity – Expressions Evaluation, Type conversions.                                                                                                                                                                                                                                        |                                                                                                   |   |   |      |   |
| Practical:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |   |   |      |   |
| 1.Algorithm, pseudocode, flowcharts for simple scientific and statistical problems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                   |   |   |      |   |
| 2.I/O statements, operators, expressions and decision-making constructs(if, if-else, break, continue                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                   |   |   |      |   |
| 3.C Programming using Simple statements and expressions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                   |   |   |      |   |
| 4.Create Looping statements- for, while, do-while.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                   |   |   |      |   |
| Case Study: Develop a system to manage student records, including personal information, academic performance, and attendance. Enrich with appropriate Algorithm ,a neat Flowchart, Pseudocode.                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                   |   |   |      |   |
| UNIT 2 ARRAYS AND STRINGS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |   |   | 6+12 |   |
| Arrays: Introduction – Declaration of Arrays – Storing Values in Array – Accessing elements of the Array– Calculating the length of the Array – Operations on Array – one dimensional arrays – Two dimensional Arrays – String: Declaring, Initializing, Printing and reading strings, String input and output functions, String handling functions, Arrays of strings.                                                                                                                                                                                                                                                |                                                                                                   |   |   |      |   |
| Practicals:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                   |   |   |      |   |
| 1.Create simple programs for one dimensional and two dimensional arrays.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                   |   |   |      |   |
| 2.Practice all string handling functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |   |   |      |   |
| Case Study : Use arrays for Storing Student Information,for Managing Grades ,for Attendance Tracking .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                   |   |   |      |   |
| UNIT 3 FUNCTION AND STORAGE CLASS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                   |   |   | 6+12 |   |
| Library functions: Math functions, other miscellaneous functions such as getchar(), putchar(), malloc(), calloc(). User defined functions - function definition, functions declaration, function call, scope of variables - local variables, global variables. Function parameters: Parameter passing- call by value & call by reference, function return values, Passing arguments to Functions. Recursive functions. Storage classes-auto, register, static, extern, scope rules.                                                                                                                                    |                                                                                                   |   |   |      |   |
| Practical:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |   |   |      |   |
| 1.Implementation of C Program using user defined functions (Pass by value and Pass by reference).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                   |   |   |      |   |
| 2.Implementation of Recursion Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                   |   |   |      |   |
| Case Study : Use functions to add and display more students,calculate average grades,sort students by average grade.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                   |   |   |      |   |
| UNIT 4 STRUCTURES AND POINTERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                   |   |   | 6+12 |   |
| Basics of structures-structure data types, type definition, accessing structures, Structure operations, Complex structures-nested structures, structures containing arrays, Array of structures, Structures and Functions, Unions. Pointers: Understanding Computer Memory –Memory Management-Dynamic memory Allocation-Memory leaks-Introduction to Pointers – declaring Pointer Variables – Pointer Expressions and Pointer Arithmetic – Null Pointers – Generic Pointers - Passing Arguments to Functions using Pointer – Pointer and Arrays –Use of pointers in self-referential structures, notion of linked list |                                                                                                   |   |   |      |   |
| Practical:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                   |   |   |      |   |
| 1.C Programming using Pointers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                   |   |   |      |   |
| 2.Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                   |   |   |      |   |
| Case Study: Use complex structures operation in a student management system                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                   |   |   |      |   |



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| UNIT 5 MACROS AND FILE PROCESSING                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      | 6+12 |      |      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| Preprocessor Directives: Introduction to preprocessor directives in Simple macros using `#define`, conditional macros using `#ifdef`, `#ifndef`, `#endif`, `#else`, and `#elif`. Files: Introduction to Files – Opening a file – Reading Data from Files – Writing Data to Files – Detecting the End-of-file –Closing a file – Sequential access file-Random Access Files – Binary Files – Command line arguments. |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| <b>Practical:</b>                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1.Programming using macros and storage classes                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2.Implementation of Command line Arguments like argc,argv                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3.Files- reading and writing, file operations, random access                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4.Develop an application for any one of the following scenarios : Student Management System /Stock Management System/ Banking Application / Ticket Reservation System                                                                                                                                                                                                                                              |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| <b>Case Study:</b> Make a separate file for the student management system to read,write,delete ,access data from it.                                                                                                                                                                                                                                                                                               |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      | 90   |      |      |  |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                | Create simple applications in C using basic constructs                                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                | Create C programs using arrays and strings                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                | Create modular applications in C using functions.                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                | Create modular applications in C using structures and pointers.                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                | Create applications using macros and file processing                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| REFERENCES                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.                                                                                                                                                                                                                                                                                         |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996.                                                                                                                                                                                                                                                                                               |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4.. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.                                                                                                                                                                                                                                                                                          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                    | CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                    | PO1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | -    | -    | -    |  |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    | -    |  |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | 2   | 2   | -   | -   | -   | 1   | -   | 1    | -    | 2    | 2    | 1    |  |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | 2   | 2   | 1   | 1   | -   | 1   | 1   | 1    | 1    | 2    | 2    | -    |  |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | 2   | 2   | 1   | 1   | -   | 1   | 1   | 1    | 1    | 2    | 2    | 1    |  |
| AVG                                                                                                                                                                                                                                                                                                                                                                                                                | 2                                                                                                                                                               | 2   | 2   | 2   | 1   | 1   | -   | 1   | 1   | 1    | 1    | 2    | 2    | 1    |  |



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| U24BS01                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | PHYSICS AND CHEMISTRY LABORATORY |  | L | T  | P | C |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--|---|----|---|---|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  | 0 | 0  | 4 | 2 |
| Course Objectives                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
| 1                                                     | This session aims to provide the learners hands-on-training on the practical applications of the concepts learnt in the theoretical sessions on bending of beams,application of laser,. The course will also train the learner to observe good lab practices, record readings and analyse and interpret the results.                                                                                                                                                          |                                  |  |   |    |   |   |
| 2                                                     | This session aims to provide the learners hands-on-training on the practical applications of the concepts learnt in the theoretical sessions on water treatment, electrochemistry, lubricants, composites and nanomaterials using simple chemical methods. The course will also train the learner to observe good lab practices, record readings and graphically represent the results, as well as analyse and interpret the influence of reaction conditions on the results. |                                  |  |   |    |   |   |
| LIST OF EXPERIMENTS:                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
| PHYSICS LABORATORY                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
| 1                                                     | Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular objects                                                                                                                                                                                                                                                                                                                                                                       |                                  |  |   |    |   |   |
| 2                                                     | Simple harmonic oscillations of cantilever.                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                  |  |   |    |   |   |
| 3                                                     | Uniform bending – Determination of Young’s modulus                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |  |   |    |   |   |
| 4                                                     | Laser- Determination of the wave length of the laser using grating                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |  |   |    |   |   |
| 5                                                     | Ultrasonic Interferometer-Determination of compressibility of given liquid                                                                                                                                                                                                                                                                                                                                                                                                    |                                  |  |   |    |   |   |
| 6                                                     | a) Optical fibre -Determination of Numerical Aperture and acceptance angle b) Compact disc- Determination of width of the groove using laser.                                                                                                                                                                                                                                                                                                                                 |                                  |  |   |    |   |   |
| 7                                                     | Non-uniform bending - Determination of Young’s modulus                                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |  |   |    |   |   |
| CHEMISTRY LABORATORY                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
| 1                                                     | Estimation of mixture of acids by conductometric titration                                                                                                                                                                                                                                                                                                                                                                                                                    |                                  |  |   |    |   |   |
| 2                                                     | Estimation of iron by potentiometric titration                                                                                                                                                                                                                                                                                                                                                                                                                                |                                  |  |   |    |   |   |
| 3                                                     | Conductometric titration of barium chloride against sodium sulphate (precipitation titration)                                                                                                                                                                                                                                                                                                                                                                                 |                                  |  |   |    |   |   |
| 4                                                     | Determination of alkalinity in a water sample                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                  |  |   |    |   |   |
| 5                                                     | Estimation of hardness of water by EDTA method                                                                                                                                                                                                                                                                                                                                                                                                                                |                                  |  |   |    |   |   |
| 6                                                     | Estimation of hydrochloric acid by pHmetric method                                                                                                                                                                                                                                                                                                                                                                                                                            |                                  |  |   |    |   |   |
| 7                                                     | Determination of chloride content of water sample by Argentometric method                                                                                                                                                                                                                                                                                                                                                                                                     |                                  |  |   |    |   |   |
| 8                                                     | Determination of viscosity of a polymer using ostwald's viscometer.                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |  |   |    |   |   |
| 9                                                     | Estimation of iron content using spectrophotometer.                                                                                                                                                                                                                                                                                                                                                                                                                           |                                  |  |   |    |   |   |
| TOTAL PERIODS                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   | 60 |   |   |
| Course Outcomes                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
| At the end of the course, the student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                  |  |   |    |   |   |
|                                                       | Gain knowledge about torque and rigidity modulus of a material and understand the principles of simple harmonic motion and bending of beams                                                                                                                                                                                                                                                                                                                                   |                                  |  |   |    |   |   |

[illegible]



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| U24TP110                                                                                                                                                                                                                                                                                                                                                                                      | COMMUNICATION SKILLS LAB I                                                                                                          | L | T | P  | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                     | 0 | 0 | 2  | 1 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                     |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                             | Demonstrate communicative competence in academic and professional contexts.                                                         |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                             | Apply language skills effectively in academic and workplace contexts.                                                               |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                             | Apply appropriate listening strategies to comprehend different types of audio materials such as lectures, discussions, and videos.  |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                             | Express opinions effectively by using language across various media.                                                                |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                             | Demonstrate English language proficiency through participation in listening and speaking activities relevant to authentic contexts. |   |   |    |   |
| UNIT I                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                     |   |   | 6  |   |
| <b>Listening:</b> Listening as a key skill- its importance -Listening for general information-specific details - Introduction to classmates – Audio / video (formal & informal)<br><b>Speaking:</b> Making telephone Calls, Introducing a friend, Making polite requests, polite offers and replying to polite requests - Understanding basic instructions for filling out a bank application |                                                                                                                                     |   |   |    |   |
| UNIT II                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                     |   |   | 6  |   |
| <b>Listening:</b> Listen to a process information<br><b>Speaking:</b> Small talk on general topics and current scenario                                                                                                                                                                                                                                                                       |                                                                                                                                     |   |   |    |   |
| UNIT III                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                     |   |   | 6  |   |
| <b>Listening:</b> Listen to event narration and stories<br><b>Speaking:</b> Picture description- describing locations in workplaces                                                                                                                                                                                                                                                           |                                                                                                                                     |   |   |    |   |
| UNIT IV                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                     |   |   | 6  |   |
| <b>Listening:</b> Listening to discussions and debates<br><b>Speaking:</b> Role Play                                                                                                                                                                                                                                                                                                          |                                                                                                                                     |   |   |    |   |
| UNIT V                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                     |   |   | 6  |   |
| <b>Listening:</b> Listening/watching documentaries<br><b>Speaking:</b> Formal and informal talk -making predictions- talking about a given topic-giving opinions                                                                                                                                                                                                                              |                                                                                                                                     |   |   |    |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                     |   |   | 30 |   |





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**At the end of the course, the student will be able to**

|            |                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | To listen and comprehend complex academic texts                                                                                      |
| <b>CO2</b> | To speak fluently and accurately in formal and informal communicative contexts                                                       |
| <b>CO3</b> | To express their opinions effectively in both oral and written medium of communication                                               |
| <b>CO4</b> | Ability to listen/view and comprehend different spoken discourses/excerpts different accents and to speak clearly in simple language |
| <b>CO5</b> | Ability to read and evaluate texts critically                                                                                        |

**List of experiments**

|          |                                                                                          |
|----------|------------------------------------------------------------------------------------------|
| <b>1</b> | Self-Introduction / Introducing a friend                                                 |
| <b>2</b> | Small talk                                                                               |
| <b>3</b> | Narrating an event or story                                                              |
| <b>4</b> | Discussion/debate on a given topic                                                       |
| <b>5</b> | Listening to TED Talks (Being an active listener: giving verbal and non-verbal feedback) |

**ASSESSMENT PATTERN**

End Semester Listening & Speaking activity will be conducted.

**TEXT BOOKS**

1. Brooks, Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011.
2. Richards, C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010

**REFERENCES**

1. Bhatnagar, Nitin and Mamta Bhatnagar. Communicative English for Engineers and Professionals. Pearson: New Delhi, 2010
2. Hughes, Glyn and Josephine Moate. Practical English Classroom. Oxford University Press: Oxford, 2014
3. Ladousse, Gillian Porter. Role Play. Oxford University Press: Oxford, 2014
4. English and Soft Skills, Dr. S.P. Dhanavel, Orient BlackSwan, 2013
5. Vargo, Mari. Speak Now Level 4. Oxford University Press: Oxford, 2013.

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO1</b> | 0          | 0          | 0          | 0          | 0          | 0          | 1          | 2          | 3          | 2           | 2           | -           | -           | -           |
| <b>CO2</b> | 0          | 0          | 0          | 0          | 0          | 1          | 1          | 2          | 3          | 3           | 2           | -           | -           | -           |
| <b>CO3</b> | 0          | 0          | 0          | 0          | 0          | 1          | 2          | 1          | 1          | 1           | 2           | -           | -           | -           |
| <b>CO4</b> | 0          | 0          | 0          | 0          | 0          | 0          | 1          | 2          | 3          | 2           | 2           | -           | -           | -           |
| <b>CO5</b> | 0          | 0          | 0          | 0          | 0          | 1          | 2          | 2          | 2          | 2           | 2           | -           | -           | -           |
| <b>AVG</b> | 0          | 0          | 0          | 0          | 0          | 0.6        | 1.4        | 1.8        | 2.4        | 2.0         | 2           | -           | -           | -           |



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|                                                                                                                                                                                                                                                                       |                                                                                                 |    |   |   |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|----|---|---|---|
| U24EN201                                                                                                                                                                                                                                                              | Professional English                                                                            | L  | T | P | C |
|                                                                                                                                                                                                                                                                       |                                                                                                 | 2  | 0 | 0 | 2 |
| Course Objectives                                                                                                                                                                                                                                                     |                                                                                                 |    |   |   |   |
| 1                                                                                                                                                                                                                                                                     | Demonstrate understanding of reading and writing skills through meaningful language activities. |    |   |   |   |
| 2                                                                                                                                                                                                                                                                     | Apply technical vocabulary to communicate effectively in technical and professional contexts.   |    |   |   |   |
| 3                                                                                                                                                                                                                                                                     | Apply key grammar concepts to produce clear, accurate, and effective written communication.     |    |   |   |   |
| 4                                                                                                                                                                                                                                                                     | Evaluate writing examples based on purpose, audience, and context.                              |    |   |   |   |
| 5                                                                                                                                                                                                                                                                     | Apply knowledge of job applications and interviews to prepare for internships and placements.   |    |   |   |   |
| UNIT 1 APPLIED LANGUAGE SKILLS                                                                                                                                                                                                                                        |                                                                                                 | 6  |   |   |   |
| Reading: Reading user manuals, brochures, posters, pamphlets<br>Writing: Review Writing (Book Review and Movie Review)<br>Grammar: Tenses, Prepositional phrases<br>Vocabulary Development: Technical vocabulary (synonyms and antonyms)                              |                                                                                                 |    |   |   |   |
| UNIT 2 PRACTICAL WRITING AND GRAMMAR SKILLS                                                                                                                                                                                                                           |                                                                                                 | 6  |   |   |   |
| Reading: Reading longer technical texts<br>Writing: Writing response to a complaint letter<br>Grammar: Active and passive voice, Infinitives and Gerunds<br>Vocabulary Development: Sequence words, Misspelled words                                                  |                                                                                                 |    |   |   |   |
| UNIT 3 PROFESSIONAL WRITING AND ANALYTICAL READING                                                                                                                                                                                                                    |                                                                                                 | 6  |   |   |   |
| Reading:Case Studies, Excerpts from literary texts, news reports etc.<br>Writing: Letter to the Editor, Checklists<br>Grammar: If Conditionals, Articles<br>Vocabulary Development: Collocation, Cause and effect expression                                          |                                                                                                 |    |   |   |   |
| UNIT4 DEVELOPING WRITING AND LANGUAGE SKILLS                                                                                                                                                                                                                          |                                                                                                 | 6  |   |   |   |
| Reading: Reading for detailed comprehension, newspaper articles<br>Writing: Essay writing<br>Grammar: Reported speech, Modals<br>Vocabulary Development: Conjunctions                                                                                                 |                                                                                                 |    |   |   |   |
| UNIT 5 LANGUAGE SKILLS FOR CAREER SUCCESS                                                                                                                                                                                                                             |                                                                                                 | 6  |   |   |   |
| Reading: Company profiles, Statement of purpose, an excerpt of interview with professionals<br>Writing: Job / Internship application – Cover letter & Resume<br>Grammar: Relative Clauses, Numerical adjectives<br>Vocabulary Development: Single sentence definition |                                                                                                 |    |   |   |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                         |                                                                                                 | 30 |   |   |   |



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| Course Outcomes                                                                                                                                                                                                                       |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, the student will be able to                                                                                                                                                                                 |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                                                                                                                                                                                                   | Read and comprehend various forms of technical and informational texts and extract the necessary information for application or analysis.                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                                                                                                                                                                                   | Improve their vocabulary to articulate ideas clearly and effectively in professional and academic contexts.                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                                                                                                                                                                                   | Use grammar accurately in written communication.                                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                                                                                                                                                                                   | Demonstrate proficiency in writing clear, structured responses, reviews, essays, and professional documents using appropriate tone, format, and language. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                                                                                                                                                                                   | Create professional documents as well as communicate effectively in professional scenarios, ensuring success in job and internship applications.          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                                                                                                                                                                                            |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1.English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition)                                                                                                          |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2.English for Science & Technology Cambridge University Press, 2021.                                                                                                                                                                  |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3.English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University. |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                                                                                                                            |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.                                                                                                                               |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi                                                                                                                                          |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003                                                                                                                                                    |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.                                                                                                     |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.                                                                                                                                |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO-PO, PSO Mapping                                                                                                                                                                                                                    |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'                                                                                             |                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                       | PO1                                                                                                                                                       | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                                                                                   | 0                                                                                                                                                         | 0   | 0   | 0   | 1   | 0   | 1   | 2   | 3   | 2    | 2    | -    | -    | -    |
| CO2                                                                                                                                                                                                                                   | 0                                                                                                                                                         | 0   | 0   | 0   | 1   | 0   | 1   | 3   | 3   | 2    | 2    | -    | -    | -    |
| CO3                                                                                                                                                                                                                                   | 0                                                                                                                                                         | 0   | 0   | 0   | 1   | 0   | 1   | 1   | 3   | 2    | 2    | -    | -    | -    |
| CO4                                                                                                                                                                                                                                   | 0                                                                                                                                                         | 0   | 0   | 0   | 1   | 1   | 2   | 3   | 3   | 3    | 2    | -    | -    | -    |
| CO5                                                                                                                                                                                                                                   | 0                                                                                                                                                         | 0   | 0   | 0   | 1   | 1   | 2   | 2   | 3   | 3    | 3    | -    | -    | -    |
| AVG                                                                                                                                                                                                                                   | -                                                                                                                                                         | -   | -   | -   | 1.0 | 0.4 | 1.4 | 2.2 | 3   | 2.4  | 2.2  | -    | -    | -    |



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| U24MA204                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MATHEMATICS FOR ELECTRICAL ENGINEERING                                                                                                                                                                     | L | T | P | C   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                            | 3 | 1 | 0 | 4   |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                            |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To introduce the basic concepts of differential equation and to find its solutions.                                                                                                                        |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To understand the basic concept of Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients. |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To acquaint the knowledge of Analytic functions and conformal mapping.                                                                                                                                     |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To make the students to understand the methods of complex analysis be used for efficiently solving the problems that occur in various branches of engineering disciplines.                                 |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | To familirize the students with Gradient, divergence and curl of a vector point function and related identities                                                                                            |   |   |   |     |
| UNIT 1 DIFFERENTIAL EQUATIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                            |   |   |   | 9+3 |
| Higher order linear differential equations with constant coefficients - Method of variation of parameters – Homogenous equation of Euler’s and Legendre’s type – System of simultaneous linear differential equations with constant coefficients .<br><b>Experiential Learning</b> : MATLAB – Solving ordinary differential equations with constant coefficients (Homogeneous case)<br><b>Industrial applications</b> : Heat Transfer: In electronic devices, differential equations model heat conduction and convection, ensuring components operate within safe temperature limits.<br><b>Content beyond syllabus</b> : Solving ODE by using Method of undetermined coefficients.                                                                                                                                                                                |                                                                                                                                                                                                            |   |   |   |     |
| UNIT 2 LAPLACE TRANSFORMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                            |   |   |   | 9+3 |
| Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.<br><b>Experiential Learning</b> : MATLAB – Solving differential equations using Laplace Transform.<br><b>Industrial Application</b> : Modulation and Demodulation: The Laplace Transform helps in analysing modulated signals and designing demodulation techniques, ensuring effective data transmission and reception.<br><b>Content Beyond Syllabus</b> : Solving Simultaneous differential equation using Laplace Transform. |                                                                                                                                                                                                            |   |   |   |     |
| UNIT 3 ANALYTIC FUNCTIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                            |   |   |   | 9+3 |
| Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c$ , $cz$ , $1/z$ , - Bilinear transformation.<br><b>Experiential Learning</b> : MATLAB :To plot the real and imaginary parts of an analytic function over a region of the complex plane using fplot or fsurf.<br><b>Industrial Applications</b> : Telecommunications Modulation Techniques: Analytic functions are used in various modulation schemes (e.g., amplitud modulation, frequency modulation) to describe signal characteristics and behavior                                                                                                                                                                     |                                                                                                                                                                                                            |   |   |   |     |



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**content beyond syllabus :** Find the image of rectangular region of Z-Plane under the transformation  $W=Z^2$

**UNIT 4 COMPLEX INTEGRATION**

**9+3**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi circular contour.

**Experiential Learning :** MATLAB : Activity - Numerical Complex Integration Along a Circular Contour

**Industrial Application :** Determine the complex stresses of materials and model vibration and dynamic behaviour

**Content Beyond Syllabus :** Consider a function representing temperature distribution  $T(z)$ , where  $z$  is a complex variable, using contour integration to evaluate the integral over closed contour.

**UNIT 5 VECTOR CALCULUS**

**9+3**

Differentiation of vectors: Gradient, Divergence, Curl and Directional derivatives – Line, Surface and Volume Integrals - Statement of Green's, Gauss divergence and Stoke's theorem - Simple applications involving rectangular parallelepiped and cubes.

**Experiential Learning :** MATLAB : Activity - 1. Computation of Directional derivatives and  
 2. Computation of normal and tangent to the given surface

**Industrial Application :** concepts of temperature gradients and fluid velocity

**Content Beyond Syllabus :** A mosquito is at the location  $(3,2,1)$  in  $R^3$ . She knows that the temperature  $T$  near there is given by  $T=2x^2+y^2-z^2$ .

(i). She wishes to stay at the same temperature, but must fly in some initial direction. Find a direction in which the initial rate of change of the temperature is 0.

(ii). If you and another student both get correct answers in part (a), must the directions you give be the same? Why or why not?

(iii). What initial direction or directions would suit the mosquito if she wanted to cool down as fast as possible?

**TOTAL PERIODS**

**60**

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Apply various techniques in solving differential equations.                                                            |
| <b>CO2</b> | Analyze Laplace transformation concepts and apply them to solve differential equations with given boundary conditions. |
| <b>CO3</b> | Construct analytic functions and apply conformal mapping.                                                              |
| <b>CO4</b> | Apply and evaluate complex integration for contour integrals.                                                          |
| <b>CO5</b> | Estimate vector identities and interpret integral theorems in a vector field.                                          |

**TEXT BOOKS**

|    |                                                                                                                                                                 |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Veerarajan.T, "Engineering Mathematics, for semester I and II", Updated second Edition, Tata McGraw Hill Education , private Limited ,2019.                     |
| 2. | Grewal B.S and Grewel J.S . "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 45th Edition, 2020.                                                 |
| 3. | Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, H. Jin Kim, Taeho Im, "Engineering Mathematics with MATLAB" CRC Press Publishers , I st Edition , 2017. |

**REFERENCES**





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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 |   |   |   |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|---|---|---|---|
| U24TA201                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | தமிழரும் தொழில்நுட்பமும் /TAMILS AND TECHNOLOGY | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 | 1 | 0 | 0 | 1 |
| அலகு I நெசவுமற்றும் பானைத்தொழில்நுட்பம்:<br>UNIT I WEAVING AND CERAMIC TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                 | 3 |   |   |   |
| சங்ககாலத்தில் நெசவுத்தொழில் - பானைத்தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல்குறியிடிகள்                                                                                                                                                                                                                                                                                                                                                                                         |                                                 |   |   |   |   |
| Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.                                                                                                                                                                                                                                                                                                                                                                                  |                                                 |   |   |   |   |
| அலகு II வடிவமைப்பு மற்றும் கட்டிடத்தொழில்நுட்பம்:<br>UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                        |                                                 | 3 |   |   |   |
| சங்ககாலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்ககாலத்தில் வீட்டுப்பொருட்களில் வடிவமைப்பு - சங்ககாலத்தில் கட்டுமானப்பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடைஅமைப்புபற்றியவிவரங்கள் - மாமல்லபுரச்சிற்பங்களும், கோவில்களும் - சோழர்காலத்துப்பெருங்கோவில்கள் மற்றும் பிறவழிபாட்டுத்தலங்கள் - நாயக்கர்காலகோவில்கள் - மாதிரிகட்டமைப்புகள் பற்றிய அறிதல், மதுரைமீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலைநாயக்கர்மஹால் - செட்டிநாடுவீடுகள் - பிரிட்டிஷ்காலத்தில் சென்னையில் இந்தோ-சரோசெனிக்கட்டிடக்கலை |                                                 |   |   |   |   |
| Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.                    |                                                 |   |   |   |   |
| அலகு III உற்பத்தித்தொழில்நுட்பம் :<br>UNIT III MANUFACTURING TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 | 3 |   |   |   |
| கப்பல்கட்டும்கலை - உலோகவியல் - இரும்புத்தொழிற்சாலை - இரும்பைஉருகுக்குதல், எஃகு - வரலாற்றுச்சான்றுகளாகசெம்பு மற்றும் தங்கநாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணிஉருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடிமணிகள் - சுடுமண்மணிகள் - சங்குமணிகள் - எலும்புத்துண்டுகள் - தொல்லியல்சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின்வகைகள்                                                                                                                                                                         |                                                 |   |   |   |   |
| Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.                                                                                                                                                                           |                                                 |   |   |   |   |
| அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத்தொழில்நுட்பம்:<br>UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY                                                                                                                                                                                                                                                                                                                                                                                                   |                                                 | 3 |   |   |   |
| அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக்குமிழித்தூம்பின் முக்கியத்துவம் - கால்நடைபராமரிப்பு - கால்நடைகளுக்காகவடிவமைக்கப்பட்டகிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச்சார்ந்த செயல்பாடுகள் - கடல்சார்அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல்குறித்தபண்டைய அறிவு - அறிவுசார்சமூகம்                                                                                                                                                                                                    |                                                 |   |   |   |   |





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Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**அலகு V அறிவியல்தமிழ் மற்றும் கணித்தமிழ் :**

**UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**

**3**

அறிவியல்தமிழின்வளர்ச்சி - கணித்தமிழ்வளர்ச்சி - தமிழ்நூல்களையின்பதிப்பு செய்தல் - தமிழ்மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக்கல்விக்கழகம் - தமிழ் மின்நூலகம் - இணையத்தில்தமிழ் அகராதிகள் - சொற்குவைத்திட்டம்.

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

**TOTAL PERIODS**

**15**

## TEXT BOOKS

1. தமிழகவரலாறு - மக்களும்பண்பாடும் - கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடுபாடநூல் மற்றும் கல்வியியல்பணிகள்கழகம்)
2. கணினித்தமிழ் - முனைவர்இல. சுந்தரம் (விகடன்பிரசுரம்)
3. கீழடி - வைகைநதிக்கரையில் சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4. பொருநை - ஆற்றங்கரைநாகரிகம் (தொல்லியல்துறைவெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies)
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies)
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by:DepartmentofArchaeology& Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.



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| U24PH204                                                                                                                                                                                                                                                                                                                                                                                                                              | PHYSICS FOR ELECTRICAL ENGINEERING- II                                                                                                                                                                | L | T | P | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                       | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                       |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                     | To provide students with a comprehensive understanding of the fundamental principles governing electrostatics, electric fields, electric potential, capacitance, and electrical circuits.             |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                     | To provide a comprehensive understanding of the fundamental principles of magnetism, its relationship with electric fields, and the mathematical frameworks that describe magnetic phenomena.         |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                     | To develop an understanding of the different types of magnetic behavior exhibited by materials, the underlying theories that explain these behaviors, and their practical applications in technology. |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                     | To understand the fundamental principles that govern the interaction between light and matter in semiconductor and organic semiconductor devices,                                                     |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                     | To provide a deep understanding of the physical principles and practical methods for creating, characterizing, and utilizing nanomaterials and plasma technology.                                     |   |   |   |   |
| UNIT 1 ELECTRICITY                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                       |   |   | 9 |   |
| Electric monopoles - Electric field- Electric flux - Electric potential - electrical energy- capacitor-Conductors and Insulators-Electric dipole and polarization - electric current -voltage sources- resistance-Maxwell's equation for electrostatics – E due to straight conductors, circular loop, infinite sheet of current -electric field intensity (D) - Electric potential .                                                 |                                                                                                                                                                                                       |   |   |   |   |
| Experiential Learning: Electromotive force & magnetomotive force<br>Industrial Applications: Ultracapacitor<br>Content Beyond Syllabus :Relation between electric .& magnetic circuits,                                                                                                                                                                                                                                               |                                                                                                                                                                                                       |   |   |   |   |
| UNIT 2 MAGNETISM                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                       |   |   | 9 |   |
| Sources of magnetism- Monopoles-Magnetic field and force-magnetic field and current distribution-magnetic dipole- Magnetic potential energy-Inductor- Electric and magnetic field comparison,Maxwell's equation for magnetostatics - B in straight conductors, circularloop, infinite sheet of current - Lorentz force, magnetic field intensity (H) – Magnetic flux density (B) – magnetic materials – Magnetization – Applications. |                                                                                                                                                                                                       |   |   |   |   |
| Experiential learning: Magnetic sensors<br>Industrial Application: Magnetic levitation<br>Content Beyond Syllabus : Electromagnetic interference(shielding),                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                       |   |   |   |   |
| UNIT 3 MAGNETIC MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                       |   |   | 9 |   |
| Magnetic Materials : Properties of dia, para, ferro, anti ferro and ferri magnetic materials -Langevin's theory of paramagnetism – Weiss theory of Ferromagnetism – Domain theory of ferromagnetism - hysteresis – soft and hard magnetic materials – Ferrites – Applications -magnetic recording and readout - Storage of magnetic data, Tapes, floppy,magnetic disc drives –Bubble memor                                            |                                                                                                                                                                                                       |   |   |   |   |
| Experiential Learning:Ferromagnetic energy loss(Apparatus available in Physics)<br>Industrial application: Sensors in keyboard functions. mouses and track pads, wearable devices.<br>Content Beyond Syllabus: Magnetic bubble memory.                                                                                                                                                                                                |                                                                                                                                                                                                       |   |   |   |   |
| UNIT 4 OPTICAL PROPERTIES OF MATERIALS                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                       |   |   | 9 |   |
| Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain -- Optoelectronic devices: light detectors and solar cells – light emitting                                                                                                                                                                                                               |                                                                                                                                                                                                       |   |   |   |   |



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diode – LASER Diodes- optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators (Amplitude type)

**Experiential Learning:** solar cell( taking students to the solar panel in the campus)  
**Industrial application:** Quality control,fabrication and precision processes  
**Content Beyond Syllabus:** organic light emitting diode

|                                                    |          |
|----------------------------------------------------|----------|
| <b>UNIT 5 PLASMA TECHNOLOGY AND NANO MATERIALS</b> | <b>9</b> |
|----------------------------------------------------|----------|

Plasma Technology: properties of plasma- types of plasma- thermal and non thermal plasma-Production of glow discharge plasma-Cold plasma-applications  
 Nano Materials - synthesis - plasma arcing – Chemical vapour deposition – sol-gel - Electro deposition – ball milling – properties of nanoparticles and applications-Supercapacitors. – Carbon nano tubes –fabrication - arc method – pulsed laser deposition - Chemical vapour deposition - structure,properties & applications.

**Experiential Learning:** Nanotechnology in Integrated Circuits (ICs)  
**Industrial application:** Plasma for Electromagnetic Field (EMF) Manipulation  
**Content Beyond Syllabus:** Carbon Nanotubes and Graphene in Conductors

|                      |           |
|----------------------|-----------|
| <b>TOTAL PERIODS</b> | <b>45</b> |
|----------------------|-----------|

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Analyze and evaluate electric fields and potentials for various charge distributions using electric flux, polarization, and Maxwell's equations in practical electrostatics problems |
| <b>CO2</b> | Apply magnetostatics principles to analyze magnetic fields, calculate H and B, and evaluate the effects of magnetic materials and inductors in practical applications                |
| <b>CO3</b> | Analyze the properties and theories of magnetic materials and evaluate their applications in ferrites and magnetic data storage devices.                                             |
| <b>CO4</b> | Analyze optical processes in semiconductors and evaluate the operation of optoelectronic devices, including LEDs, LASER diodes, solar cells, and optical modulators.                 |
| <b>CO5</b> | Evaluate the properties and applications of nanoparticles in energy storage devices including supercapacitors.                                                                       |

**TEXT BOOKS**

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017
- 2.E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGrawHill (Indian Edition), 2017.

**REFERENCES**

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019
- 4.D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.

|  |                                                                                                             |
|--|-------------------------------------------------------------------------------------------------------------|
|  | <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b> |
|--|-------------------------------------------------------------------------------------------------------------|



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|     | Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|-----|----------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
|     | PO1                                                            | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1 | 3                                                              | 3   | 2   | 2   | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 3    | 2    |  |
| CO2 | 3                                                              | 3   | 2   | 2   | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 3    | 2    |  |
| CO3 | 3                                                              | 3   | 2   | 2   | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 3    | 2    |  |
| CO4 | 3                                                              | 3   | 2   | 1   | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 2    | 2    |  |
| CO5 | 3                                                              | 3   | 2   | 1   | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 2    | 2    |  |
| AVG | 3                                                              | 3   | 2   | 1.6 | 1   | -   | -   | -   | 1   | 1    | -    | 3    | 2.6  | 2    |  |



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| U24CY201                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | GREEN AND SUSTAINABLE CHEMISTRY                                                                                                                                | L | T | P | C        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                | 2 | 0 | 0 | 2        |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                |   |   |   |          |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Provide students with fundamental knowledge in addressing global environmental challenges and climate change-related issues.                                   |   |   |   |          |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Enable students to understand and analyze the interconnectedness of the biosphere, ecosystems, and the health of humans and animals.                           |   |   |   |          |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Equip students with the ability to apply environmental chemistry principles to study the chemical behavior, and impacts of pollutants in air, water, and soil. |   |   |   |          |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Develop the capability to evaluate and compare various renewable and non-renewable energy system in terms of their environmental effects, and sustainability.  |   |   |   |          |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Develop the capability to evaluate and compare various renewable and non-renewable energy system in terms of their environmental effects, and sustainability.  |   |   |   |          |
| <b>UNIT 1 ROLE OF CHEMISTRY - CURRENT CHALLENGES FOR SUSTAINABLE DEVELOPMENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                |   |   |   | <b>6</b> |
| Role of chemistry in addressing the challenges for sustainable development and solving global issues. Nexus among biosphere environment, human and animal health. Introduction to bio-diversity-threats and conservation of bio-diversity. Millennium development goals (MDG) and sustainable development goals (SDG), clean development mechanism (CDM).<br><br><a href="#">Experiential Learning: Climate Action</a><br><a href="#">Industrial Application: Green chemistry in pharmaceutical industry.</a><br><a href="#">Content Beyond Syllabus: Pollution Reduction.</a>                                                                     |                                                                                                                                                                |   |   |   |          |
| <b>UNIT 2 SUSTAINABLE ENVIRONMENTAL CHEMISTRY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                |   |   |   | <b>6</b> |
| Climate change – greenhouse effect - global warming - sea level rise - intrusion and inundation, , ozone layer depletion, El Niño and La Niña – carbon credits, carbon trading ,carbon foot print, legal provision for environmental protection, coastal zone management-soft and hard measures, Ecosystem – estuaries - corals, mangroves, wetlands, sand dunes etc.<br><br><a href="#">Experiential Learning: Volcanic eruption.</a><br><a href="#">Industrial Application: Eco friendly products.</a><br><a href="#">Content Beyond Syllabus: Pollution Act.</a>                                                                                |                                                                                                                                                                |   |   |   |          |
| <b>UNIT 3 PRINCIPLES OF SUSTAINABLE GREEN CHEMISTRY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                |   |   |   | <b>6</b> |
| Sources, reactions and effect of chemicals in environments – Factory effluent and treatment, Handling of Hazards-Design of green pesticides for agriculture.- Introduction to Biocides: types and applications, Organic Insecticides – Carbamates, Chlorinated hydrocarbons, cypermethrin, Pyrethrin, silica gel, rotenone- synthesis properties and practical applications. -reduction of toxicity, improved recycling and improved product performance.<br><br><a href="#">Experiential Learning: Roof Garden</a><br><a href="#">Industrial Application: Organic farming</a><br><a href="#">Content Beyond Syllabus : Chlorinated Pesticides</a> |                                                                                                                                                                |   |   |   |          |
| <b>UNIT 4 SUSTAINABLE ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                |   |   |   | <b>6</b> |
| Present energy challenges and the possible energy solutions - Solar energy- Solar panel-Solar water heater-solar heat collector and applications- Wind energy- Types – production - advantages and disadvantages-applications. Nuclear energy – production - advantages and disadvantages- applications. Geothermal energy – Production and applications – Bio fuels.                                                                                                                                                                                                                                                                              |                                                                                                                                                                |   |   |   |          |



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Experiential Learning: PV Cell  
Industrial Application: Sustainable Transport  
Content Beyond Syllabus: Biomass energy

**UNIT5 GOOD HEALTH AND WELL BEING -WATER-SOIL-AIR**

**6**

Ground water contamination and contamination of water bodies. The role of chemistry in developing appropriate technological solutions for water treatment using Electrodialysis, Forward osmosis and advanced oxidation using photocatalysis and waste water treatment. Reclamation of soil. Current air pollution situation and trends. Factors responsible for air pollution. Air pollution assessment, monitoring and mitigation.

Experiential Learning: Clean Water and Sanitation  
Industrial Application: Sustainable Home  
Content Beyond Syllabus: Life on Land

**TOTAL PERIODS 30**

**Course Outcomes**

At the end of the course, the student will be able to

|     |                                                                                                                                          |
|-----|------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Explain the role of chemistry in sustainable development and global environmental change issues.                                         |
| CO2 | Study the interrelationship among the biosphere, ecosystems, human and animal health, and evaluate ecosystem                             |
| CO3 | Apply environmental chemistry principles to identify the sources, reactions, and impacts of chemicals and pollutants in the environment. |
| CO4 | Evaluate renewable and non-renewable energy systems and assess their environmental, technological, and sustainability implications.      |
| CO5 | Design appropriate chemistry-based solutions for wastewater treatment, soil reclamation, and air pollution monitoring and mitigation.    |

**TEXT BOOKS**

- 1.Anubha Kaushik and C.P. Kaushik's "Perspectives in Environmental Studies",6th Edition, NewAge International Publishers ,2018.
- 2.BennyJoseph, 'Environmental Science and Engineering',TataMcGraw-Hill,NewDelhi,2016.
- 3.Gilbert M.Masters, 'Introduction to Environmental Engineering and Science',2ndedition,Pearson Education, 2004.
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6. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

**CO-PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 2   | 1   | 1   | -   | -   | 1   | 3   | 2   | 2    | 2    | -    | -    | -    |
| CO2 | 2   | 3   | 1   | 2   | -   | -   | 1   | 3   | 2   | 2    | 2    | -    | -    | -    |
| CO3 | 3   | 2   | 2   | 2   | -   | -   | 1   | 3   | 2   | 2    | 2    | -    | -    | -    |
| CO4 | 2   | 3   | 2   | 2   | -   | -   | 1   | 3   | 2   | 1    | 2    | -    | -    | -    |
| CO5 | 3   | 3   | 3   | 3   | -   | -   | 1   | 3   | 2   | 2    | 2    | -    | -    | -    |
| AVG | 2.6 | 2.6 | 1.8 | 2   | -   | -   | 1   | 3   | 2   | 1.8  | 2    | -    | -    | -    |





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| U24CS201                                                                                                                                                                                                                                                                                                                                                                                                                                                         | PYTHON PROGRAMMING                                                                     | L | T | P     | C   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---|---|-------|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                        | 3 | - | 3     | 4.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                        |   |   |       |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To understand the basics of python programming.                                        |   |   |       |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To define Python functions and strings.                                                |   |   |       |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To use Python data structures - lists, tuples, dictionaries to represent complex data. |   |   |       |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To perform file operations in Python.                                                  |   |   |       |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To learn & use python libraries.                                                       |   |   |       |     |
| UNIT 1 INTRODUCTION TO PYTHON                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                        |   |   | 9 + 9 |     |
| Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: circulate the values of n variables, distance between two points.                                                                                                                                                                   |                                                                                        |   |   |       |     |
| Practicals:<br>1.Implement a python program to print an Electricity Bill. (for domestic usage.)<br>2.Implement a Python program to exchange the values of two variables. (using simple statements and expressions )                                                                                                                                                                                                                                              |                                                                                        |   |   |       |     |
| UNIT 2 CONTROL FLOW, FUNCTIONS, STRINGS                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                        |   |   | 9 + 9 |     |
| Conditionals: Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while,for, break, continue, pass; Fruitful functions, return values, parameters, local and global scope, function composition,Lambda functions, recursion; Strings: string slices, immutability, string functions and methods, string module; Illustrative programs: square root, sum of individual digits of a number. |                                                                                        |   |   |       |     |
| Practicals:<br>1.Implement a Python program to print a Number series & Number Patterns.(using Iterative loops).<br>2.Implement a Python program to find Factorial and largest number in a list(using Functions.).<br>3.Implement a Python program to perform operations on strings like string reverse,string concatenation & substring .(use switch case).                                                                                                      |                                                                                        |   |   |       |     |
| UNIT 3 LISTS, TUPLES, DICTIONARIES                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                        |   |   | 9 + 9 |     |
| Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs:Students marks statement,Linear Search, Binary Search.                                                                                                                           |                                                                                        |   |   |       |     |
| Practicals:<br>1.Implement a Python program using Lists & Tuples. (operations of list & tuples - Book Catalogue)<br>2.Implement a Python program using Sets, Dictionaries. (operations of Sets - Product Categories , operations on Dictionaries - Product Categories)                                                                                                                                                                                           |                                                                                        |   |   |       |     |
| UNIT 4 FILES, EXCEPTIONS AND MODULES                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                        |   |   | 9 + 9 |     |
| Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages, Python Itertools&functools modules, Illustrative programs: Marks range validation.                                                                                                                                                                                                          |                                                                                        |   |   |       |     |
| Practicals:<br>1.Implement a Python program to perform file operations (copy from one file to another, word count, longest word).<br>2.Implement a Python program to handle Exceptions.( voter’s age validity).                                                                                                                                                                                                                                                  |                                                                                        |   |   |       |     |
| UNIT 5 LIBRARIES, PACKAGES                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                        |   |   | 9 + 9 |     |



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Python libraries - NumPy -Array manipulations, numeric ranges, Slicing, indexing, Searching, Sorting, and splitting, Pandas - Data Analysis, Data-frame, Data selection, group-by, Series, sorting, searching, and statistics, dask (pandas wrapper) ,Matplotlib- Data visualization , Line plot, Style properties, multi line plot, scatter plot

**Practicals:**

1.Implement a Python program to create a weather data chart using Python Standard Libraries (pandas, numpy. Matplotlib, scipy ) .

**TOTAL PERIODS** **90**

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                  |
|------------|------------------------------------------------------------------|
| <b>CO1</b> | Develop and execute simple Python programs                       |
| <b>CO2</b> | Learn to handle strings and functions in python.                 |
| <b>CO3</b> | Represent compound data using Python lists, tuples, dictionaries |
| <b>CO4</b> | Read and write data from/to files in Python programs.            |
| <b>CO5</b> | Perform basic operations using python Libraries                  |

**TEXT BOOKS**

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
- 2.Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS

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1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling
- 4.Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
- 5.Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|------|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | -    | 2   | -   | -   | -   | -   | -    | 1    | -    | -    | -    |
| <b>CO2</b> | 3   | 3   | -   | -    | 2   | -   | -   | -   | -   | -    | 1    | -    | -    | -    |
| <b>CO3</b> | 2   | 3   | 2   | -    | 3   | -   | -   | 1   | -   | -    | 1    | -    | -    | -    |
| <b>CO4</b> | 2   | 2   | -   | 3    | 3   | -   | -   | -   | 1   | -    | 2    | -    | -    | -    |
| <b>CO5</b> | 1   | 2   | -   | 2    | 3   | -   | -   | 1   | 1   | -    | 3    | -    | -    | -    |
| <b>AVG</b> | 2.2 | 2.4 | 2   | 2.32 | 2.6 | -   | -   | 1   | 1   | -    | 1.6  | -    | -    | -    |



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|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                             |   |   |     |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---|---|-----|---|
| U24CE203                                                                                                                                                                                                                                                                                                                                                                     | ENGINEERING GRAPHICS FOR ELECTRONICS<br>AND COMMUNICATION ENGINEERING                                                       | L | T | P   | C |
|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                             | 6 | - | 9   | 4 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                             |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                                            | To learn the construction of engineering curves and projection techniques for constructing conic curves, points, and lines. |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                            | To understand the techniques for projecting and visualizing surfaces and solids in various orientations.                    |   |   |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                                            | To determine the true shape of sectioned solids and develop their lateral surfaces.                                         |   |   |     |   |
| 4                                                                                                                                                                                                                                                                                                                                                                            | To develop skills in 3D projection and perspective projection techniques for simple solids.                                 |   |   |     |   |
| 5                                                                                                                                                                                                                                                                                                                                                                            | To introduce simulations, 2D/3D transformations and their applications in engineering graphics.                             |   |   |     |   |
| UNIT 1 PLANE CURVES , PROJECTION OF POINTS AND STRAIGHT LINES                                                                                                                                                                                                                                                                                                                |                                                                                                                             |   |   | 6+9 |   |
| Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method. Orthographic projection- Principles-Principal Planes-First angle projection-projection of points and straight lines inclined to both the principal planes                                                            |                                                                                                                             |   |   |     |   |
| UNIT II PROJECTION OF PLANES AND SOLIDS                                                                                                                                                                                                                                                                                                                                      |                                                                                                                             |   |   | 6+9 |   |
| Projection of planes inclined to both the principal planes -. Projection of simple solids like prisms, pyramids, cylinder, and cone. When the axis is inclined to one of the principal planes and parallel to the other by rotating object method.                                                                                                                           |                                                                                                                             |   |   |     |   |
| UNIT III PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES                                                                                                                                                                                                                                                                                                          |                                                                                                                             |   |   | 6+9 |   |
| Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other —obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.                                                                         |                                                                                                                             |   |   |     |   |
| UNIT IV ISOMETRIC AND PERSPECTIVE PROJECTION                                                                                                                                                                                                                                                                                                                                 |                                                                                                                             |   |   | 6+9 |   |
| Principles of isometric projection — isometric scale —isometric projections of simple solids - Freehand sketching of multiple views from pictorial views of objects. Perspective projection of simple Solids-Prisms, pyramids and cylinders by visual ray method.                                                                                                            |                                                                                                                             |   |   |     |   |
| UNIT V FUNDAMENTALS OF ELECTRONIC CIRCUIT DRAWING                                                                                                                                                                                                                                                                                                                            |                                                                                                                             |   |   | 6+9 |   |
| Standard Electrical Signs and Symbols used in Electrical and Electronic Practices and trades – Sketch of various components – Wiring diagrams and Layout diagrams – Different Substation layouts from high voltage to domestic three phase distribution networks, earthing – Plate earthing – pipe earthing, MATLAB – Simulink Basics – Schematic. ORCAD – Simple Schematic. |                                                                                                                             |   |   |     |   |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                             |   |   | 75  |   |



At the end of the course, the student will be able to

|     |                                                                                                            |
|-----|------------------------------------------------------------------------------------------------------------|
| CO1 | Master basic geometric constructions essential for engineering applications and projecting straight lines. |
| CO2 | Acquire skills in planes, and solids using first angle projection.                                         |
| CO3 | Learn techniques for sectioning solids and developing their surfaces.                                      |
| CO4 | Understand principles of isometric and perspective projection for realistic representation.                |
| CO5 | Understand the role of simulations in engineering graphics and perform geometric transformations.          |

|                                                                                                     |
|-----------------------------------------------------------------------------------------------------|
| 1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53 Edition, 2019. |
| 2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.    |
| 3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015       |
| 4. John Molnar P E, “Building Construction Drafting and Design”, CBS, 1987                          |

|                                                                                                                                                                                                                                           |
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| 1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edition, 2019.                                                                                                                                                |
| 2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.                                                                                                                    |
| 3. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005. |
| 4. Parthasarathy N. S. and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.                                                                                                                                |
| 5. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India, 2nd Edition, 2009.                                                                                                                                           |
| 6. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.                                                                                                                                      |
| 7. Autodesk Fusion 360 For Beginners: Part Modeling, Assemblies, and Drawings – Tutorial Book                                                                                                                                             |

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

[illegible]



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| U24ME101                                                                                       |                                                                                                                                                                                                                                                                   | ENGINEERING PRACTICES LABORATORY |  | L | T | P | C |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|--|---|---|---|---|
|                                                                                                |                                                                                                                                                                                                                                                                   |                                  |  | 0 | 0 | 4 | 2 |
| Course Objectives                                                                              |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| The main learning objective of this course is to provide hands on training to the students in: |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 1                                                                                              | Draw pipe line plan; layout and connect various pipe fittings used in common household plumbing work                                                                                                                                                              |                                  |  |   |   |   |   |
| 2                                                                                              | To make wood joints commonly used in household wood.                                                                                                                                                                                                              |                                  |  |   |   |   |   |
| 3                                                                                              | To make various electrical connections in typical household electrical wiring installations.                                                                                                                                                                      |                                  |  |   |   |   |   |
| 4                                                                                              | Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work. |                                  |  |   |   |   |   |
| 5                                                                                              | Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.                                                                                                                                                                |                                  |  |   |   |   |   |
| GROUP – A (CIVIL & ELECTRICAL)                                                                 |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| PART I CIVIL ENGINEERING PRACTICES 15                                                          |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| LIST OF EXPERIMENTS IN PLUMBING WORK                                                           |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 1                                                                                              | a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.                                                                                                        |                                  |  |   |   |   |   |
|                                                                                                | b) Preparing plumbing line sketches.                                                                                                                                                                                                                              |                                  |  |   |   |   |   |
|                                                                                                | c) Laying pipe connection to the suction side of a pump                                                                                                                                                                                                           |                                  |  |   |   |   |   |
|                                                                                                | d) Laying pipe connection to the delivery side of a pump.                                                                                                                                                                                                         |                                  |  |   |   |   |   |
|                                                                                                | e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.                                                                                                                                                       |                                  |  |   |   |   |   |
| LIST OF EXPERIMENTS IN WOOD WORK                                                               |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 2                                                                                              | a) Sawing,                                                                                                                                                                                                                                                        |                                  |  |   |   |   |   |
|                                                                                                | b) Planning and                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
|                                                                                                | c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.                                                                                                                                                                                  |                                  |  |   |   |   |   |
| Wood Work Study                                                                                |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 3                                                                                              | a) Studying joints in door panels and wooden furniture                                                                                                                                                                                                            |                                  |  |   |   |   |   |
|                                                                                                | b) Studying common industrial trusses using models.                                                                                                                                                                                                               |                                  |  |   |   |   |   |
| PART II ELECTRICAL ENGINEERING PRACTICES 15                                                    |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| LIST OF EXPERIMENTS                                                                            |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 4                                                                                              | a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket                                                                                                                                          |                                  |  |   |   |   |   |
| 5                                                                                              | b) Staircase wiring                                                                                                                                                                                                                                               |                                  |  |   |   |   |   |
| 6                                                                                              | c) Fluorescent Lamp wiring with introduction to CFL and LED types.                                                                                                                                                                                                |                                  |  |   |   |   |   |
| 7                                                                                              | d) Energy meter wiring and related calculations/ calibration                                                                                                                                                                                                      |                                  |  |   |   |   |   |
| 8                                                                                              | e) Study of Iron Box wiring and assembly                                                                                                                                                                                                                          |                                  |  |   |   |   |   |
|                                                                                                | f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)                                                                                                                                                                            |                                  |  |   |   |   |   |
|                                                                                                | g) Study of emergency lamp wiring/Water heater                                                                                                                                                                                                                    |                                  |  |   |   |   |   |
| GROUP – B (MECHANICAL AND ELECTRONICS)                                                         |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| PART III MECHANICAL ENGINEERING PRACTICES 16                                                   |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| LIST OF EXPERIMENTS IN WELDING WORK                                                            |                                                                                                                                                                                                                                                                   |                                  |  |   |   |   |   |
| 9                                                                                              | a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.                                                                                                                                                                                          |                                  |  |   |   |   |   |
|                                                                                                | b) Practicing gas welding.                                                                                                                                                                                                                                        |                                  |  |   |   |   |   |



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**LIST OF EXPERIMENTS IN BASIC MACHINING WORK**

- 10 a) (simple)Turning.  
 b) (simple)Drilling.  
 c) (simple)Tapping.

**LIST OF EXPERIMENTS IN ASSEMBLY WORK**

- 11 a) Assembling a centrifugal pump.  
 b) Assembling a household mixer.  
 c) Assembling an airconditioner.

**LIST OF EXPERIMENTS IN SHEET METAL WORK**

- 12 a) Making of a square tray

**LIST OF EXPERIMENTS IN FOUNDRY WORK**

- 13 a) Demonstrating basic foundry operations.

**PART IV ELECTRONIC ENGINEERING PRACTICES**

**15**

**LIST OF EXPERIMENTS IN SOLDERING WORK**

- 14 a) Soldering simple electronic circuits and checking continuity.

**LIST OF EXPERIMENTS IN ELECTRONIC ASSEMBLY AND TESTING WORK**

- 15 a) Assembling and testing electronic components on a small PCB

**LIST OF EXPERIMENTS IN ELECTRONIC EQUIPMENT STUDY**

- 16 a)Study an elements of smart phone  
 17 b)Assembly and dismantle of LED TV  
 18 c)Assembly and dismantle of computer/ laptop

**TOTAL**

**60**

**COURSE OUTCOMES:**

**Upon completion of this course, the students will be able to:**

- 1 To practice and Experience the plumping work  
 2 To gain practical experience in carpentry by crafting a variety of joints.  
 3 To acquire knowledge in the methodology and techniques of wiring for electrical connections.  
 4 To gain knowledge in welding, sheet metal fabrication, and lathe operations.  
 5 To learn about electronic components, equipment, and their functions—such as resistors, color coding, measuring AC signal parameters, gates, circuits, and more.

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/<br>PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |
| CO2       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |
| CO3       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |
| CO4       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |
| CO5       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |
| AVG       | 3   | 2   | -   | -   | 1   | 1   | 1   | -   | -   | -    | 2    | 2    | 1    | 1    |



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| U24TP210                                                                                                                                                   | COMMUNICATION SKILLS LAB II                                                                                                        | L | T | P  | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                            |                                                                                                                                    | 0 | 0 | 2  | 1 |
| Course Objectives                                                                                                                                          |                                                                                                                                    |   |   |    |   |
| 1                                                                                                                                                          | Demonstrate understanding of spoken English in various contexts and participate in effective discussions in professional settings. |   |   |    |   |
| 2                                                                                                                                                          | Demonstrate effective speaking and presentation skills.                                                                            |   |   |    |   |
| 3                                                                                                                                                          | Identify appropriate group discussion skills and apply them to participate in effective professional discussions.                  |   |   |    |   |
| 4                                                                                                                                                          | Analyze issues and ideas to demonstrate critical thinking skills.                                                                  |   |   |    |   |
| 5                                                                                                                                                          | Apply communication strategies in real-life and workplace contexts through participation in mock interviews.                       |   |   |    |   |
| UNIT I                                                                                                                                                     |                                                                                                                                    |   |   | 6  |   |
| Listening: Listening to voicemail & messages, Audio texts, for writing short answers<br>Speaking: Conversation between the interlocutor and each candidate |                                                                                                                                    |   |   |    |   |
| UNIT II                                                                                                                                                    |                                                                                                                                    |   |   | 6  |   |
| Listening: Listening to podcasts, anecdotes and identifying topics, context etc..<br>Speaking: Presentation on any given topic (Non - Technical)           |                                                                                                                                    |   |   |    |   |
| UNIT III                                                                                                                                                   |                                                                                                                                    |   |   | 6  |   |
| Listening: One extended conversation or monologue - interview, discussion, lectures and educational videos<br>Speaking: Group Discussion.                  |                                                                                                                                    |   |   |    |   |
| UNIT IV                                                                                                                                                    |                                                                                                                                    |   |   | 6  |   |
| Listening: Listening to presentation and 5 min informal talk<br>Speaking: Presentation on any given topic (Technical)                                      |                                                                                                                                    |   |   |    |   |
| UNIT V                                                                                                                                                     |                                                                                                                                    |   |   | 6  |   |
| Listening: Listening to interview skills<br>Speaking: Mock interview                                                                                       |                                                                                                                                    |   |   |    |   |
| TOTAL PERIODS                                                                                                                                              |                                                                                                                                    |   |   | 30 |   |

| At the end of the course, the student will be able to |                                                                                                                                                                          |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1                                                   | Understand accurately and respond to a variety of spoken content to showcase their ability to capture both main ideas and supporting details.                            |
| CO2                                                   | Enhance the students to make effective presentations.                                                                                                                    |
| CO3                                                   | Speak effectively in group discussions held in a formal/semi-formal context.                                                                                             |
| CO4                                                   | Ability to interpret different genres of texts, infer implied meanings and evaluate it for ideas as well as for methods of presentation relevant in different situations |
| CO5                                                   | Motivate and prepare the students to attend job interviews and be successful in their pursuit.                                                                           |
| List of experiments                                   |                                                                                                                                                                          |
| 1                                                     | Conversation                                                                                                                                                             |
| 2                                                     | Presentation on any given topic ( Non - Technical)                                                                                                                       |
| 3                                                     | Group Discussion                                                                                                                                                         |





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|   |                                              |
|---|----------------------------------------------|
| 4 | Presentation on any given topic ( Technical) |
| 5 | Mock interview                               |

**ASSESSMENT PATTERN**

End Semester Listening & Speaking activity will be conducted.

**TEXT BOOKS**

1. Debra Daise, CharlNorloff, and Paul Carne Reading and Writing (Level 4) Oxford University Press: Oxford, 2011
2. Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011

**REFERENCES**

1. E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan: Hyderabad, 2012
2. Withrow, Jeans and et al. Inspired to Write. Readings and Tasks to develop writing skills. Cambridge University Press: Cambridge, 2004
3. English and Soft Skills, Dr. S.P. Dhanavel, Orient BlackSwan, 2013
4. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
5. Interact English Lab Manual for Undergraduate Students,. Orient Balck Swan: Hyderabad, 2016
- 6 E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
7. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
8. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 0   | 0   | 0   | 0   | 0   | 1   | 2   | 2   | 3   | 2    | 2    | -    | -    | -    |
| CO2 | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 2   | 2   | 2    | 2    | -    | -    | -    |
| CO3 | 0   | 0   | 0   | 0   | 1   | 1   | 2   | 3   | 2   | 3    | 2    | -    | -    | -    |
| CO4 | 0   | 0   | 0   | 2   | 1   | 2   | 2   | 2   | 2   | 2    | 2    | -    | -    | -    |
| CO5 | 0   | 0   | 0   | 0   | 1   | 1   | 2   | 2   | 3   | 2    | 2    | -    | -    | -    |
| AVG | 0   | 0   | 0   | 0.4 | 0.6 | 1.2 | 1.8 | 2.2 | 2.4 | 2.2  | 2    | -    | -    | -    |



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| U24MA304                                                                                                                                                                                                                                                                                                                                                      | Transforms and Partial Differential Equations                                                                                                                                               | L | T | P   | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|-----|---|
|                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                             | 3 | 1 | 0   | 4 |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                             |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                             | To introduce the basic concepts of Partial differential equation and to find its solutions.                                                                                                 |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                             | To introduce Fourier series analysis which is vital to many applications in engineering apart from its use in solving boundary value problems.                                              |   |   |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                             | To acquaint the student with Fourier series techniques to solve heat and wave flow problems in engineering.                                                                                 |   |   |     |   |
| 4                                                                                                                                                                                                                                                                                                                                                             | To familiarize the student with Fourier transform techniques used in solving various practical engineering problems.                                                                        |   |   |     |   |
| 5                                                                                                                                                                                                                                                                                                                                                             | To introduce the effective mathematical tools for the solutions of difference equations that model several physical processes and to develop transform techniques for discrete time systems |   |   |     |   |
| UNIT 1 PARTIAL DIFFERENTIAL EQUATIONS                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                             |   |   | 9+3 |   |
| Formation of partial differential equations – Singular integrals – Solutions of standard types of first order partial differential equations (except $f(x^m z^k p, y^n z^k q) = 0$ ) – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous type. |                                                                                                                                                                                             |   |   |     |   |
| Experiential Learning: Solving PDEs Using MATLAB's Built-in Functions (MATLAB PDE Toolbox)                                                                                                                                                                                                                                                                    |                                                                                                                                                                                             |   |   |     |   |
| Industrial Application: Heat Dissipation in Power Electronics (Heat Conduction)                                                                                                                                                                                                                                                                               |                                                                                                                                                                                             |   |   |     |   |
| Content Beyond Syllabus: Formation of PDE of all planes which are at different distance from the origin                                                                                                                                                                                                                                                       |                                                                                                                                                                                             |   |   |     |   |
| UNIT 2 FOURIER SERIES                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                             |   |   | 9+3 |   |
| Dirichlet's conditions -Necessary and sufficient condition for existence of Fourier series –General Fourier series – Odd and even functions – Half range sine series –Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.                                                                                    |                                                                                                                                                                                             |   |   |     |   |
| Experiential Learning: Fourier Series Representation in MATLAB (Fourier Series Approximation of a Square Wave)                                                                                                                                                                                                                                                |                                                                                                                                                                                             |   |   |     |   |
| Industrial Application: Simplify complex periodic signals, enabling efficient design of circuits, signal processing, power systems, and control applications                                                                                                                                                                                                  |                                                                                                                                                                                             |   |   |     |   |
| Content Beyond Syllabus: Determine the first two harmonic of the Fourier series from the table which gives the different variations of a periodic function over the period T                                                                                                                                                                                  |                                                                                                                                                                                             |   |   |     |   |
| UNIT 3 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                             |   |   | 9+3 |   |
| Classification of PDE – Method of separation of variables – Fourier Series Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction.                                                                                                                   |                                                                                                                                                                                             |   |   |     |   |
| Experiential Learning: Solving PDEs in MATLAB: Finite Element Method (FEM)                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                             |   |   |     |   |
| Industrial Application: Heat Transfer and Thermal Systems                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |   |   |     |   |
| Content Beyond Syllabus: Problems on finding solution of one dimensional wave equation using real world object (Guitar String Vibration)                                                                                                                                                                                                                      |                                                                                                                                                                                             |   |   |     |   |
| UNIT 4 FOURIER TRANSFORMS                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                             |   |   | 9+3 |   |



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Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**Experiential Learning:** Fourier Transform in MATLAB: Two-Dimensional Fourier Transform (2D)

**Industrial Application:** Signal Processing in Remote Sensing

**Content Beyond Syllabus:** Self reciprocal of any Function using Sine and Cosine transform

## UNIT 5 Z – TRANSFORMS AND DIFFERENCE EQUATIONS

9+3

Z-transforms – Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems – Convolution theorem – Formation of difference equations – Solution of difference equations using Z – transform.

**Experiential Learning:** MATLAB Solving Higher-Order Difference Equations using Z Transforms

**Industrial Application:** Fourier Transform in Structural and Environmental Engineering AND Difference Equations in Transportation Engineering

**Content Beyond Syllabus:** Inverse Z-transforms by power series method

TOTAL PERIODS

60

### Course Outcomes

At the end of the course, the student will be able to

|     |                                                                                             |
|-----|---------------------------------------------------------------------------------------------|
| CO1 | Formulate and solve partial differential equations.                                         |
| CO2 | Evaluate Fourier series of periodic functions.                                              |
| CO3 | Apply the method of separation of variables to find the solution of heat and wave equation. |
| CO4 | Apply Fourier transform techniques.                                                         |
| CO5 | Examine Z transform techniques and solve difference equations.                              |

### TEXT BOOKS

- 1.Grewal B.S., "Higher Engineering Mathematics", 44<sup>th</sup> Edition, Khanna Publishers, New Delhi, 2017
- 2.Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley, India, 2016
- 3.Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.
- 4.Veerarajan.T, "Transforms and Partial Differential Equations", second Edition, Tata Mcgraw Hill Education, private Limited, 2014.
- 5.Won Y. Yang, Young K. Choi, Jaekwon Kim, Man Cheol Kim, H. Jin Kim, Taeho Im, "Engineering Mathematics with MATLAB" CRC Press Publishers, 1<sup>st</sup> Edition, 2017.

### REFERENCES

- 1.Dass, H.K., and Er. Rajnish Verma, "Higher Engineering Mathematics", S.Chand Private Ltd., 2011.
- 2.Peter V.O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012
- 3.James, G., "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
- 4.Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012



| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| CO2                                                                                                                                                             | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| CO3                                                                                                                                                             | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| CO4                                                                                                                                                             | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| CO5                                                                                                                                                             | 3   | 3   | 2   | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |
| AVG                                                                                                                                                             | 3   | 3   | 2.6 | -   | -   | -   | -   | -   | -   | -    | -    | 1    | -    | -    |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                        |   |   |   |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE301                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Electrical Machines - I                                                                                                                                                | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                        | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                        |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Introduce techniques of Magnetic-circuit and to understand the concept of electromechanical energy conversion system.                                                  |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Working principles of electrical machines using the concepts of electromechanical energy conversion principles and derive expressions for generated voltage and torque |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Familiarize the working principle of DC machines and identify the appropriate machine for a given application based on its characteristics.                            |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | To impart a knowledge of various losses taking place in D.C. machines and study the different testing methods to arrive at their performance.                          |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections.        |   |   |   |   |
| UNIT 1 MAGNETIC CIRCUITS & ELECTROMECHANICAL ENERGY CONVERSION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                        |   |   | 9 |   |
| <p>Magnetic circuits – Laws governing magnetic circuits –Flux linkage, Inductance and energy – Statically &amp; Dynamically induced EMF, Principle of electromechanical energy conversion forces and torque in magnetic field systems- energy balance in magnetic circuits- magnetic force-energy &amp; co-energy in singly excited and multi excited magnetic field system, mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines- magnetic saturation and leakage fluxes.</p> <p>Experiential Learning (Activity Based Learning simulate electromechanical energy conversion in rotating machines.</p> <p>Industrial Application: Magnetic actuators in relays, solenoids, circuit breakers</p> <p>Content Beyond Syllabus: Operation and V-I characteristics of Solar Cell</p> |                                                                                                                                                                        |   |   |   |   |
| UNIT 2 DC GENERATORS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                        |   |   | 9 |   |
| <p>Constructional features of a DC machine – Principle of Operation of DC generator – EMF equation – Methods of Excitation – Types of generators – No load and Load characteristics of DC generators – Commutation – Armature Reaction and its effects – Parallel operation of DC shunt generators – Applications.</p> <p>Experiential Learning: Build a small DC generator model using motor hardware kits</p> <p>Industrial Application: Used in small-scale power generation, welding generators, battery charging units</p> <p>Content Beyond Syllabus: Regenerative braking using DC generators</p>                                                                                                                                                                                                             |                                                                                                                                                                        |   |   |   |   |
| UNIT 3 DC MOTORS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                        |   |   | 9 |   |
| <p>Principle of operation, significance of back emf, torque equations and power developed by armature, types of DC motors — Electrical and Mechanical characteristics - Starting, speed control and braking of DC motors - Losses in DC machines, Efficiency, testing on dc machines- Brake test, Swinburne's and Hopkinson's test – Permanent magnet DC motors (PMDC) and its applications.</p> <p>Experiential Learning: Conduct speed control of DC motors using Arduino and PWM</p>                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                        |   |   |   |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Industrial Application: Electric traction systems (trains, trams), robotics, lifts, conveyors<br>Content Beyond Syllabus: IoT-based DC motor control system                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                    |
| <b>UNIT 4 TRANSFORMERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>9</b>                                                                                                                                                                           |
| Construction and principle of operation, equivalent circuit, phasor diagrams, testing - polarity test, open circuit and short circuit tests, voltage regulation, losses and efficiency, all day efficiency, Sumpner's test, separation of core losses, parallel operation of single-phase transformers, applications of single-phase transformer, Auto-Transformers – Construction, working, comparison with two winding transformers, Three phase Transformers – Construction and types of connections. |                                                                                                                                                                                    |
| Experiential Learning: Perform OC/SC test and compute equivalent circuit using simulation tools<br>Industrial Application: Power distribution, UPS systems, isolation transformers in medical equipment<br>Content Beyond Syllabus: Smart transformer monitoring systems using IOT                                                                                                                                                                                                                       |                                                                                                                                                                                    |
| <b>UNIT 5 APPLICATIONS OF DC MACHINES AND ELECTRIC VEHICLE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>9</b>                                                                                                                                                                           |
| Applications of DC Generators – Series, Shunt and Compound Generators as Boosters, Exciters and small power supplies, Applications of DC Motors – Series, Shunt and Compound Motors in Traction, Lathes, drilling machines, Presses, Electric Vehicles – Effectiveness of DC motors in Electric Vehicles – torque characteristics, speed control.                                                                                                                                                        |                                                                                                                                                                                    |
| Experiential Learning: Build a simulation model for EV with DC Motors<br>Industrial Application: Traction systems<br>Content Beyond Syllabus: Efficacy of AC and DC Machines in EVs - A Comparative analysis                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>45</b>                                                                                                                                                                          |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                    |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                    |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Able to understand and Apply the laws governing the electromechanical energy conversion for single and multiple excited systems.                                                   |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Able to understand the construction and working principle of DC machines. Interpret various characteristics of DC machines.                                                        |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Able to compute various performance parameters of the DC machines, by conducting suitable tests and interpret their characteristics.                                               |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Able to understand the working principle operation of single phase transformer including its equivalent circuit and how to determine the efficiency and regulation of transformer. |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Able to describe the working principle of auto transformer and three phase transformers with different types of connections.                                                       |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                    |
| 1. Nagrath, I.J. and Kothari.D.P., 'Electric Machines', McGraw-Hill Education, 2004                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                    |
| 2.Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Sixth edition, McGraw Hill Books Company, 2003.                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                    |
| 3.P.C. Sen'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd Edition 2013.                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                    |
| 4. M.N. Bandyopadhyay, 'Electrical Machines Theory and Practice', PHI Learning PVT                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                    |
| 5. Er. R.K. Rajput " Electrical Machines." Sixth edition, Lakshmi Publications Pvt.Ltd 2015                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                    |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                    |



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1. Stephen J. Chapman, 'Electric Machinery Fundamentals' 4th edition, McGraw Hill Education Pvt. Ltd, 2010.
2. B.R. Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, Reprint 2015.
3. B.L. Theraja and A.K. Theraja, 'A Textbook of Electrical Technology Vol II AC and DC Machines'.
4. P.C. Sen 'Principles of Electric Machines and Power Electronics' John Wiley & Sons; 3rd Edition 2013.
5. Theodore Wildi, "Electrical Machines, Drives, and Power Systems", Pearson Education., (5th Edition), 2002.

| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 3   | 2   | –   | –   | 1   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| CO2                                                                                                                                                             | 3   | 2   | –   | –   | 1   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| CO3                                                                                                                                                             | 2   | 3   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | –    |
| CO4                                                                                                                                                             | 3   | 2   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| CO5                                                                                                                                                             | 2   | 2   | –   | –   | 1   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |
| AVG                                                                                                                                                             | 2.6 | 2.2 | –   | 2.0 | 1.4 | –   | –   | –   | –   | –    | –    | 2.8  | 2.2  | –    |

| S.NO. | Product based Projects                                                                     |
|-------|--------------------------------------------------------------------------------------------|
| 1     | Compare experimental results with theoretical calculations of MMF and winding inductance.  |
| 2     | Analyze no-load & load characteristics, verify the EMF equation experimentally.            |
| 3     | Develop a speed control system for DC motors using Pulse Width Modulation (PWM) technique. |
| 4     | Conduct Open Circuit & Short Circuit Tests and analyse transformer efficiency.             |
| 5     | Implement automatic phase correction using microcontrollers and sensors.                   |





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|                                                                                                                                                                                                                                                                                                                         |                                                                                |        |        |        |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|--------|--------|--------|----------|
| U24EE302                                                                                                                                                                                                                                                                                                                | Electron Devices and Circuit                                                   | L<br>3 | T<br>0 | P<br>3 | C<br>4.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                       |                                                                                |        |        |        |          |
| 1                                                                                                                                                                                                                                                                                                                       | To understand the structure of basic electronic devices                        |        |        |        |          |
| 2                                                                                                                                                                                                                                                                                                                       | To be exposed to active and passive circuit elements                           |        |        |        |          |
| 3                                                                                                                                                                                                                                                                                                                       | To familiarize the operation and applications of transistor like BJT and FET.  |        |        |        |          |
| 4                                                                                                                                                                                                                                                                                                                       | To explore the characteristics of amplifier gain and frequency response        |        |        |        |          |
| 5                                                                                                                                                                                                                                                                                                                       | To learn the required functionality of positive and negative feedback systems. |        |        |        |          |
| UNIT 1 PN JUNCTION DEVICES                                                                                                                                                                                                                                                                                              |                                                                                |        |        | 9+9    |          |
| PN junction diode –structure, operation and V-I characteristics, diffusion and transition capacitance – Clipping & Clamping circuits - Rectifiers – Half Wave and Full Wave Rectifier– Display devices- LED, Laser diodes, Zener diode characteristics- Zener diode Reverse characteristics – Zener diode as regulator. |                                                                                |        |        |        |          |
| <a href="#">Experiential Learning (Activity Based Learning): Simulate the characteristics of a Rectifier Diode</a><br><a href="#">Industrial Application: Voltage multiplier circuits</a><br><a href="#">Content Beyond Syllabus: Operation and V-I characteristics of Solar Cell</a>                                   |                                                                                |        |        |        |          |
| <b>Lab Components</b><br>1. VI characteristics of PN junction Diode and Zener diode<br>2. Characteristics of Half wave rectifier and Full wave rectifier<br>3. Photo diode & Photo transistor characteristics                                                                                                           |                                                                                |        |        |        |          |
| UNIT 2 TRANSISTORS                                                                                                                                                                                                                                                                                                      |                                                                                |        |        | 9+9    |          |
| BJT, JFET, MOSFET, UJT- structure, operation, characteristics and Biasing                                                                                                                                                                                                                                               |                                                                                |        |        |        |          |
| <a href="#">Experiential Learning (Activity Based Learning):Astable Multivibrator using Transistor</a><br><a href="#">Industrial Application: MOSFET as logic circuits</a><br><a href="#">Content Beyond Syllabus: IGBT</a>                                                                                             |                                                                                |        |        |        |          |
| <b>Lab Components</b><br>1. Characteristics of BJT in CE, CB, CC configuration<br>2. Characterisitcs of JFET and UJT                                                                                                                                                                                                    |                                                                                |        |        |        |          |
| UNIT 3 AMPLIFIERS                                                                                                                                                                                                                                                                                                       |                                                                                |        |        | 9+9    |          |
| BJT small signal model – Analysis of CE amplifier- Gain and frequency response –MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.                                                                                                                   |                                                                                |        |        |        |          |
| <a href="#">Experiential Learning (Activity Based Learning): Frequency response of common source fet amplifier</a><br><a href="#">Industrial Application: CC Amplifier In Impedance Matching and Buffering</a><br><a href="#">Content Beyond Syllabus: Hybrid <math>\pi</math> model</a>                                |                                                                                |        |        |        |          |
| <b>Lab Components</b><br>1.Frequency Response of CE amplifier                                                                                                                                                                                                                                                           |                                                                                |        |        |        |          |



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Department: Electrical and Electronics Engineering, R2024, CBCS

|                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                        |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT 4 MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIERS</b>                                                                                                                                                                                                       |                                                                                                                                                                                                        | <b>9+9</b> |
| BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods                                                                        |                                                                                                                                                                                                        |            |
| Experiential Learning (Activity Based Learning): Differential Amplifier using FET<br>Industrial Application: Differential Amplifier in Biomedical applications<br>Content Beyond Syllabus: Role of Power amplifiers in Industrial Motor control and automation        |                                                                                                                                                                                                        |            |
| <b>Lab Components</b><br>1.Differential Amplifier using BJT<br>2. Realization of passive filter.                                                                                                                                                                      |                                                                                                                                                                                                        |            |
| <b>UNIT 5 FEEDBACK AMPLIFIERS AND OSCILLATORS</b>                                                                                                                                                                                                                     |                                                                                                                                                                                                        | <b>9+9</b> |
| Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts oscillators.                                                                                |                                                                                                                                                                                                        |            |
| Experiential Learning (Activity Based Learning):<br>Industrial Application: Role of Feedback Amplifiers in Industrial Control and Signal Processing Applications<br>Content Beyond Syllabus: Crystal Oscillator operation and characteristics and frequency Stability |                                                                                                                                                                                                        |            |
| <b>Lab Components</b><br>1.Design OF RC Phase Shift Oscillator                                                                                                                                                                                                        |                                                                                                                                                                                                        |            |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                  |                                                                                                                                                                                                        | <b>90</b>  |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                |                                                                                                                                                                                                        |            |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                          |                                                                                                                                                                                                        |            |
| <b>CO1</b>                                                                                                                                                                                                                                                            | Explain the structure and operation of PN junction devices (diode, Zener diode, LED and Laser, Design clipper, clamper, half wave and full wave rectifier, regulator circuits using PN junction diodes |            |
| <b>CO2</b>                                                                                                                                                                                                                                                            | Analyze the structure and characteristics BJT, FET, MOSFET, UJT, Thyristor and IGBT                                                                                                                    |            |
| <b>CO3</b>                                                                                                                                                                                                                                                            | Analyze the performance of various configurations of BJT and MOSFET based amplifier                                                                                                                    |            |
| <b>CO4</b>                                                                                                                                                                                                                                                            | Explain the characteristics of MOS based cascade and differential amplifier C                                                                                                                          |            |
| <b>CO5</b>                                                                                                                                                                                                                                                            | Explain the operation of various feedback amplifiers and oscillators                                                                                                                                   |            |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                     |                                                                                                                                                                                                        |            |
| David A. Bell , "Electronic devices and circuits", Oxford University higher education, 5th edition 2008.                                                                                                                                                              |                                                                                                                                                                                                        |            |
| Sedra and smith, "Microelectronic circuits", 7th Edition., Oxford University Press, 2017                                                                                                                                                                              |                                                                                                                                                                                                        |            |
| Robert L.Boylestad, "Electronic devices and circuit theory", 11th edition, Pearson prentice Hall 2013                                                                                                                                                                 |                                                                                                                                                                                                        |            |
| Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2003.                                                                                                                                                                        |                                                                                                                                                                                                        |            |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                     |                                                                                                                                                                                                        |            |
| 1. Balbir Kumar, Shail.B.Jain, "Electronic devices and circuits" PHI learning private limited, 2nd edition 2014.                                                                                                                                                      |                                                                                                                                                                                                        |            |



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.2. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2017.

Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, Second edition, 2012.

| <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b><br><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b> |            |            |     |            |            |     |     |     |     |      |      |            |            |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|-----|------------|------------|-----|-----|-----|-----|------|------|------------|------------|------|
|                                                                                                                                                                                      | PO1        | PO2        | PO3 | PO4        | PO5        | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1       | PSO2       | PSO3 |
| CO1                                                                                                                                                                                  | 3          | 2          | –   | –          | 2          | –   | –   | –   | –   | –    | –    | 3          | 2          | –    |
| CO2                                                                                                                                                                                  | 3          | 3          | –   | –          | 2          | –   | –   | –   | –   | –    | –    | 3          | 3          | –    |
| CO3                                                                                                                                                                                  | 3          | 3          | –   | 2          | 2          | –   | –   | –   | –   | –    | –    | 3          | 3          | –    |
| CO4                                                                                                                                                                                  | 2          | 2          | –   | 2          | 2          | –   | –   | –   | –   | –    | –    | 2          | 2          | –    |
| CO5                                                                                                                                                                                  | 2          | 2          | –   | –          | 2          | –   | –   | –   | –   | –    | –    | 2          | 2          | –    |
| AVG                                                                                                                                                                                  | <b>2.6</b> | <b>2.4</b> | –   | <b>2.0</b> | <b>2.0</b> | –   | –   | –   | –   | –    | –    | <b>2.6</b> | <b>2.4</b> | –    |

| S.NO. | Product based Projects                                                                                                              |
|-------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Implement automatic voltage stabilization for varying sunlight conditions                                                           |
| 2     | Design a low-power MOSFET logic circuit for industrial automation                                                                   |
| 3     | Build a BJT-based CE amplifier with optimized gain and frequency response.                                                          |
| 4     | Design a single-tuned amplifier for precise frequency filtering.                                                                    |
| 5     | Develop a Wien bridge oscillator for precision signal generation. Develop a Wien bridge oscillator for precision signal generation. |



# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24CS308                                                                                                                                                                                                                                            | DATA STRUCTURE                                               | L | T | P   | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|---|---|-----|---|
|                                                                                                                                                                                                                                                     |                                                              | 3 | 0 | 2   | 4 |
| Course Objectives                                                                                                                                                                                                                                   |                                                              |   |   |     |   |
| 1                                                                                                                                                                                                                                                   | To understand the concepts of ADTs.                          |   |   |     |   |
| 2                                                                                                                                                                                                                                                   | To Learn linear data structures – lists, stacks, and queues. |   |   |     |   |
| 3                                                                                                                                                                                                                                                   | To understand non-linear data structures – trees and graphs. |   |   |     |   |
| 4                                                                                                                                                                                                                                                   | To apply Tree and Graph structures.                          |   |   |     |   |
| 5                                                                                                                                                                                                                                                   | To understand sorting and searching                          |   |   |     |   |
| UNIT 1 LISTS                                                                                                                                                                                                                                        |                                                              |   |   | 9+6 |   |
| Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of lists                                                       |                                                              |   |   |     |   |
| <a href="#">Experiential Learning (Activity Based Learning): Music Playlist Creation</a><br><a href="#">Industrial Application: Memory Management</a><br><a href="#">Content Beyond Syllabus: Performance analysis of List</a>                      |                                                              |   |   |     |   |
| <b>Practical:</b><br>1. Implementation of Singly Linked List                                                                                                                                                                                        |                                                              |   |   |     |   |
| UNIT 2 STACKS AND QUEUES                                                                                                                                                                                                                            |                                                              |   |   | 9+6 |   |
| Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions<br>Infix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues.                         |                                                              |   |   |     |   |
| <a href="#">Experiential Learning (Activity Based Learning): Text editor undo and redo operations</a><br><a href="#">Industrial Application: Network protocol Management</a><br><a href="#">Content Beyond Syllabus: Time Complexity Derivation</a> |                                                              |   |   |     |   |
| <b>Practical:</b><br>1.Array and Linked list implementation of Stack and Queue ADTs<br>2. Implementation of Evaluating Postfix Expressions, Infix to Postfix conversion                                                                             |                                                              |   |   |     |   |
| UNIT 3 TREES                                                                                                                                                                                                                                        |                                                              |   |   | 9+6 |   |
| Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVL Trees – Priority Queue (Heaps) – Binary Heap.                                                                                                        |                                                              |   |   |     |   |
| <a href="#">Experiential Learning (Activity Based Learning): File Structure Creation</a><br><a href="#">Industrial Application: To Implement Decision making algorithms in AI</a><br><a href="#">Content Beyond Syllabus: Red black tree</a>        |                                                              |   |   |     |   |
| <b>Practical:</b><br>1.Implementation of Binary Search Tree ADTs                                                                                                                                                                                    |                                                              |   |   |     |   |
| UNIT4 MULTIWAY SEARCH TREES AND GRAPHS                                                                                                                                                                                                              |                                                              |   |   | 9+6 |   |
| B-Tree – B+ Tree – Graph Definition – Representation of Graphs – Types of Graph - Breadth-first traversal – Depth-first traversal – Dijkstra's algorithm – Minimum Spanning Tree – Prim's                                                           |                                                              |   |   |     |   |
| <a href="#">Experiential Learning (Activity Based Learning): Creation of Library Management System</a>                                                                                                                                              |                                                              |   |   |     |   |



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Industrial Application: Efficient data storage and accessing

Content Beyond Syllabus: Greedy Method

## Practical:

- 1.Implementation of Dijkstra's Algorithm
2. Implementation of Prim's Algorithm

## UNIT 5 SORTING AND SEARCHING TECHNIQUES

9+6

Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

Experiential Learning (Activity Based Learning): Implementation of Online Leaderboards

Industrial Application :

Content Beyond Syllabus: Time complexity on Searching a node

## Practical:

- 1.Implementation of Linear Search and Binary Search
- 2.Implementation of Insertion Sort
- 3.Implementation of Merge Sort

TOTAL PERIODS

75

## Course Outcomes

At the end of the course, the student will be able to

- |     |                                                                                          |
|-----|------------------------------------------------------------------------------------------|
| CO1 | Define linear and non-linear data structures.                                            |
| CO2 | Implement linear and non-linear data structure operations.                               |
| CO3 | Use appropriate linear/non-linear data structure operations for solving a given problem. |
| CO4 | Analyze the various searching and sorting algorithms.                                    |
| CO5 | Apply appropriate graph algorithms for graph applications                                |

## TEXT BOOKS

1."Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005."

2.Kamthane, Introduction to Data Structures in C, 1st Edition, Pearson Education, 2007

3."Ellis Horowitz and Sartaj Sahni, Anderson Freed "Fundamentals of Data Structures in C", University Press, 2008."

4."Ellis Horowitz and Sartaj Sahni, Dinesh Mehta "Fundamentals of Data Structures in C++", Silicon Press, 2007."

## REFERENCES

1.Langsam, Augenstein and Tanenbaum, Data Structures Using C and C++, 2nd Edition, Pearson Education, 2015.

2.Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, Introduction to Algorithms", Fourth Edition, Mcgraw Hill/ MIT Press, 2022.

3.Alfred V. Aho, Jeffrey D. Ullman,John E. Hopcroft ,Data Structures and Algorithms, 1st edition, Pearson, 2002.

4.Kruse, Data Structures and Program Design in C, 2nd Edition, Pearson Education, 2006

5.Yashavant Kanetkar, "Data Structures Through C", BPB press, 4th edition, 2022.



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| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |      |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                 | PO1 | PO2 | PO3  | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 3   | 3   | -    | -   | -   | -   | -   | -   | -   | -    | -    | -    | 2    | -    |
| CO2                                                                                                                                                             | 3   | 3   | 2    | -   | 3   | -   | -   | -   | -   | -    | -    | -    | 3    | 3    |
| CO3                                                                                                                                                             | 3   | 3   | 3    | -   | 3   | -   | -   | -   | -   | 2    | -    | -    | 3    | 3    |
| CO4                                                                                                                                                             | 3   | 3   | -    | 3   | 3   | -   | 2   | -   | -   | -    | -    | -    | 3    | 3    |
| CO5                                                                                                                                                             | 3   | 3   | 3    | 3   | 3   | -   | 2   | -   | 3   | 3    | -    | 3    | 3    | 3    |
| AVG                                                                                                                                                             | 3   | 3   | 2.66 | 3   | 3   | -   | 2   | -   | 3   | 2.5  | -    | 3    | 2.8  | 3    |



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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EE303                                                                                                                                                                                                                                                                                | Circuit Analysis                                                           | L | T | P    | C   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|---|---|------|-----|
|                                                                                                                                                                                                                                                                                         |                                                                            | 3 | 0 | 3    | 4.5 |
| Course Objectives                                                                                                                                                                                                                                                                       |                                                                            |   |   |      |     |
| Design a smart power distribution system for a small home and optimize energy usage.                                                                                                                                                                                                    |                                                                            |   |   |      |     |
| 1                                                                                                                                                                                                                                                                                       | To introduce Electric Circuits and its Analysis                            |   |   |      |     |
| 2                                                                                                                                                                                                                                                                                       | To provide key concepts to analyze and understand electrical circuit       |   |   |      |     |
| 3                                                                                                                                                                                                                                                                                       | To impart knowledge on solving circuit equations using network theorems    |   |   |      |     |
| 4                                                                                                                                                                                                                                                                                       | To educate on obtaining the transient response of circuits                 |   |   |      |     |
| 5                                                                                                                                                                                                                                                                                       | To introduce the phenomenon of resonance                                   |   |   |      |     |
| 6                                                                                                                                                                                                                                                                                       | To introduce Phasor diagrams and analysis of single & three phase circuits |   |   |      |     |
| UNIT 1 DC CIRCUITS                                                                                                                                                                                                                                                                      |                                                                            |   |   | 9+9  |     |
| Electrical quantities, Ohm’s Law, Resistors - Series and parallel combinations, Current Division rule, Voltage Division rule, Source transformation - Kirchhoff’s laws, Nodal and Mesh Analysis, Star Delta Transformation                                                              |                                                                            |   |   |      |     |
| Experiential Learning (Activity Based Learning): Simple circuit analysis<br>Industrial Application: Grid Analysis, Electrical Design,Power Analysis<br>Content Beyond Syllabus: Pspice simulation                                                                                       |                                                                            |   |   |      |     |
| Lab Components                                                                                                                                                                                                                                                                          |                                                                            |   |   |      |     |
| 1. Simulation and experimental verification of series and parallel electrical circuit using fundamental laws.                                                                                                                                                                           |                                                                            |   |   |      |     |
| UNIT 2 AC CIRCUITS                                                                                                                                                                                                                                                                      |                                                                            |   |   | 9+3  |     |
| Sinusoidal Functions - RMS(effective) and Average Values - Phasor Representation – Sinusoidal Excitation Applied to Purely Resistive - Inductive and Capacitive Circuits - RL - RC and RLC Series and Parallel Circuits- Nodal and Mesh Analysis –Measurement of Power and Power Factor |                                                                            |   |   |      |     |
| Experiential Learning (Activity Based Learning): Measurement of power and power factor using 3 wattmeter method<br>Industrial Application : Power factor correction for energy efficiency<br>Content Beyond Syllabus : Pspice simulation of RLC circuit                                 |                                                                            |   |   |      |     |
| Lab Components:                                                                                                                                                                                                                                                                         |                                                                            |   |   |      |     |
| 1. Experimental validation of frequency response of RLC electric circuit                                                                                                                                                                                                                |                                                                            |   |   |      |     |
| UNIT 3 NETWORK THEOREMS (Both DC AND AC)                                                                                                                                                                                                                                                |                                                                            |   |   | 9+18 |     |
| Superposition theorem, Thevenin’s and Norton’s theorem – Maximum power transfer theorem – Reciprocity theorem Statement: application to DC and AC Circuits                                                                                                                              |                                                                            |   |   |      |     |
| Experiential Learning (Activity Based Learning): Experimental verification of Maximum Power transfer theorem<br>Industrial Application : Radio receivers, television sets, and oscillator circuits use LCR circuits for tuning purposes.<br>Content Beyond Syllabus : Millman's theorem |                                                                            |   |   |      |     |
| Lab Components                                                                                                                                                                                                                                                                          |                                                                            |   |   |      |     |
| 1. Simulation and experimental verification of electrical circuit problems using Thevenin’s theorem.                                                                                                                                                                                    |                                                                            |   |   |      |     |





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2. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
3. Simulation and experimental verification of electrical circuit problems using Superposition theorem

## UNIT 4 TRANSIENT ANALYSIS AND RESONANCE

9+6

Introduction –Laplace transforms and Inverse Laplace transforms- standard test signals - Transient response of RL, RC & RLC Networks using Laplace transform for source free, step input and Sinusoidal AC input. Series and Parallel resonance - Quality factor and Bandwidth.

Experiential Learning (Activity Based Learning): Demo based learning for the understanding of inductor and capacitor transient response

Industrial Application : Transients in power system

Content Beyond Syllabus : Matlab simulation of RC circuit

### Lab Components:

1. Experimental validation of R-C, RLC electric circuit transients

## UNIT 5 THREE PHASE CIRCUITS

9+9

Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced and unbalanced – phasor diagram of voltages and currents – power measurement in three phase circuits– Power Factor Calculations

Experiential Learning (Activity Based Learning): Demo based learning for star and delta connected loads in laboratory

Industrial Application : star-delta starter

Content Beyond Syllabus : Power Quality in three phase circuits

### Lab Components:

1. Simulation of three phase balanced and unbalanced star, delta networks circuit.

TOTAL PERIODS

90

## Course Outcomes

At the end of the course, the student will be able to

- |     |                                                                                                               |
|-----|---------------------------------------------------------------------------------------------------------------|
| CO1 | Understand the circuit's behaviour and analysis of DC circuits                                                |
| CO2 | Understand the circuit's behaviour and analysis of AC circuits                                                |
| CO3 | Apply network theorems to determine behaviour of the given DC and AC circuits                                 |
| CO4 | Compute the transient response for step and sinusoidal input and understand the concept of resonance circuits |
| CO5 | Compute power, line/ phase voltage and currents of the given three phase circuits                             |

## TEXT BOOKS

1. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, 9th edition, New Delhi, 2020.

2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Seventh Edition, McGraw Hill, 2022.



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3. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013.

## REFERENCES

1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.

2. Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill, First Edition, 2019.

3. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015.

4. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley Sons, Inc. 2018.

5. Sudhakar A and Shyam Mohan SP, "Circuits and Networks Analysis and Synthesis", McGraHill, 2015.

### CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 2   | –   | –   | –   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| CO2 | 3   | 3   | –   | –   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | –    |
| CO3 | 3   | 3   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | 1    |
| CO4 | 2   | 3   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 2    | 3    | 1    |
| CO5 | 3   | 3   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | 1    |
| AVG | 2.8 | 2.8 | –   | 2.0 | 2.0 | –   | –   | –   | –   | –    | –    | 2.8  | 2.8  | 1.0  |

| S.No. | Product based Projects                                                                           |
|-------|--------------------------------------------------------------------------------------------------|
| 1     | Smart DC Circuit Analysis for Energy Efficiency                                                  |
| 2     | Design a real-time power factor correction device using RLC circuits.                            |
| 3     | Use network theorems to develop an electrical fault detection system for AC and DC circuits.     |
| 4     | Design a circuit protection device that detects and mitigates transient surges in power systems. |
| 5     | Develop a three-phase power monitoring system for industrial applications.                       |
| 6     | Use AI-based predictive analysis to optimize power flow in industrial applications.              |



| U24EE304 | ELECTRICAL MACHINES-1 LABORATORY | L | T | P | C   |
|----------|----------------------------------|---|---|---|-----|
|          |                                  | 0 | 0 | 3 | 1.5 |

### Course Objectives

|   |                                                                                                                                      |
|---|--------------------------------------------------------------------------------------------------------------------------------------|
| 1 | To expose the students to determine the characteristics of DC machines and transformers by performing experiments on these machines. |
| 2 | To provide hands on experience to evaluate the performance parameters of DC machines and transformer by conducting suitable tests.   |

### List of Experiments

1. Open circuit and load characteristics of DC shunt generator.

2. Load test on DC shunt, series and compound motor.

3. Swinburne's test and speed control of DC shunt motor.

4. Hopkinson's test on DC motor – generator set.

5. Load test on single-phase transformer.

6. Open circuit and short circuit tests on single phase transformers.

7. Sumpner's test on single phase transformers.

8. Separation of no-load losses in single phase transformers.

**TOTAL PERIODS** **45**

### Course Outcomes

At the end of the course, the student will be able to

|     |                                                                                           |
|-----|-------------------------------------------------------------------------------------------|
| CO1 | Construct the circuit with appropriate connections for the given DC machine /transformer. |
| CO2 | Experimentally determine the characteristics of different types of DC machines.           |
| CO3 | Demonstrate the speed control techniques for a DC motor for industrial applications       |
| CO4 | Identify suitable methods for testing of transformer and DC machines.                     |
| CO5 | Predetermine the performance parameters of transformers and DC motor.                     |

### CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 2   | –   | –   | 3   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| CO2 | 3   | 3   | –   | –   | 3   | –   | –   | –   | –   | –    | –    | 3    | 3    | –    |
| CO3 | 2   | 2   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |
| CO4 | 2   | 2   | –   | 2   | 2   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |
| CO5 | 2   | 2   | –   | –   | 2   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |
| AVG | 2.4 | 2.2 | –   | 1.6 | 2.4 | –   | –   | –   | –   | –    | –    | 2.4  | 2.2  | –    |



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| U24TP310          |                                                                                                | GENERAL APTITUDE & LOGICAL REASONING | L | T | P | C |
|-------------------|------------------------------------------------------------------------------------------------|--------------------------------------|---|---|---|---|
|                   |                                                                                                |                                      | 0 | 0 | 2 | 1 |
| COURSE OBJECTIVES |                                                                                                |                                      |   |   |   |   |
| 1                 | Master fundamental and advanced quantitative aptitude skills essential for competitive exam    |                                      |   |   |   |   |
| 2                 | Develop speed and accuracy in solving arithmetic, algebraic, and data interpretation problems. |                                      |   |   |   |   |
| 3                 | Apply mathematical concepts to solve real-life and recruitment-related problems.               |                                      |   |   |   |   |
| 4                 | Strengthen logical reasoning skills, including number series and coding-decoding.              |                                      |   |   |   |   |
| 5                 | Prepare confidently for placement and competitive exam aptitude sections.                      |                                      |   |   |   |   |
| Topics            |                                                                                                |                                      |   |   |   |   |
| 1.                | Number System                                                                                  |                                      |   |   |   |   |
| 2.                | LCM & HCF                                                                                      |                                      |   |   |   |   |
| 3.                | Divisibility                                                                                   |                                      |   |   |   |   |
| 4.                | Number and Decimal Fractions                                                                   |                                      |   |   |   |   |
| 5.                | Percentages                                                                                    |                                      |   |   |   |   |
| 6.                | Ratio & Proportion                                                                             |                                      |   |   |   |   |
| 7.                | Profit, Loss and Discount                                                                      |                                      |   |   |   |   |
| 8.                | Average & Mixtures                                                                             |                                      |   |   |   |   |
| 9.                | Simple Interest and Compound Interest                                                          |                                      |   |   |   |   |
| 10.               | Time and Work                                                                                  |                                      |   |   |   |   |
| 11.               | Time and Distance                                                                              |                                      |   |   |   |   |
| 12.               | Pipes and Cistern                                                                              |                                      |   |   |   |   |
| 13.               | Problems on Race                                                                               |                                      |   |   |   |   |
| 14.               | Problems on Trains                                                                             |                                      |   |   |   |   |
| 15.               | Problems on Ages                                                                               |                                      |   |   |   |   |
| 16.               | Permutations & Combinations                                                                    |                                      |   |   |   |   |
| 17.               | Probability                                                                                    |                                      |   |   |   |   |
| 18.               | Data Interpretation (Multiple charts & caselets)                                               |                                      |   |   |   |   |
| 19.               | Logarithms                                                                                     |                                      |   |   |   |   |
| 20.               | Surds & Indices                                                                                |                                      |   |   |   |   |
| 21.               | Boats and Stream                                                                               |                                      |   |   |   |   |
| 22.               | Measurement                                                                                    |                                      |   |   |   |   |
| 23.               | Algebra                                                                                        |                                      |   |   |   |   |
| 24.               | Calendar                                                                                       |                                      |   |   |   |   |
| 25.               | Data Sufficiency & Logical Data Analysis                                                       |                                      |   |   |   |   |
| 26.               | Work Efficiency & Manpower Problems                                                            |                                      |   |   |   |   |
| 27.               | Complex Number Series (Arithmetic & Geometric)                                                 |                                      |   |   |   |   |
| 28.               | Advanced Approximation & Simplification Techniques                                             |                                      |   |   |   |   |



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TOTAL:30

At the end of the course, the student will be able to

- |     |                                                   |
|-----|---------------------------------------------------|
| CO1 | Solve arithmetic & algebra problems with accuracy |
| CO2 | Interpret complex data & charts                   |
| CO3 | Apply logical reasoning techniques                |
| CO4 | Solve time & work/distance problems               |
| CO5 | Excel in recruitment aptitude tests               |

## TEXT BOOKS

- |    |                                                                             |
|----|-----------------------------------------------------------------------------|
| 1. | R.S. Aggarwal, <i>Quantitative Aptitude</i> , S. Chand                      |
| 2. | Ananta Ashisha, <i>Data Interpretation &amp; Data Sufficiency</i> , Arihant |

## REFERENCES

- |    |                                                     |
|----|-----------------------------------------------------|
| 1. | S.P. Bakshi, <i>General Aptitude</i> , Arihant      |
| 2. | Rakesh Yadav, <i>Competitive Aptitude</i> , Arihant |

## CO-PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO2 |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO3 |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO4 |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO5 |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| AVG |     |     |     |     |     |     |     |     |     |      | 1    |      |      |      |



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|                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                     |   |   |   |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----|
| U24RM312                                                                                                                                                                                                                                                                                                                                   | INTRODUCTION TO PROBLEM SOLVING                                                                                                     | L | T | P | C   |
|                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                     | 0 | 0 | 1 | 0.5 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                          |                                                                                                                                     |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                          | Develop an understanding of the types and characteristics of problems in research and real-life scenarios                           |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                          | Enable students to explore creative and critical thinking strategies for solving complex problems                                   |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                          | Introduce engineering-oriented and methodical problem-solving techniques using logical and algorithmic thinking.                    |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                          | Equip students to analyze, model, and evaluate real-world problems in diverse domains.                                              |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                          | Foster the ability to apply scientific inquiry and strategic design to derive optimized solutions                                   |   |   |   |     |
| UNIT1 Problem Solving                                                                                                                                                                                                                                                                                                                      |                                                                                                                                     |   |   | 2 |     |
| Problem – types and characteristics, Problem vs research question, Curiosity and observation in research, Introduction to critical and analytical thinking, Literature Survey, Redefined Problem Statement                                                                                                                                 |                                                                                                                                     |   |   |   |     |
| UNIT2 The Art and Craft of Creative Problem Solving                                                                                                                                                                                                                                                                                        |                                                                                                                                     |   |   | 3 |     |
| Understanding the nature of problems, Techniques for defining and analysing problems, Strategies for investigating problems, Tactics for solving problems, Creative thinking methods for generating solutions, Evaluating and implementing solutions effectively, The toolbox, Algebra, Combinatronics, Number Theory, Geometry, Calculus. |                                                                                                                                     |   |   |   |     |
| UNIT3 Problem Solving for New Engineers                                                                                                                                                                                                                                                                                                    |                                                                                                                                     |   |   | 2 |     |
| Formulation, Myths of Discovery, Experimenting with Storytelling, Variation, Strategic Design, Randomness.                                                                                                                                                                                                                                 |                                                                                                                                     |   |   |   |     |
| UNIT4 Methodical Approach in Problem Solving                                                                                                                                                                                                                                                                                               |                                                                                                                                     |   |   | 2 |     |
| Scientific methods and its applications in research, Algorithmic thinking, Step-wise problem decomposition, Heuristics and Optimization strategies, Comparative analysis of problem solving techniques                                                                                                                                     |                                                                                                                                     |   |   |   |     |
| UNIT5 Real-life Examples in Problem Solving techniques                                                                                                                                                                                                                                                                                     |                                                                                                                                     |   |   | 6 |     |
| Problem solving examples in Healthcare, Education, Urban and Infrastructure, Business and Workplace related problems, Technology and Software, Agriculture and Environment, Engineering and Design, Society and Community problems                                                                                                         |                                                                                                                                     |   |   |   |     |
| TOTAL: 15                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                     |   |   |   |     |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                      |                                                                                                                                     |   |   |   |     |
| CO1                                                                                                                                                                                                                                                                                                                                        | Demonstrate critical, analytical, and observational skills to redefine a research problem                                           |   |   |   |     |
| CO2                                                                                                                                                                                                                                                                                                                                        | Apply creative thinking and problem analysis techniques to generate and evaluate solutions.                                         |   |   |   |     |
| CO3                                                                                                                                                                                                                                                                                                                                        | Use mathematical tools like algebra, number theory, and geometry to solve structured problems                                       |   |   |   |     |
| CO4                                                                                                                                                                                                                                                                                                                                        | Adopt algorithmic, heuristic, and optimization strategies in scientific problem solving.                                            |   |   |   |     |
| CO5                                                                                                                                                                                                                                                                                                                                        | Analyze and apply appropriate problem-solving approaches to real-life sector-specific problems.                                     |   |   |   |     |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                     |   |   |   |     |
| 1.                                                                                                                                                                                                                                                                                                                                         | G. Polya, How to Solve It: A New Aspect of Mathematical Method, 2nd ed. Princeton, NJ, USA: Princeton University Press, 2014.       |   |   |   |     |
| 2.                                                                                                                                                                                                                                                                                                                                         | M. Buie, Problem Solving for New Engineers: What Every Engineering Manager Wants You to Know. Boca Raton, FL, USA: CRC Press, 2018. |   |   |   |     |



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|                                                                                                                                                                        |                                                                                                                           |     |      |     |      |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|-----|-----|-----|-----|------|------|------|------|------|
| 3.                                                                                                                                                                     | A. Barker, How to Solve Almost Any Problem: The Creative Approach to Any Problem Solving. New York, NY, USA: Wiley, 2001. |     |      |     |      |     |     |     |     |      |      |      |      |      |
| 4.                                                                                                                                                                     | P. Zeitz, The Art and Craft of Problem Solving, 3rd ed. Hoboken, NJ, USA: Wiley, 2016.                                    |     |      |     |      |     |     |     |     |      |      |      |      |      |
| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                           |     |      |     |      |     |     |     |     |      |      |      |      |      |
| CO/PO                                                                                                                                                                  | PO1                                                                                                                       | PO2 | PO3  | PO4 | PO5  | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                    | 3                                                                                                                         | 3   | -    | 2   | -    | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO2                                                                                                                                                                    | 3                                                                                                                         | 3   | 2    | 2   | 2    | -   | -   | -   | -   | -    | 2    | -    | -    | -    |
| CO3                                                                                                                                                                    | 3                                                                                                                         | 3   | 3    | -   | 2    | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO4                                                                                                                                                                    | 3                                                                                                                         | 3   | 3    | 3   | 2    | -   | -   | -   | -   | -    | -    | -    | -    | -    |
| CO5                                                                                                                                                                    | 3                                                                                                                         | 3   | 3    | 3   | 3    | 2   | 2   | -   | 2   | 2    | 2    | -    | -    | -    |
| AVG                                                                                                                                                                    | 3                                                                                                                         | 2   | 2.75 | 2.5 | 2.25 | 2   | 2   | -   | 2   | 2    | 2    | -    | -    | -    |





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| U24MA402                                                                                                                                                                                                                                                                                                                                                                                             | LINEAR ALGEBRA AND NUMERICAL METHODS                                                                                                                                                                                                      | L | T | P   | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|-----|---|
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                           | 3 | 1 | 0   | 4 |
| Course Objectives:                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                           |   |   |     |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                    | To introduce the basic notions of vector spaces which will then be used to solve related problems.                                                                                                                                        |   |   |     |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                    | To understand the concepts of vector space, linear transformations , inner product spaces and orthogonalization.                                                                                                                          |   |   |     |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                    | To introduce the basic concepts of solving algebraic and transcendental equations.                                                                                                                                                        |   |   |     |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                    | To introduce the Interpolation operators and numerical techniques of interpolation in various intervals, numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines. |   |   |     |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                    | To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.                                                                                                                                   |   |   |     |   |
| UNIT 1 VECTOR SPACES                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                           |   |   | 9+3 |   |
| Vector spaces – Subspaces – Linear combinations and linear system of equations – Linear independence and linear dependence – Bases and dimensions.                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                           |   |   |     |   |
| <b>Experiential Learning</b> : MATLAB -Vector Addition and Scalar Multiplication.<br><b>Industrial Application:</b> Solving Power Flow Analysis Using Vector Spaces.<br><b>Content Beyond syllabus:</b> A linear functional is a linear map that maps vectors in $V$ to the underlying field (e.g., real numbers).                                                                                   |                                                                                                                                                                                                                                           |   |   |     |   |
| UNIT 2 LINEAR TRANSFORMATION AND INNER PRODUCT SPACES                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                           |   |   | 9+3 |   |
| Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Inner product - Norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.                                                                                                                                                 |                                                                                                                                                                                                                                           |   |   |     |   |
| <b>Experiential Learning</b> : MATLAB - To compute the inner product of two matrices element-wise.<br><b>Industrial Application:</b> Analyzing and Transforming a signal using a linear transformation.<br><b>Content Beyond syllabus</b> : A vector space equipped with an inner product allows for geometric concepts such as distance, angle, and orthogonality.                                  |                                                                                                                                                                                                                                           |   |   |     |   |
| UNIT 3 SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                           |   |   | 9+3 |   |
| Solution of algebraic and transcendental equations - Fixed point iteration method -Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method.                                                                                        |                                                                                                                                                                                                                                           |   |   |     |   |
| <b>Experiential Learning</b> :MATLAB - Newton-Raphson Method<br><b>Industrial Application:</b> Linear Algebra in Image Processing.<br><b>Content Beyond syllabus</b> : Eigenvalues of a matrix by Jacobi method.                                                                                                                                                                                     |                                                                                                                                                                                                                                           |   |   |     |   |
| UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                           |   |   | 9+3 |   |
| Interpolation operators (Forward, Backward, shifting operators and its Properties) – Newton’s forward and backward difference interpolation for equal intervals – Lagrange’s and Newton’s divided difference interpolations for unequal intervals - Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson’s 1/3 rules. |                                                                                                                                                                                                                                           |   |   |     |   |
| <b>Experiential Learning</b> : MATLAB -Newton’s forward and backward difference interpolation for                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                           |   |   |     |   |



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equal intervals.

**Industrial Application:** Performance Analysis in Distributed Systems.

**Content Beyond syllabus :** Hermite Interpolation.

## UNIT 5 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

9+3

Single step methods: Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations - Multi step methods: Milne's and Adams- Bash forth predictor corrector methods for solving first order equations.

**Experiential Learning :** MATLAB -Solving an ODE with Runge-Kutta Method (RK4).

**Industrial Application:** Network Traffic Prediction.

**Content Beyond syllabus :** Problems of Fourth order Runge-Kutta method for solving Second order equations.

**TOTAL PERIODS**

60

### Course Outcomes

**At the end of the course, the student will be able to**

|            |                                                                                                                                                                           |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.                                                           |
| <b>CO2</b> | Demonstrate accurate and efficient use of advanced algebraic techniques.                                                                                                  |
| <b>CO3</b> | Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems. |
| <b>CO4</b> | Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.                                            |
| <b>CO5</b> | Solve the ordinary differential equations with initial conditions by using certain techniques with engineering applications.                                              |

### TEXT BOOKS

1.Friedberg. A.H., Insel. A.J. and Spence. L., "Linear Algebra", Prentice Hall of India, New Delhi, 4<sup>th</sup> Edition, 2004.

2.Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10<sup>th</sup> Edition, Khanna Publishers, New Delhi, 2015.

3.Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.

4.Won Y.Yang, Young K.Choi, Jaekwon Kim, Man Cheol Kim, H.Jin Kim, Taeho Im, "Engineering Mathematics with MATLAB" CRC Press Publishers , 1<sup>st</sup> Edition , 2017.

### REFERENCES

1.Kolman. B. Hill. D.R., "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint, 2009.

2.Kumaresan. S., "Linear Algebra – A Geometric Approach", Prentice – Hall of India, New Delhi, Reprint, 2010.

3.Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.

4.Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.

5.Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.

6.Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3<sup>rd</sup> Edition, New Delhi, 2007.



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7. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and scientists" 8th edition, Pearson Education, Asia, 2007.

| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO/<br>PO                                                                                                                                                       | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |
| CO2                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |
| CO3                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |
| CO4                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |
| CO5                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |
| AVG                                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | -   | -   | 1   | -   | -    | 1    | 1    | -    | -    |



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|                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                         |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE401                                                                                                                                                                                                                                                                                                                                                                                                         | ELECTROMAGNETIC THEORY                                                                                                  | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                         | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                         |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                | To design wireless power transfer system                                                                                |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                | To introduce the basic mathematical concepts related to electromagnetic vector fields                                   |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                | To impart knowledge on the concepts of Electrostatic fields, electric potential, energy density and their applications. |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                | Magneto static fields, magnetic flux density, vector potential and its applications                                     |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                | Different methods of emf generation and Maxwell's equations                                                             |   |   |   |   |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                | Electromagnetic waves and characterizing parameters                                                                     |   |   |   |   |
| UNIT 1 ELECTROSTATICS – I                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                         |   |   | 9 |   |
| Sources and effects of electromagnetic fields - Coordinate Systems - Vector fields –Gradient - Divergence, Curl – theorems and applications - Coulomb's Law – Electric field intensity - Electric Field Intensity due to Line Charge - E due to Line Charge and Surface Charge Distribution - Gauss's law and applications.                                                                                      |                                                                                                                         |   |   |   |   |
| Experiential Learning (Activity Based Learning): Electrostatic Dust Collector.                                                                                                                                                                                                                                                                                                                                   |                                                                                                                         |   |   |   |   |
| Industrial Application: Transmission Lines: Analyze electric fields around high-voltage power lines.                                                                                                                                                                                                                                                                                                             |                                                                                                                         |   |   |   |   |
| Content Beyond Syllabus: EMF Shielding Techniques: Explore materials and methods used to shield sensitive equipment from EMF.                                                                                                                                                                                                                                                                                    |                                                                                                                         |   |   |   |   |
| UNIT 2 ELECTROSTATICS – II                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                         |   |   | 9 |   |
| Electric potential – Electric fields and equipotential plots, Uniform and Non-Uniform fields, Utilization factor – Electric field in free space, conductors, dielectric -Dielectric polarization – Dielectric strength, Electric fields in multiple dielectrics – Boundary conditions, capacitance, Energy density, Poisson's and Laplace's equations – solutions by Direct Integration method, Applications.    |                                                                                                                         |   |   |   |   |
| Experiential Learning (Activity Based Learning): Paper Capacitor.                                                                                                                                                                                                                                                                                                                                                |                                                                                                                         |   |   |   |   |
| Industrial Application: Transformer Design: Ensuring uniform fields to prevent hotspots.                                                                                                                                                                                                                                                                                                                         |                                                                                                                         |   |   |   |   |
| Content Beyond Syllabus: Quantum Potential: Explore the concept of electric potential in quantum mechanics.                                                                                                                                                                                                                                                                                                      |                                                                                                                         |   |   |   |   |
| UNIT 3 MAGNETOSTATICS                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                         |   |   | 9 |   |
| Lorentz force, magnetic field intensity (H) – Biot– Savart's Law - Ampere's Circuit Law and practical applications– Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media – Boundary conditions, Scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance and mutual inductance, Energy density, Applications. |                                                                                                                         |   |   |   |   |
| Experiential Learning (Activity Based Learning): Hall Effect Speed Sensor.                                                                                                                                                                                                                                                                                                                                       |                                                                                                                         |   |   |   |   |
| Industrial Application: Inductive Charging Systems: Design coils for efficient wireless power transfer.                                                                                                                                                                                                                                                                                                          |                                                                                                                         |   |   |   |   |
| Content Beyond Syllabus: Temperature Effects: Analyze how temperature variations affect magnetic flux density.                                                                                                                                                                                                                                                                                                   |                                                                                                                         |   |   |   |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>UNIT 4 ELECTRODYNAMIC FIELDS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>9</b>  |
| <p>Magnetic Circuits - Faraday's law – Transformer and motional EMF – Displacement current - Maxwell's equations (differential and integral form) – Time varying potential – Relation between field theory and circuit theory, Applications.</p> <p>Experiential Learning (Activity Based Learning): Wireless Energy Transfer Across Air Gap.<br/>Industrial Application: Wireless Charging Systems.<br/>Content Beyond Syllabus: Electromagnetic compatibility (EMC) and interference (EMI).</p>                                                                             |           |
| <b>UNIT 5 ELECTROMAGNETIC WAVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>9</b>  |
| <p>Electromagnetic Wave Generation and Wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossless and lossy dielectrics, conductors-skin depth, Poynting vector, Plane wave reflection and refraction – Standing Wave, Applications.</p> <p>Experiential Learning (Activity Based Learning): FM Radio Signal Blocker Using Foil Box.<br/>Industrial Application: Radar systems and satellite communication.<br/>Content Beyond Syllabus: Nonlinear Skin Effect: Study skin effect under high-power conditions.</p> |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>45</b> |

|                                                              |                                                                                                                                                              |
|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>At the end of the course, the student will be able to</b> |                                                                                                                                                              |
| <b>CO1</b>                                                   | Visualize and explain Gradient, Divergence, and Curl operations on electromagnetic vector fields and identify the electromagnetic sources and their effects. |
| <b>CO2</b>                                                   | Compute and analyze electrostatic fields, electric potential, energy density along with their applications.                                                  |
| <b>CO3</b>                                                   | Compute and analyze magneto static fields, magnetic flux density, vector potential along with their applications.                                            |
| <b>CO4</b>                                                   | Explain different methods of emf generation and Maxwell's equations                                                                                          |
| <b>CO5</b>                                                   | Explain the concept of electromagnetic waves and characterizing parameters                                                                                   |
| <b>TEXT BOOKS</b>                                            |                                                                                                                                                              |
| <b>1</b>                                                     | Mathew N. O. Sadiku, S.V. Kulkarni 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015.                          |
| <b>2</b>                                                     | William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indian edition, 2014.                                                  |
| <b>3</b>                                                     | Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 2010.                                             |
| <b>4</b>                                                     | "K A Gangadhar, 'Electromagnetic Field Theory', Khanna Publishers; Sixteenth Edition Eighth Reprint :2015"                                                   |
| <b>REFERENCES</b>                                            |                                                                                                                                                              |
| <b>1</b>                                                     | V.V.Sarwate, 'Electromagnetic fields and waves', Second Edition, Newage Publishers, 2018.                                                                    |



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|   |                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------|
| 2 | J.P.Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition, Khanna Publishers 2013. |
|---|-------------------------------------------------------------------------------------------------------------------------|

|   |                                                                                                                          |
|---|--------------------------------------------------------------------------------------------------------------------------|
| 3 | Joseph. A.Edminister, 'Schaum's Outline of Electromagnetics, Fifth Edition (Schaum's Outline Series), McGraw Hill, 2018. |
|---|--------------------------------------------------------------------------------------------------------------------------|

|   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 4 | S.P.Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill Education(India) Private Limited, 2017. |
|---|-----------------------------------------------------------------------------------------------------------------------------|

## CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium,  
1-Weak Programme Outcomes (POs) and Programme Specific  
Outcomes PSOs'

| CO/<br>PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1       | 3   | 3   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 3    | 2    | –    |
| CO2       | 3   | 3   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 3    | 3    | –    |
| CO3       | 3   | 3   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 3    | 3    | –    |
| CO4       | 3   | 2   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 2    | 2    | –    |
| CO5       | 3   | 2   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 2    | 2    | –    |
| AVG       | 3.0 | 2.6 | 2.0 | 2.0 | 2.0 | 2.0 | –   | –   | –   | –    | 2.0  | 2.6  | 2.4  | –    |

## Product based Projects ( in Team)

|   |                                         |
|---|-----------------------------------------|
| 1 | Electrostatic Dust Collector            |
| 2 | Paper Capacitor                         |
| 3 | Hall Effect Speed Sensor                |
| 4 | Wireless Energy Transfer Across Air Gap |
| 5 | FM Radio Signal Blocker Using Foil Box  |



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| U24EE402                                                                                                                                                                                                                                                                                                                       | Digital Logic Circuits                                                                                                 | L | T | P | C |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                |                                                                                                                        | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                              |                                                                                                                        |   |   |   |   |
| To develop digital simulation techniques to support the development of innovative, application- oriented logic circuits used in industries like automotive electronics, artificial intelligence, and consumer electronics.                                                                                                     |                                                                                                                        |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                              | Analyze various number systems and simplify logical expressions using Boolean laws to optimize digital circuit design. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                              | Design combinational circuits using logic gates and MSI devices for real-world applications.                           |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                              | To design synchronous logic circuits, FSMs and introduce ASMs.                                                         |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                              | To analyze and study asynchronous sequential circuits and Programmable Logic Devices.                                  |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                              | To introduce digital simulation techniques for development of application oriented logic circuit                       |   |   |   |   |
| UNIT 1 NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES                                                                                                                                                                                                                                                                               |                                                                                                                        |   |   |   | 9 |
| Review of number system- error detection, corrections & codes conversions - Boolean algebra: De Morgan's theorem - switching functions and minimization using K-maps & Quine McCluskey method - Digital Logic Families -comparison of RTL, DTL, TTL, ECL and MOS families - Operation characteristics of digital logic family. |                                                                                                                        |   |   |   |   |
| Experiential Learning (Activity Based Learning):Study of basic digital ICs ,Implementation of Boolean function using logic gates.                                                                                                                                                                                              |                                                                                                                        |   |   |   |   |
| Industrial Application : Design a circuit that converts input from one binary code to another (e.g., BCD to Gray, Binary to Excess-3).                                                                                                                                                                                         |                                                                                                                        |   |   |   |   |
| Content Beyond Syllabus : Introduction to low-power digital design for IoT applications.                                                                                                                                                                                                                                       |                                                                                                                        |   |   |   |   |
| UNIT 2 COMBINATIONAL LOGIC CIRCUITS                                                                                                                                                                                                                                                                                            |                                                                                                                        |   |   |   | 9 |
| Representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - simplification and implementation of combinational logic – multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.                                                            |                                                                                                                        |   |   |   |   |
| Experiential Learning (Activity Based Learning): Implementation of Mux and De-mux, Code converters. Industrial Application : 4-to-1 Multiplexer-Based Calculator                                                                                                                                                               |                                                                                                                        |   |   |   |   |
| Content Beyond Syllabus : Implementation using MSI devices and programmable logic devices.                                                                                                                                                                                                                                     |                                                                                                                        |   |   |   |   |
| UNIT 3 SYNCHRONOUS SEQUENTIAL CIRCUITS                                                                                                                                                                                                                                                                                         |                                                                                                                        |   |   |   | 9 |
| Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Mealy models- Counters, state diagram; state reduction; state assignment.                       |                                                                                                                        |   |   |   |   |
| Experiential Learning (Activity Based Learning): Design a basic synchronous voting system                                                                                                                                                                                                                                      |                                                                                                                        |   |   |   |   |
| Industrial Application : Data storage and communication, Control system.                                                                                                                                                                                                                                                       |                                                                                                                        |   |   |   |   |
| Content Beyond Syllabus : FSM , ASM                                                                                                                                                                                                                                                                                            |                                                                                                                        |   |   |   |   |
| UNIT 4 ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PLD                                                                                                                                                                                                                                                                                |                                                                                                                        |   |   |   | 9 |
| Asynchronous sequential logic Circuits-Transition stability, flow stability-race conditions, hazards & errors in digital circuits; analysis of asynchronous sequential logic circuits introduction to                                                                                                                          |                                                                                                                        |   |   |   |   |





Experiential Learning (Activity Based Learning): Mini Project: Traffic Light Controller (Using FPGA or PAL/PLA)  
 Industrial Application : Explore asynchronous design issues (races, hazards) and learn PLD-based implementation.  
 Content Beyond Syllabus : Introduction to Verilog for PLD development

|                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>UNIT5 VHDL</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>9</b> |
| <p>RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages – Subprograms – Test bench. (Simulation /Tutorial Examples: adders, counters, flip flops, Multiplexers &amp; De multiplexers).</p> <p>Experiential Learning (Activity Based Learning): ,Mini Project: VHDL-Based Alarm System Industrial Application : ASIC &amp; FPGA</p> <p>Content Beyond Syllabus : VHDL in ASIC/FPGA commercial design</p> |          |

|  |               |    |
|--|---------------|----|
|  | TOTAL PERIODS | 45 |
|--|---------------|----|

**At the end of the course, the student will be able to**

|            |                                                                                  |
|------------|----------------------------------------------------------------------------------|
| <b>CO1</b> | Simplify the logical expressions using reduction techniques.                     |
| <b>CO2</b> | Design and implement combinational circuits using basic gates(basic digital ICs) |
| <b>CO3</b> | Design and implement various synchronous circuits.                               |
| <b>CO4</b> | Design various synchronous and asynchronous circuits using Flip Flops            |
| <b>CO5</b> | Use HDL for simulating and testing RTL, combinatorial and sequential circuits    |

|   |                                                                                                |
|---|------------------------------------------------------------------------------------------------|
| 1 | Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rd Edition, 2005. |
| 2 | Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill, 1st Edition, 2003         |
| 3 | William Keitz, "Digital Electronics-A Practical Approach with VHDL", Pearson, 2013.            |

|   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 1 | Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010 |
| 2 | Charles H. Roth, Jr., Fundamentals of Logic Design, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US, 2014.              |
| 3 | Botros, "HDL Programming Fundamentals, VHDL & Verilog", Cengage, 2013.                                                      |
| 4 | Gaganpreet Kaur, "VHDL Basics to Programming", Pearson, 2013.                                                               |

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 3   | –   | –   | 2   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |
| <b>CO2</b> | 3   | 3   | 2   | –   | 3   | –   | –   | –   | –   | –    | –    | 3    | 3    | –    |

[illegible]



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|                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                          |   |   |   |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE403                                                                                                                                                                                                                                                                                                                                                                                                                             | ELECTRICAL MACHINES II                                                                                                                   | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                          | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                    | To control the speed of various types of AC motors.                                                                                      |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                    | To provide knowledge on construction, theory of operation and performance of synchronous generators.                                     |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                    | To impart knowledge on the operation, starting methods and current Loci of synchronous motors.                                           |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                    | To explain the details of the construction, principle of operation and performance of three-phase induction motors.                      |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                    | To provide exposure on the starting and speed control of three-phase induction motors.                                                   |   |   |   |   |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                    | To explain the details of the construction, principle of operation and performance of single-phase induction motors and special machines |   |   |   |   |
| UNIT 1 SYNCHRONOUS GENERATOR                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                          |   |   |   | 9 |
| Construction-Stator & Rotor, Armature Windings-coil span factor, distribution factor - EMF Equation, Efficiency - Voltage Regulation-EMF, MMF, PSA, ASA methods - Salient and Non-Salient Pole Machines- Slip Test - Two reaction theory - Active and Reactive Power Generation from Alternators Parallel Operation, Effects in load distribution with change in excitation and mechanical input - Characteristics-capability curves |                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Armature winding-lap and wave - laboratory demonstration Industrial Application: Captive generation-diesel generator sets<br>Content Beyond Syllabus: Power generation at two different frequencies                                                                                                                                                                                 |                                                                                                                                          |   |   |   |   |
| UNIT 2 SYNCHRONOUS MOTOR                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                          |   |   |   | 9 |
| Principle of Operation, starting methods, Power input and Power developed equations, Operation on infinite bus bars, Current loci for constant power input, constant excitation and constant power developed, O-curves, V-curves, inverted V-curves - Hunting-Damper windings - Synchronous condensers.                                                                                                                              |                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Role of Synchronous motor for pf improvement Industrial Application: Demonstration of usage of Synchronous condensers in a typical substation<br>Content Beyond Syllabus: Scope of Synchronous motor as a motor in electrical systems                                                                                                                                               |                                                                                                                                          |   |   |   |   |
| UNIT 3 THREE PHASE INDUCTION MOTOR                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                          |   |   |   | 9 |
| Constructional details-Types of rotors - Principle of operation-Slip - Torque-Speed characteristics - Power Stages-Losses and Efficiency - No-load and Blocked-rotor Test-Circle Diagram - Equivalent circuit - Induction Generators.                                                                                                                                                                                                |                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Design of rotor of squirrel cage induction motor Industrial Application: Role of 3 phase induction motors in elevators, lifts and powerlifting<br>Content Beyond Syllabus: Slip and Induction Generators                                                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| UNIT 4 STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTORS                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                          |   |   |   | 9 |



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Need for Starting - Types of starters - DOL, Rotor Resistance, Auto Transformer - Star-Delta Starters - Speed Control-Stator side - Voltage control, frequency control, pole changing - From Rotor side-cascaded connection, slip power recovery scheme, Braking-dynamic braking, regenerative braking – plugging.

Experiential Learning (Activity Based Learning): Demonstration of Laboratory based Multiple stators winding based Induction motor

Industrial Application: Induction motor for a variable speed application

Content Beyond Syllabus: Design of rotor resistance starter

### UNIT 5 SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES

9

Single phase Induction Motor-Construction, Principle of operation - Double field revolving theory - Starting - Equivalent circuit-No-load & Blocked Rotor test - Performance analysis - Special machines-Shaded pole induction motor, Repulsion motor - Hysteresis motor, Servo motor, Stepper motor - Linear Induction motor- introduction to magnetic levitation systems.

Experiential Learning (Activity Based Learning): Laboratory demonstration of Single-phase induction motor's universality

Industrial Application : Role of various slip phase induction motors in control systems

Content Beyond Syllabus : Microcontroller based stepper motor control

**TOTAL PERIODS**

**45**

### At the end of the course, the student will be able to

|            |                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Understand the theory of synchronous generators and the calculation of the regulation of non-salient pole and salient pole alternators by various methods. |
| <b>CO2</b> | Describe the complete operation of synchronous motors including its starting methods.                                                                      |
| <b>CO3</b> | Comprehend the various features of three phase induction motors, starting from their principle of operation.                                               |
| <b>CO4</b> | Choose the appropriate method of starting of three-phase induction motors                                                                                  |
| <b>CO5</b> | Comprehend the various features of single-phase induction motors, and special machines                                                                     |

### TEXT BOOKS

|          |                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------|
| <b>1</b> | P.S. Bhimbhra, 'Electrical Machinery', Khanna Publishers, edition 2, 2021.                               |
| <b>2</b> | D.P. Kothari and I.J. Nagrath, 'Electric Machines', McGraw Hill Publishing Company Ltd, 5th Edition 2017 |
| <b>3</b> | M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2011.     |
| <b>4</b> | J.B. Gupta, "Theory and Performance of Electrical Machines", S.K.Kataria and Sons, 2009                  |

### REFERENCES

|          |                                                                                                             |
|----------|-------------------------------------------------------------------------------------------------------------|
| <b>1</b> | B. L. Theraja and AK Theraja, "A Text book of Electrical Technology", Volume 2, S. Chand Publications, 2015 |
|----------|-------------------------------------------------------------------------------------------------------------|



| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO/<br>PO                                                                                                                                                              | PO1                                                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| <b>CO1</b>                                                                                                                                                             | 3                                                                                | 3   | 2   | 2   | 2   | 2   | –   | –   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO2</b>                                                                                                                                                             | 3                                                                                | 2   | 2   | 2   | 2   | 2   | –   | –   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO3</b>                                                                                                                                                             | 3                                                                                | 2   | 2   | 2   | 2   | 2   | –   | –   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO4</b>                                                                                                                                                             | 3                                                                                | 2   | 3   | 2   | 2   | 2   | –   | –   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO5</b>                                                                                                                                                             | 3                                                                                | 2   | 2   | 2   | 2   | 2   | –   | –   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>AVG</b>                                                                                                                                                             | 3.0                                                                              | 2.2 | 2.2 | 2.0 | 2.0 | 2.0 | –   | –   | 2.0 | 2.0  | 2.0  | 3.0  | 2.0  | –    |
| <b>Product based Projects ( in Team)</b>                                                                                                                               |                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | Armature winding-lap and wave - laboratory demonstration                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | Role of Synchronous motor for pf improvement                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | Design of rotor of squirrel cage induction motor                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | Demonstration of Laboratory based Multiple stators winding based Induction motor |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | Laboratory demonstration of Single-phase induction motor's universality          |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24MC413                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Indological Studies                                                                                                                                                                  | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                      | 2 | 0 | 0 | 2 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                      |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduce students to the fundamental concepts of Indological Studies and Indian Knowledge Systems (IKS), highlighting their civilizational, cultural, and philosophical foundations |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Enable students to understand the contributions of ancient India to Science, Technology, Engineering, Mathematics, health, economy, art, and architecture                            |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Develop awareness of wellness concepts such as psychosomatic harmony, Ayurveda, and Yoga for holistic personal and professional life                                                 |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Foster appreciation of India’s cultural identity, heritage, and global influence through art, architecture, and traditions                                                           |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Encourage independent learning, research skills, creativity, and application of traditional knowledge to contemporary challenges including Atmanirbhar Bharat                        |   |   |   |   |
| UNIT 1 Introduction to Indological Studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                      |   |   |   | 6 |
| Overview of IKS- civilizational identity, culture and uniqueness of Bharat; Wisdom through ages                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                      |   |   |   |   |
| Session 1: Indian Knowledge System (IKS) & Civilizational Identity                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                      |   |   |   |   |
| <ul style="list-style-type: none"><li>What is IKS – Explanation of Indian Knowledge System</li><li>Why should one study IKS</li><li>Importance of Civilizational Identity in Personality Development</li></ul>                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                      |   |   |   |   |
| Civilizational identity as an anchor to shape personal identity                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                      |   |   |   |   |
| Session 2: Culture of India & IKS in Daily Life                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                      |   |   |   |   |
| <ul style="list-style-type: none"><li>Introduction to Culture of India – Important Aspects</li><li>Uniqueness of Bharat in terms of:<ul style="list-style-type: none"><li>Land</li><li>Language</li><li>Diversity</li><li>History</li><li>Knowledge Traditions</li></ul></li><li>IKS for Daily Life – Shruti and Smriti</li><li>IKS for Daily Life – 18 Mahapuranas and Puranas</li><li>IKS for Daily Life – Itihasa (Ramayana and Mahabharata)</li><li>IKS for Daily Life – Economy of Ancient Bharat</li></ul> |                                                                                                                                                                                      |   |   |   |   |
| UNIT 2 Contributions of IKS to STEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                      |   |   |   | 6 |
| Contributions of IKS in the field of Science, Technology, Engineering and Mathematics                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                      |   |   |   |   |
| Session 3: Contributions of IKS to Science & Technology                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                      |   |   |   |   |
| <ul style="list-style-type: none"><li>Contributions of IKS to Science</li><li>Contributions of IKS to Technology and Engineering<ul style="list-style-type: none"><li>Engineering and metallurgical practices of ancient India;</li><li>Contributions to Mathematics – number system, zero, algebra and geometry;</li></ul></li></ul>                                                                                                                                                                            |                                                                                                                                                                                      |   |   |   |   |
| Session 4: Contributions of IKS to Mathematics & Astronomy                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                      |   |   |   |   |
| <ul style="list-style-type: none"><li>Contributions of IKS to Mathematics</li><li>Contributions of IKS to Astronomy</li></ul>                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                      |   |   |   |   |
| UNIT 3 Idea of wellness in Ancient India                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                      |   |   |   | 6 |



# Meenakshi Sundararajan Engineering College

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Psychosomatic harmony ; Ayurveda - its main proponents, daily and seasonal routine; Yoga for holistic health

## Session 5: Psychosomatic Harmony & Ayurveda

- Introduction to the Session -Psychosomatic Harmony – Beyond Mind and Body (Panchakosha Viveka)
- Ayurveda – Daily and Seasonal Routine

## Session 6: Yoga & Contributions of Ancient Indian Scholars

- Introduction to the Yoga & Contributions of Ancient Indian Scholars
- Contributions of Charaka and Sushruta
- Yoga for a Happy and Healthy Life
- Ashtanga Yoga and the Concept of Yama and Niyama
- Yoga for Daily Life

## UNIT4 Economy of Ancient India

6

Arthashastra- governance, public administration, economy; footprints of Bharat outside India; IKS for Atmanirbhar Bharat .

## Session 7: Arthashastra – Governance & Administration

- Introduction to the Session -Arthashastra – Context and Historical Background
- Saptanga Theory and its Relevance to Modern Management
- Governance and Public Administration in Arthashastra

## Session 8: Global Footprints of Bharat & Atmanirbhar Bharat

- Introduction to the Session- Footprints of Bharat Outside India – Temples
- Other Living Traditions Outside India
- IKS as an Inspiration for Self-Employment and Creation of Atmanirbhar Bharat

## UNIT 5 Art and Architecture of India

6

64 Kalas; Music, dance, painting, temple art and architecture; Thanjavur Brihadeeshwara Temple- A case study

## Session 9: Indian Art Traditions – 64 Kalas, Music & Painting

- Introduction to the Session -Overview of the 64 Kalas
- Different Traditions of Music in India
- Different Forms of Painting across India

## Session 10: Temple Art & Architecture – Case Study Approach

- Introduction to Temple Art and Architecture
- Different Styles of Temple Architecture in India
- Case Study: Brihadeeshwara Temple

**TOTAL:30**

## At the end of the course, the student will be able to

|     |                                                                                              |
|-----|----------------------------------------------------------------------------------------------|
| CO1 | Identify core principles and ancient Indian contributions to global science and philosophy   |
| CO2 | Develop a deep appreciation for traditional wisdom and its role in shaping cultural identity |
| CO3 | Apply traditional frameworks to solve contemporary professional and personal challenges      |
| CO4 | Strengthen creative thinking and communication through collaborative projects.               |
| CO5 | Gain the skills to independently research heritage topics aligned with their career goals    |

## TEXT BOOKS

|   |                                                                                        |
|---|----------------------------------------------------------------------------------------|
| 1 | Dharampal, Indian Science and Technology in the Eighteenth Century, Other India Press. |
| 2 | B. Mahadevan (Ed.), Indian Knowledge Systems – Vol. 1 & 2, IIT Madras Publications.    |
| 3 | Swami Vivekananda, Complete Works of Swami Vivekananda, Advaita Ashrama.               |

## REFERENCES

|   |                                                                         |
|---|-------------------------------------------------------------------------|
| 1 | Kautilya, Arthashastra, translated by R. Shamasastri, Penguin Classics. |
| 2 | Sushruta Samhita, translated by K.K. Bhishagratna                       |
| 3 | Patanjali, Yoga Sutras, with commentary by Swami Satchidananda          |





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| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |            |            |            |            |            |            |            |            |            |             |             |             |             |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
|                                                                                                                                                                        | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
| <b>CO1</b>                                                                                                                                                             | 1          | 1          | -          | -          | -          | 2          | 3          | 1          | 1          | -           | 1           |             |             |             |
| <b>CO2</b>                                                                                                                                                             | -          | -          | -          | -          | -          | 2          | 3          | 1          | 1          | -           | 1           |             |             |             |
| <b>CO3</b>                                                                                                                                                             | 1          | 2          | 2          | 1          | -          | 2          | 3          | 1          | 1          | 1           | 2           |             |             |             |
| <b>CO4</b>                                                                                                                                                             | -          | -          | -          | -          | -          | 1          | 2          | 2          | 3          | 1           | 1           |             |             |             |
| <b>CO5</b>                                                                                                                                                             | 1          | 1          | 1          | 2          | 1          | 2          | 3          | 1          | 2          | 1           | 3           |             |             |             |
| <b>AVG</b>                                                                                                                                                             | 0.6        | 0.8        | 0.6        | 0.6        | 0.2        | 1.8        | 2.8        | 1.2        | 1.6        | 0.6         | 1.6         |             |             |             |



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|                                                                                                                                                                                                                                                                                                                   |                                                            |   |   |      |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---|---|------|-----|
| U24EE404                                                                                                                                                                                                                                                                                                          | INTEGRATED CIRCUITS                                        | L | T | P    | C   |
|                                                                                                                                                                                                                                                                                                                   |                                                            | 3 | 0 | 3    | 4.5 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                 |                                                            |   |   |      |     |
| Students develop analytical skills and gain practical expertise in the design, evaluation, and application of analog integrated circuits, including operational amplifiers and specialized ICs, across various real-world systems.                                                                                |                                                            |   |   |      |     |
| 1                                                                                                                                                                                                                                                                                                                 | Bridge theoretical knowledge with industry practices       |   |   |      |     |
| 2                                                                                                                                                                                                                                                                                                                 | Evaluate frequency response and feedback mechanisms        |   |   |      |     |
| 3                                                                                                                                                                                                                                                                                                                 | Design and implement analog circuits                       |   |   |      |     |
| 4                                                                                                                                                                                                                                                                                                                 | Design timing and waveform generation circuits             |   |   |      |     |
| 5                                                                                                                                                                                                                                                                                                                 | Incorporate switching regulators and decoupling techniques |   |   |      |     |
| UNIT - I IC FABRICATION                                                                                                                                                                                                                                                                                           |                                                            |   |   | 9    |     |
| IC classification - Fundamental of monolithic IC technology- Epitaxial growth - Masking and etching - Diffusion of impurities - Realisation of monolithic ICs and packaging - Fabrication of diodes, capacitance, resistance, FETs and PV cell.                                                                   |                                                            |   |   |      |     |
| <a href="#">Experiential Learning : Design of first and second order filters</a><br><a href="#">Industrial Application : Manufacturing of semiconductors</a><br><a href="#">Content Beyond Syllabus : Demo IC fabrication</a>                                                                                     |                                                            |   |   |      |     |
| UNIT - II CHARACTERISTICS OF OPAMP                                                                                                                                                                                                                                                                                |                                                            |   |   | 9+18 |     |
| Ideal OP-AMP characteristics - DC characteristics- AC characteristics - Differential amplifier - Frequency response of OP-AMP - Non-Inverting Amplifier – Basic applications of op-amp - Summer, differentiator - V/I & I/V converters - Voltage-shunt feedback and inverting amplifier - Voltage series feedback |                                                            |   |   |      |     |
| <a href="#">Experiential Learning : Integrator Project</a><br><a href="#">Industrial Application : Manufacturing of inverters</a><br><a href="#">Content Beyond Syllabus : Inverter Battery</a>                                                                                                                   |                                                            |   |   |      |     |
| Lab Components                                                                                                                                                                                                                                                                                                    |                                                            |   |   |      |     |
| 1. Application of inverting amplifier                                                                                                                                                                                                                                                                             |                                                            |   |   |      |     |
| 2. Application of non-inverting amplifier                                                                                                                                                                                                                                                                         |                                                            |   |   |      |     |
| 3. Application of Op Amp-comparator circuits                                                                                                                                                                                                                                                                      |                                                            |   |   |      |     |
| 4. 4.Application of Op Amp-integrator circuits                                                                                                                                                                                                                                                                    |                                                            |   |   |      |     |
| 5. Op amp differentiator circuits                                                                                                                                                                                                                                                                                 |                                                            |   |   |      |     |
| 6. Instrumentation Amplifier                                                                                                                                                                                                                                                                                      |                                                            |   |   |      |     |
| UNIT - III APPLICATIONS OF OPAMP                                                                                                                                                                                                                                                                                  |                                                            |   |   | 9+9  |     |
| Instrumentation amplifier and its applications for transducer Bridge – Comparators - Multi vibrators - Waveform generators, clippers, clammers, peak detector - S/H circuit - D/A converter (R- 2R ladder and weighted resistor types) - A/D converters using OP-AMPs - Log and antilog amplifiers.               |                                                            |   |   |      |     |
| <a href="#">Experiential Learning : First and second order filters design</a>                                                                                                                                                                                                                                     |                                                            |   |   |      |     |



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Industrial Application : Applications of converters

Content Beyond Syllabus : Buck Converter

### Lab Components

1. A/D converter using Op Amp
2. D/A converter using Op Amp
3. Clipper using Op Amp
4. Clamper using Op Amp

### UNIT - IV SPECIAL ICs

9+9

Functional block - characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC - AD633 Analog multiplier ICs - 565-phase locked loop IC - Multiplexer and DeMultiplexer

Experiential Learning : Real Time Project using Multiplexer and

Demultiplexer Industrial Application : Use of multiplex in power plant

Content Beyond Syllabus : Application of phase locked loop IC

### Lab Components

1. Voltage to frequency characteristics of NE/SE 566 IC
2. Multiplexer and De Multiplexer

### UNIT - V APPLICATION ICs

9+9

AD623 Instrumentation Amplifier and its application as load cell weight measurement IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators, switching regulator - AI tool SnapEDA - Decoupling capacitors - optimize bills of materials for cost or power reduction

Experiential Learning : Mini Project using AI - SnapEDA for billing system

Industrial Application : Applications of Voltage regulators

Content Beyond Syllabus : Application of SMPS

### Lab Components

1. Variability voltage regulator using LM317 IC
2. Mini Project on Design and implementation of audio volume control using differential amplifier
3. Mini Project on Design and implementation of light detector using Operational amplifier.

**TOTAL PERIODS**

**90**

### COURSE OUTCOME

**At the end of the course, the student will be able to**

- |            |                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Explain monolithic IC fabrication process                                                                                                                  |
| <b>CO2</b> | Explain the fabrication of diodes, capacitance, resistance, FETs and PV Cell                                                                               |
| <b>CO3</b> | Analyze the characteristics and basic applications (inverting/non-inverting amplifier, summer differentiator, integrator, V/I and I/V converter) of Op-Amp |

[illegible]



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| U24EE405            | ELECTRICAL MACHINES II LABORATORY                                                                                | L | T | P  | C   |
|---------------------|------------------------------------------------------------------------------------------------------------------|---|---|----|-----|
|                     |                                                                                                                  | 0 | 0 | 3  | 1.5 |
| COURSE OBJECTIVES   |                                                                                                                  |   |   |    |     |
| 1                   | Build a generator using magnets and coils.                                                                       |   |   |    |     |
| 2                   | To impart the necessary knowledge in predetermining the regulation of an Alternator                              |   |   |    |     |
| 3                   | To conduct experiments to determine the negative and zero sequence impedances of an alternator                   |   |   |    |     |
| 4                   | To teach the synchronization procedure for an alternator and to draw the V and inverted V curves                 |   |   |    |     |
| 5                   | To conduct load test to determine the performance characteristics of 3 phase and 1 phase Induction Motors        |   |   |    |     |
| 6                   | To conduct no load and blocked rotor tests on 3 phase and 1 phase induction motors                               |   |   |    |     |
| LIST OF EXPERIMENTS |                                                                                                                  |   |   |    |     |
| 1                   | Regulation of three phase alternators by EMF and MMF methods.                                                    |   |   |    |     |
| 2                   | Regulation of three phase alternators by ZPF and ASA methods.                                                    |   |   |    |     |
| 3                   | Regulation of three phase salient pole alternator by slip test.                                                  |   |   |    |     |
| 4                   | Measurements of negative sequence and zero sequence impedance of alternators.                                    |   |   |    |     |
| 5                   | V and Inverted V curves of Three Phase Synchronous Motor.                                                        |   |   |    |     |
| 6                   | Load test on three-phase induction motor.                                                                        |   |   |    |     |
| 7                   | No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters). |   |   |    |     |
| 8                   | Separation of No-load losses of three-phase induction motor.                                                     |   |   |    |     |
| 9                   | Load test on single-phase induction motor.                                                                       |   |   |    |     |
| 10                  | No load and blocked rotor test on single-phase induction motor.                                                  |   |   |    |     |
|                     | Case Study                                                                                                       |   |   |    |     |
|                     | Efficiency and Health Check for a Workshop Motor                                                                 |   |   |    |     |
| TOTAL PERIODS       |                                                                                                                  |   |   | 45 |     |

|                                                              |                                                                                       |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>At the end of the course, the student will be able to</b> |                                                                                       |
| <b>CO1</b>                                                   | Find the performance characteristics of AC machines using direct and indirect methods |
| <b>CO2</b>                                                   | Compute the regulation of three phase alternators using the predetermination methods. |
| <b>CO3</b>                                                   | Study the saliency nature of synchronous machines.                                    |
| <b>CO4</b>                                                   | Check the performance of the single-phase induction motor.                            |
| <b>CO5</b>                                                   | Study the starting and speed control of AC machines.                                  |
| <b>TEXT BOOKS</b>                                            |                                                                                       |
| <b>1</b>                                                     | Dr. PS Bhimbra, "Electrical Machinery," Khanna Publishers, 2nd edition, 2001          |



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|            |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 2          | O Elgerd, "Electrical Energy System Theory - An Introduction," McGraw Hill Education                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3          | BL Theraja, AK Theraja, "A Text Book of Electrical Technology," Vol. 2, S Chand Publishers, 2015                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1          | D.P. Kothari and I.J. Nagrath, ‘Electric Machines’, McGraw Hill Publishing Company Ltd, 5th Edition 2017                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2          | M.N. Bandyopadhyay, Electrical Machines Theory and Practice, PHI Learning PVT LTD., New Delhi, 2011.                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3          | J.B. Gupta, “Theory and Performance of Electrical Machines”, S.K.Kataria and Sons, 2009                                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
|            | CO-PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |
|            | PO1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1        | 3                                                                                                                                                               | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| CO2        | 3                                                                                                                                                               | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| CO3        | 3                                                                                                                                                               | 2   | 2   | 2   | 2   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| CO4        | 3                                                                                                                                                               | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| CO5        | 3                                                                                                                                                               | 2   | 2   | 2   | 3   | 2   | –   | 3   | 2   | 2    | 2    | 3    | 2    | –    |
| AVG        | 3.0                                                                                                                                                             | 2.0 | 2.0 | 2.0 | 2.8 | 2.0 | –   | 2.2 | 2.0 | 2.0  | 2.0  | 3.0  | 2.0  | –    |



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| U24TP410          | CRITICAL AND CREATIVE THINKING SKILLS                                                    | L | T | P | C        |
|-------------------|------------------------------------------------------------------------------------------|---|---|---|----------|
|                   |                                                                                          | 0 | 0 | 2 | 1        |
| COURSE OBJECTIVES |                                                                                          |   |   |   |          |
| 1                 | Develop logical, analytical, and creative reasoning abilities for problem-solving.       |   |   |   |          |
| 2                 | Analyze and decode complex patterns, sequences, and reasoning puzzles.                   |   |   |   |          |
| 3                 | Enhance skills in judgment, decision-making, and inference through real-world scenarios. |   |   |   |          |
| 4                 | prepare students for challenging critical reasoning questions in recruitment exams.      |   |   |   |          |
| 5                 | Cultivate ability to tackle abstract and visual reasoning problems confidently.          |   |   |   |          |
| Topics            |                                                                                          |   |   |   |          |
| 1.                | Coding-Decoding                                                                          |   |   |   |          |
| 2.                | Seating Arrangement (Linear, Circular, Square)                                           |   |   |   |          |
| 3.                | Data Arrangements (Ranking, Scheduling, Grouping)                                        |   |   |   |          |
| 4.                | Analogy (Verbal and Non-Verbal)                                                          |   |   |   |          |
| 5.                | Syllogisms – Statement & Conclusions                                                     |   |   |   |          |
| 6.                | Blood Relations                                                                          |   |   |   |          |
| 7.                | Clocks and Calendars                                                                     |   |   |   |          |
| 8.                | Image-Based Problems (Water, Mirror, Embedded)                                           |   |   |   |          |
| 9.                | Image Grouping                                                                           |   |   |   |          |
| 10.               | Number Series                                                                            |   |   |   |          |
| 11.               | Letter Series                                                                            |   |   |   |          |
| 12.               | Logical Puzzles                                                                          |   |   |   |          |
| 13.               | Clock Puzzles                                                                            |   |   |   |          |
| 14.               | Input-Output Pattern Recognition                                                         |   |   |   |          |
| 15.               | Complex Multi-level Direction Sense Problems                                             |   |   |   |          |
| 16.               | Statement & Assumption Analysis                                                          |   |   |   |          |
| 17.               | Theme Detection and Contextual Inference                                                 |   |   |   |          |
| 18.               | Decision Making and Problem Solving under Uncertainty                                    |   |   |   |          |
| 19.               | Making Judgments, Statement and Conclusion                                               |   |   |   |          |
| 20.               | Cause and Effect                                                                         |   |   |   |          |
| 21.               | Decision Making                                                                          |   |   |   |          |
| 22.               | Course of Action, Analogy                                                                |   |   |   |          |
| 23.               | Fact-Inference-Judgment                                                                  |   |   |   |          |
| 24.               | Resume building                                                                          |   |   |   |          |
|                   |                                                                                          |   |   |   | TOTAL:30 |





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|                                                       |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, the student will be able to |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                   | Solve seating, coding-decoding problems                                                                                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                   | Analyze syllogisms & blood relations                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                   | Recognize patterns and analogies                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                   | Apply critical reasoning to draw conclusions                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                   | Demonstrate creative thinking skills                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                            |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1.                                                    | R. S. Aggarwal. A Modern Approach to Verbal & Non-verbal Reasoning (Revised Edition 2025). S. Chand Publishing, New Delhi: 2025.                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2.                                                    | Arun Sharma. Logical Reasoning for CAT (Latest Edition). McGraw Hill Education, New Delhi: 2025                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                            |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1.                                                    | A.K. Gupta. Logical and Analytical Reasoning (Latest Edition). S. Chand Publishing, New Delhi: 2023                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2.                                                    | Edgar Thorpe. Test of Reasoning. Pearson Education, New Delhi: 2022                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                       | CO-PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                       | PO1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO2                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO3                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO4                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO5                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| AVG                                                   |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      | 1    |      |      |      |



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| U24RM412                                                                                                                                                                                                                                                                                                                      | HYPOTHESIS                                                                                                     | L | T | P | C   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                               |                                                                                                                | 0 | 0 | 1 | 0.5 |
|                                                                                                                                                                                                                                                                                                                               |                                                                                                                |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                             | To understand the fundamental principles and types of hypothesis and their role in scientific research         |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                             | To enable students to formulate clear and testable hypothesis from research problems using variable analysis   |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                             | To equip students with knowledge of research methodology and statistical tools for hypothesis testing          |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                             | To apply hypothesis in real-world, interdisciplinary research while addressing ethical considerations          |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                             | To explore advanced hypothesis techniques in modern fields such as AI, business analytics, and design thinking |   |   |   |     |
| UNIT1 Foundations of Hypothesis in Research                                                                                                                                                                                                                                                                                   |                                                                                                                |   |   | 3 |     |
| Definition and Role of Hypothesis in Research, Characteristics of good hypothesis – testable, specific, falsifiable – Difference between assumptions, theories and hypotheses, Types – Null, alternative, directional, non-directional, Hypothesis vs Research questions.                                                     |                                                                                                                |   |   |   |     |
| UNIT2 Hypothesis Formulation and Design                                                                                                                                                                                                                                                                                       |                                                                                                                |   |   | 3 |     |
| Steps in developing a hypothesis from a problem statement, Operationalization of variables, Independent, dependent, and controlled variables, Conceptual vs. empirical hypothesis, Case studies on hypothesis framing in various disciplines.                                                                                 |                                                                                                                |   |   |   |     |
| UNIT3 Research Methodology and Hypothesis Testing                                                                                                                                                                                                                                                                             |                                                                                                                |   |   | 3 |     |
| The scientific method and its relationship to hypotheses, Experimental vs. non-experimental designs, Statistical tools for hypothesis testing (t-test, chi-square, ANOVA, etc.), Type I and Type II errors, p-values, confidence intervals, Sampling techniques and hypothesis testing limitations.                           |                                                                                                                |   |   |   |     |
| UNIT4Applications of Hypothesis in Real-World Research                                                                                                                                                                                                                                                                        |                                                                                                                |   |   | 3 |     |
| Hypothesis-driven research in natural sciences, social sciences, and engineering, Hypothesis in qualitative vs. quantitative research, Hypothesis in interdisciplinary and applied research, Ethics in hypothesis formulation and testing, Case studies and analysis of published research papers.                            |                                                                                                                |   |   |   |     |
| UNIT5 Advanced Topics and Contemporary Approaches                                                                                                                                                                                                                                                                             |                                                                                                                |   |   | 3 |     |
| Hypotheses in data science, AI, and machine learning (e.g., model hypothesis space), Hypothesis in action research and participatory methods, Iterative hypothesis development in design thinking, A/B testing and hypothesis validation in business research, Writing research proposals with strong hypothesis foundations. |                                                                                                                |   |   |   |     |
| TOTAL: 15                                                                                                                                                                                                                                                                                                                     |                                                                                                                |   |   |   |     |



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| At the end of the course, the student will be able to                                                                                  |                                                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1                                                                                                                                    | Explain the characteristics, types, and significance of hypothesis in research                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                                                                                    | Develop and operationalize hypothesis using variables and domain specific frameworks                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                                                                                    | Apply statistical methods and research methodology to test and validate hypothesis                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                                                                                    | Analyze the application and ethics of hypothesis usage in various domains using case studies                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                                                                                    | Evaluate and construct advanced, iterative hypotheses in modern research contexts.                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                                                                                             |                                                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                      | C. R. Kothari and G. Garg, Research Methodology: Methods and Techniques, 4th ed. New Delhi, India: New Age International Publishers, 2019.                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                      | P. D. Leedy and J. E. Ormrod, Practical Research: Planning and Design, 12th ed. Boston, MA, USA: Pearson, 2019.                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                      | W. Goddard and S. Melville, Research Methodology: An Introduction, 4th ed. Chichester, UK: Wiley-Blackwell, 2004.                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                             |                                                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                      | J. W. Creswell and J. D. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th ed. Thousand Oaks, CA, USA: SAGE Publications, 2017. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                      | M. J. Schervish, Theory of Statistics, 2nd ed. New York, NY, USA: Springer, 1995. (for statistical hypothesis theory)                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping                                                                                                                     |                                                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                        | PO1                                                                                                                                                                   | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                    | 3                                                                                                                                                                     | 2   | -   | -   | -   | -   | -   | -   | 2   | -    | 1    |      |      |      |
| CO2                                                                                                                                    | 3                                                                                                                                                                     | 3   | 2   | -   | -   | -   | -   | -   | 2   | -    | 2    |      |      |      |
| CO3                                                                                                                                    | 3                                                                                                                                                                     | 3   | 3   | 3   | 2   | -   | -   | -   | 2   | -    | 2    |      |      |      |
| CO4                                                                                                                                    | 3                                                                                                                                                                     | 3   | 2   | 3   | 2   | 2   | 3   | 2   | 2   | 1    | 3    |      |      |      |
| CO5                                                                                                                                    | 3                                                                                                                                                                     | 3   | 3   | 3   | 3   | 2   | 2   | 2   | 3   | 2    | 3    |      |      |      |
| AVG                                                                                                                                    | 3                                                                                                                                                                     | 2.8 | 2.5 | 3   | 2.3 | 2   | 2.5 | 2   | 2.2 | 1.5  | 2.2  |      |      |      |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                          |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE501                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | TRANSMISSION & DISTRIBUTION                                                                                                                                                                                              | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                          | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To model the electric power transmission and distribution systems along with the line parameters and their performance-mechanical design of transmission lines and voltage distribution in insulator strings and cables. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To impart knowledge on the structure of electric power system and various distribution schemes.                                                                                                                          |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To study the line parameters and interference with neighboring circuits.                                                                                                                                                 |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To understand the mechanical design and performance analysis of transmission lines.                                                                                                                                      |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To familiarize the voltage distribution in insulator strings and cables.                                                                                                                                                 |   |   |   |   |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | To inculcate knowledge on the mechanical design of transmission line, sag calculations and substation layout.                                                                                                            |   |   |   |   |
| UNIT 1 STRUCTURE OF POWER SYSTEM                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                          |   |   |   | 9 |
| Structure of electric power system: generation, transmission and distribution; Choice of transmission voltage, overhead and underground systems, Types of AC and DC distributors– distributed and concentrated loads– voltage tolerances, interconnection- advantages and limitations– EHVAC and HVDC transmission -Introduction to FACTS devices.                                                                                                                                                         |                                                                                                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Field visit to our campus                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                          |   |   |   |   |
| Industrial Application: EHVAC- Long distance power Transmission, Grid Interconnection, Integration of Renewable energy                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                          |   |   |   |   |
| Content Beyond Syllabus: Grid decentralization and fault detection using AI technologies                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                          |   |   |   |   |
| UNIT 2 TRANSMISSION LINE PARAMETERS                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                          |   |   |   | 9 |
| Parameters of single and three phase transmission lines with single and double circuits - Resistance, inductance and capacitance of solid, stranded and bundled conductors, conductor types - Symmetrical and unsymmetrical spacing and transposition-application of self and mutual GMD; skin and proximity effects-Effects of earth on capacitance of transmission line - interference with neighboring communication circuits, corona discharge, factors affecting corona-advantages and disadvantages. |                                                                                                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): case study on real-time voltage control methods used in industry                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                          |   |   |   |   |
| Industrial Application: Steel plants, Chemical factories, Thermal, hydro, nuclear, or Renewable power plants.                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                          |   |   |   |   |
| Content Beyond Syllabus: Other types of conductors – AAAC (All Aluminum Alloy Conductor), CCA(Copper-Clad Aluminum)                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                          |   |   |   |   |
| UNIT 3 MODELLING AND PERFORMANCE OF TRANSMISSION LINES                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                          |   |   |   | 9 |
| Classification of lines–short line medium line and long line - equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance and surge impedance loading - transmission efficiency and voltage regulation, Evaluation of A, B, C, D constants, real and reactive power flow in lines methods of voltage control, Ferranti effect, Charging current and losses in an open circuited line.                                                                                      |                                                                                                                                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Industrial visit to local Substation- busbars, Various types of lines.                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                          |   |   |   |   |



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Industrial Application: Analyzing performance, optimizing designs, and improving system stability, reliability, and efficiency.

Content Beyond Syllabus: Power-circle diagrams

|                                                                                                                                                                                                                                                                                                                                                             |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>UNIT 4 INSULATORS AND CABLES</b>                                                                                                                                                                                                                                                                                                                         | <b>9</b> |
| Insulators-Types, voltage distribution in insulator string, improvement of string efficiency Underground Cables-Types of cables, insulation materials, Parameters of cable, Grading of cables. Capacitance of 3-core cable, heating, thermal resistance of cable.                                                                                           |          |
| Experiential Learning (Activity Based Learning): Industrial visit to local Substation - Insulators, Cables<br>Industrial Application: Power distribution systems, Transformers & Circuit Breakers, Factory transmission lines<br>Content Beyond Syllabus: Testing of insulators using AI (to ensure high reliability through AI enabled monitoring systems) |          |
| <b>UNIT 5 MECHANICAL DESIGN OF LINES AND GROUNDING</b>                                                                                                                                                                                                                                                                                                      | <b>9</b> |
| Mechanical design of transmission line, sag and tension calculations for different weather conditions - Tower spotting, Types of towers, Sub-station Layout (AIS, GIS), Methods of grounding – Substation and Building.                                                                                                                                     |          |
| Experiential Learning (Activity Based Learning): Earthing - Site visit in our campus<br>Industrial Application: Condition monitoring and predictive maintenance of transmission lines.<br>Content Beyond Syllabus: Energy storage integration in modern distribution networks.                                                                              |          |
| <b>TOTAL: 45</b>                                                                                                                                                                                                                                                                                                                                            |          |

| At the end of the course, the student will be able to |                                                                                                                                           |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b>                                            | Understand structure of power system, distribution schemes, HVDC system and FACTS devices.                                                |
| <b>CO2</b>                                            | Compute line parameters for different configurations.                                                                                     |
| <b>CO3</b>                                            | Model the transmission lines to determine the line performance and to understand the impact of Ferranti effect and corona.                |
| <b>CO4</b>                                            | Evaluate the different types of insulators and cables.                                                                                    |
| <b>CO5</b>                                            | Analyze the modelling, performance analysis and modern trends in distribution system.                                                     |
| TEXT BOOKS                                            |                                                                                                                                           |
| 1                                                     | D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.          |
| 2                                                     | C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022.                                                  |
| 3                                                     | S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008. |
| 4                                                     | V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 842013                                           |
| REFERENCES                                            |                                                                                                                                           |
| 1                                                     | B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.                                                   |
| 2                                                     | Lucas M.Faulkenberry, Walter Coffey, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.                           |
| 3                                                     | Arun Ingle, "Power transmission and distribution" Pearson Education, first edition, 2018                                                  |



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|   |                                                                                                                            |
|---|----------------------------------------------------------------------------------------------------------------------------|
| 4 | J.Brian Hardy and Colin R.Bayliss 'Transmission and Distribution in Electrical Engineering', Newnes; Fourth Edition, 2011. |
| 5 | G.Ramamurthy, "Handbook of Electrical power Distribution," Universities Press, 2013.                                       |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| CO1 | 3   | 2   | 2   | 2   | 3   | 2   | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |
| CO2 | 3   | 3   | 2   | 2   | 3   | 2   | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |
| CO3 | 3   | 3   | 3   | 2   | 3   | 2   | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |
| CO4 | 3   | 2   | 2   | 2   | 3   | 2   | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |
| CO5 | 3   | 2   | 2   | 2   | 3   | 2   | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |
| AVG | 3.0 | 2.4 | 2.2 | 2.0 | 3.0 | 2.0 | -   | 2   | 2    | 2    | 3    | 3    | 2    | 1    |

**Product based Projects ( in Team)**

|   |                                                                                             |
|---|---------------------------------------------------------------------------------------------|
| 1 | To develop a hardware-based model to demonstrate 2-wire system and 3-wire system            |
| 2 | To design a portable or table top device that calculates line parameters along with display |
| 3 | To design a Buck Boost converter for fine DC voltage control                                |
| 4 | To develop a Smart Diagnostic System for Underground Power Cables                           |
| 5 | To design a smart ground health monitoring to provide real time alerts.                     |



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| U4533502                                                                                                                                                                                                                                 | MEASUREMENT AND INSTRUMENTATION                                                                                    | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                          |                                                                                                                    | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                        |                                                                                                                    |   |   |   |   |
| 1                                                                                                                                                                                                                                        | Analyze measurement systems and errors using statistical methods to improve accuracy.                              |   |   |   |   |
| 2                                                                                                                                                                                                                                        | To Evaluate and apply electrical measuring instruments and transformers for accurate power and energy measurement. |   |   |   |   |
| 3                                                                                                                                                                                                                                        | Design and analyze bridge circuits and instrumentation amplifiers for precise electrical parameter measurement.    |   |   |   |   |
| 4                                                                                                                                                                                                                                        | Select and integrate appropriate transducers and smart sensors for real-time monitoring of physical quantities.    |   |   |   |   |
| 5                                                                                                                                                                                                                                        | Implement digital measurement systems using A/D, D/A converters, DSOs, and PLCs for industrial automation.         |   |   |   |   |
| UNIT 1 CONCEPTS OF MEASUREMENTS                                                                                                                                                                                                          |                                                                                                                    |   |   | 9 |   |
| Instruments: classification, applications instruments: classification, applications Elements of a generalized measurement system Static and dynamic characteristics - Errors in measurement Statistical evaluation of measurement data . |                                                                                                                    |   |   |   |   |
| Experiential learning: to analyze waveforms captured by DSOs for pattern recognition or anomaly detection.                                                                                                                               |                                                                                                                    |   |   |   |   |
| Industry application: Use of statistical measurement error analysis to maintain precision and quality in manufacturing environments (e.g., automotive, aerospace).                                                                       |                                                                                                                    |   |   |   |   |
| Content beyond syllabus: AI-Based Error Prediction in Measurements. Use AI algorithms to predict and correct systematic and random errors in measurement systems using historical data.                                                  |                                                                                                                    |   |   |   |   |
| UNIT 2 MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS                                                                                                                                                                                   |                                                                                                                    |   |   | 9 |   |
| Classification of instruments -- moving coil and moving iron meters - Induction type, dynamometer type watt meters - Energy meter - Megger -- Instrument transformers (CT & PT)                                                          |                                                                                                                    |   |   |   |   |
| Experiential Learning (Activity Based Learning):Visit the power distribution network in the campus to observe the application of CTs and PTs in live electrical systems.                                                                 |                                                                                                                    |   |   |   |   |
| Industrial Application: Application of instrument transformers in smart grids for precise metering and protection.                                                                                                                       |                                                                                                                    |   |   |   |   |
| Content beyond syllabus :Explore IOT-based wireless metering systems that use current and potential transformers for real-time monitoring.                                                                                               |                                                                                                                    |   |   |   |   |
| UNIT 3 AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS                                                                                                                                                                                      |                                                                                                                    |   |   | 9 |   |
| Wheatstone bridge, Kelvin double bridge - Maxwell's bridge-, Hay's bridge - Wien bridge- and Schering bridge – Errors and compensation in A.C. bridges -Instrumentation Amplifiers.                                                      |                                                                                                                    |   |   |   |   |
| Experiential learning: Hands-on Lab: Build and Test a Wheatstone Bridge with a Strain Gauge`                                                                                                                                             |                                                                                                                    |   |   |   |   |
| Industrial application: Use of Wheatstone bridges and instrumentation amplifiers in bridges, buildings, and aerospace components.                                                                                                        |                                                                                                                    |   |   |   |   |
| Content Beyond Syllabus: Simulate various bridge circuits for sensor signal conditioning and study the effect of component tolerances on accuracy.                                                                                       |                                                                                                                    |   |   |   |   |
| UNIT 4 TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS                                                                                                                                                                         |                                                                                                                    |   |   | 9 |   |
| Classification of transducers -- Measurement of pressure, temperature. , displacement,                                                                                                                                                   |                                                                                                                    |   |   |   |   |





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flow, angular velocity. - Digital transducers- - Smart sensors.

Experiential Learning: Lab Activity: Design a Temperature Monitoring System using an LM35 and Arduino Interface analog sensors to a microcontroller, calibrate outputs, and display

Industrial Application: Smart transducers are used to monitor and control parameters like flow rate, pressure, and temperature in processing plants.

Content Beyond Syllabus : application of smart sensors and calibration of smart sensors

## UNIT 5 DIGITAL INSTRUMENTATION

9

Experiential Learning: A/D converters- : types and characteristics - sampling - Errors - Measurement of voltage, current, frequency and phase, -D/A converters: types and characteristics - DSO- Data loggers- Basics of PLC programming and introduction to virtual instrumentation -Instrument standards

Experiential learning: Interface sensors with DAQ hardware to monitor and log real-time electrical signals using LabVIEW.

Industrial Application : digital instrumentation in industries

Content Beyond Syllabus : Introduction to integrating edge computing and AI to enhance local decision-making capabilities in measurement systems.

TOTAL Periods

45

## Course Outcomes

At the end of the course, the student will be able to

|     |                                                                                                                            |
|-----|----------------------------------------------------------------------------------------------------------------------------|
| CO1 | Ability to understand the fundamental art of measurement in engineering and apply the same to suit industrial application. |
| CO2 | Ability to correlate the structural elements of various instruments, in practical applications                             |
| CO3 | Ability to understand the importance of bridge circuits, in determination of various electrical parameters                 |
| CO4 | Ability to utilize various transducers and their characteristics, in different electrical applications.                    |
| CO5 | Ability to apply the concept of digital instrumentation and virtual instrumentation, in advanced measurements.             |

## TEXT BOOKS

|   |                                                                                                                                                 |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011. |
| 2 | H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010                                                                     |

## REFERENCES

|   |                                                                                                                   |
|---|-------------------------------------------------------------------------------------------------------------------|
| 1 | M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009 J.J. |
| 2 | J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011     |
| 3 | W. Bolton, Programmable Logic Controllers, 6th Edition, Elsevier, 2015                                            |
| 4 | R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 2008              |
| 5 | E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 2007 |



| <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b><br><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b> |                                                                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| CO/<br>PO                                                                                                                                                                            | PO1                                                                                                                                                                                                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                                                  | 3                                                                                                                                                                                                  | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |  |
| CO2                                                                                                                                                                                  | 3                                                                                                                                                                                                  | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |  |
| CO3                                                                                                                                                                                  | 3                                                                                                                                                                                                  | 3   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |  |
| CO4                                                                                                                                                                                  | 3                                                                                                                                                                                                  | 3   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |  |
| CO5                                                                                                                                                                                  | 3                                                                                                                                                                                                  | 3   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |  |
| AVG                                                                                                                                                                                  | 3.0                                                                                                                                                                                                | 2.6 | 2.0 | 2.0 | 3.0 | 2.0 | –   | 2.0 | 2.0 | 2.0  | 2.0  | 3.0  | 2.0  | –    |  |
| <b>PRODUCT BASED PROJECT</b>                                                                                                                                                         |                                                                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                                                    | AI-Powered Measurement Error Analyzer                                                                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                                                    | Design a compact, IoT-enabled device using CTs and PTs to monitor and log real-time voltage, current, power, and energy consumption with mobile app integration for industrial or residential use. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                                                    | Create a modular hardware kit with integrated bridge circuits                                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                                                    | Build a wireless device integrating multiple transducers                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                                                    | Develop a portable data acquisition system with built-in A/D and D/A converters, DSO interface, and basic PLC functionality, connected to a PC or mobile app for student or SME use.               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |



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| U24EE503                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                       | MICROPROCESSORS AND MICROCONTROLLERS |  | L | T | P     | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--|---|---|-------|---|
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                       |                                      |  | 3 | 0 | 2     | 4 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                       |                                      |  |   |   |       |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                        | To study the 8-bit and 16-bit microprocessors architectures and their role in real time embedded systems.                             |                                      |  |   |   |       |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                        | To realize the programming techniques which can be used in industrial control system                                                  |                                      |  |   |   |       |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                        | To realize the interfacing techniques of various peripherals such as real time sensors and actuators with 8051 controllers            |                                      |  |   |   |       |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                        | To realise the programming techniques of PIC controller used in hand held products and home appliances                                |                                      |  |   |   |       |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                        | To understand the I/O interfacing technique of ARM processor and realization by developing control system for health care application |                                      |  |   |   |       |   |
| UNIT 1: Introduction to 8085 _Microprocessor Architecture and Instruction sets                                                                                                                                                                                                                                                                                                           |                                                                                                                                       |                                      |  |   |   | 9+6   |   |
| Overview and comparison of microprocessors and microcontrollers - Architectures of 8 bit processor (8085) - Instruction set of 8085 :Data Transfer instructions , Arithmetic instructions Instruction set of 8085 : Logical & Machine control instructions. Timing diagram of 8085 processor, Handling of interrupt systems, Simple programs to understand the usage of instruction set. |                                                                                                                                       |                                      |  |   |   |       |   |
| Experiential Learning: Using software simulators like Proteus, MikroC, or TINA-TI to simulate the behaviour of the 8085 processor.                                                                                                                                                                                                                                                       |                                                                                                                                       |                                      |  |   |   |       |   |
| Industrial Application: Conveyor Belt System: In an assembly line, an 8085-based system could control a conveyor belt system.                                                                                                                                                                                                                                                            |                                                                                                                                       |                                      |  |   |   |       |   |
| Content Beyond Syllabus: 16-bit Programming Concept.                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                       |                                      |  |   |   |       |   |
| Lab Components                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                       |                                      |  |   |   |       |   |
| 1. Programs for 8-bit Arithmetic, Logical & Control instructions using 8085.                                                                                                                                                                                                                                                                                                             |                                                                                                                                       |                                      |  |   |   |       |   |
| 2. Speed control of Stepper motor using 8085.                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                       |                                      |  |   |   |       |   |
| UNIT 2: Introduction to 8051 _Microcontroller Architecture and Instruction sets                                                                                                                                                                                                                                                                                                          |                                                                                                                                       |                                      |  |   |   | 9 + 6 |   |
| Architecture & Pin diagrams Addressing modes & instruction set IO ports, Timers and counters serial data communication & interrupts Simple programs for understanding the flow of Assembly language programming.                                                                                                                                                                         |                                                                                                                                       |                                      |  |   |   |       |   |
| Experiential Learning (Activity Based Learning): Writing an assembly program to blink an LED connected to one of the I/O pins of the 8051 microcontrollers.                                                                                                                                                                                                                              |                                                                                                                                       |                                      |  |   |   |       |   |
| Industrial Application: Maintain the oven temperature in a food processing industry                                                                                                                                                                                                                                                                                                      |                                                                                                                                       |                                      |  |   |   |       |   |
| Content Beyond Syllabus: Advertisement panel using 8051                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                       |                                      |  |   |   |       |   |
| Lab Components                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                       |                                      |  |   |   |       |   |
| 1. Programs for 8-bit arithmetic, logical & control instructions using 8051 microcontroller.                                                                                                                                                                                                                                                                                             |                                                                                                                                       |                                      |  |   |   |       |   |
| 2. Traffic light control using 8051 microcontroller.                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                       |                                      |  |   |   |       |   |
| UNIT 3: 8051 Programming Using Embedded ‘C’                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                       |                                      |  |   |   | 9 + 6 |   |



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Role of Microcontroller and Microprocessor in Embedded systems, Introduction to Embedded 'C' . Port initialization, Data types, Time delay & logic operations, Data conversion & data serialization- , Simple programs to understand the C programming technique

Experiential Learning: Embedded C Programming: Write a program that detects a button pressing and toggle the state of a LED accordingly

Industrial Application : Automated Industrial Temperature Monitoring system

Content Beyond Syllabus : Serial communication protocol.

Lab Components

1. Controlling the switching activities of Relays using 8051
2. Realization of serial communication technique.
3. Realization of LCD interfacing technique

## UNIT 4: INTRODUCTION TO RISC BASED ARCHITECTURE- PIC Controller

9 + 6

PIC16 /18 architecture, Memory organization – Addressing modes – Instruction set – Programming techniques– Timers – I/O ports– Interrupt programming.

Experiential Learning: Writing simple assembly programs for Arithmetic & logical operations.

Industrial Application: Speed Control drive in hal industry

Content Beyond Syllabus: PWM signal generation using PIC controller

Lab Components

1. Controlling the Seven segment display unit.
2. PWM based Light intensity control using PIC.

## UNIT 5: INTRODUCTION TO STM 32 MICROCONTROLLER ARCHITECTURE

9+6

Architecture of STM 32 controller, Memory organization – Addressing modes – Programming techniques – Timers – I/O ports – Interrupt programming. Real time applications of ARM : Autonomous vehicle.

Experiential Learning: Study about Blynk App - an cloud based platform

Industrial Application: Front panel design of any application using Blynk App

Content Beyond Syllabus: Future Trends in STM32 Controller

Lab Components I /O Interfacing Experiments

1. Speed control of Stepper Motor using STM 32 controller.
2. Temperature Control using STM 32.
3. Decoration light control using STM 32.

**TOTAL PERIODS**

**75**

## Course Outcomes

**At the end of the course, the student will be able to**

- |            |                                                                                                                                                                  |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Write assembly language program for microprocessor and experience I/O interfacing technique.                                                                     |
| <b>CO2</b> | Write assembly language program for microcontroller and experience I/O interfacing technique.                                                                    |
| <b>CO3</b> | Write embedded 'C' program for microcontroller and experience the interfacing techniques to demonstrate the working of various peripherals with 8051 controllers |
| <b>CO4</b> | Understand and appreciate RISC architecture evolving microprocessor architecture.                                                                                |
| <b>CO5</b> | Analyse, comprehend and simulate the advanced processor-based system control.                                                                                    |

## TEXT BOOKS

- |   |                                                                                                                                          |
|---|------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Penram International (P) Ltd., Mumbai, 5 th edition, 2008. |
|---|------------------------------------------------------------------------------------------------------------------------------------------|



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|   |                                                                                                                       |
|---|-----------------------------------------------------------------------------------------------------------------------|
| 2 | Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, 2007. |
| 3 | Joseph Yiu , 'The Definitive Guide to the ARM Cortex-M0' Newnes – Elsevier, 2011.                                     |
| 4 | Kenneth Ayala, "The 8051 Microcontroller", Cengage Learning India, 2007, 3rd Edition.                                 |
| 5 | Programming With STM32: Getting Started With the Nucleo Board and C/C++                                               |

**REFERENCES**

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| 1 | Douglas V. Hall, "Micro-processors & Interfacing". Tata McGraw Hill 2nd edition, 2009                                                 |
| 2 | Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.                                                   |
| 3 | Embedded Systems: Architecture, Programming & Design, Raj Kamal, 2008, Tata McGraw Hill                                               |
| 4 | Mike Predko, " 8051 Micro-controller", McGraw Hill, 2009                                                                              |
| 5 | Muhammad Tahir and Kashif Javed, 'ARM Microprocessor Systems - Cortex-M Architecture, Programming, and Interfacing', CRC Press, 2011. |

**CO/PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 2   | 1   | 2   | 3   | 3   | 1   | –   | –   | 2   | –    | 1    | 3    | –    | 1    |
| <b>CO2</b> | 2   | 1   | 2   | 3   | 3   | 1   | –   | –   | 2   | –    | 1    | 3    | –    | 1    |
| <b>CO3</b> | 2   | 1   | 2   | 3   | 3   | 1   | –   | –   | 2   | –    | 2    | 3    | –    | 1    |
| <b>CO4</b> | 2   | 1   | 2   | 3   | 3   | 1   | –   | –   | 2   | –    | 2    | 3    | –    | 1    |
| <b>CO5</b> | 2   | 1   | 2   | 3   | 3   | 1   | –   | –   | 2   | –    | 2    | 3    | –    | 1    |
| <b>AVG</b> | 2.0 | 1.0 | 2.0 | 3.0 | 3.0 | 1.0 | –   | –   | 2.0 | –    | 1.6  | 3.0  | –    | 1.0  |

**Product Based Projects (in Team)**

|   |                                                                                                         |
|---|---------------------------------------------------------------------------------------------------------|
| 1 | Develop a Password Protection System Using 8085                                                         |
| 2 | Develop and implement a automatic water level controller using 8051 (Assembly programming)              |
| 3 | Implement a Touch screen controlled Pick and Place robot using 8051 controller(Embedded C programming ) |
| 4 | Implement a PIC controller-based oven control system in pharmaceutical industry                         |
| 5 | Develop an AI based Menopausal Women's Health Diagnosis Intelligent System using an STM microcontroller |



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|                                                                                                                                                                                                                                                                                                                           |                                                                                              |   |   |       |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---|---|-------|---|
| U24EE504                                                                                                                                                                                                                                                                                                                  | CONTROL SYSTEMS                                                                              | L | T | P     | C |
|                                                                                                                                                                                                                                                                                                                           |                                                                                              | 3 | 0 | 2     | 4 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                         |                                                                                              |   |   |       |   |
| Simulate, design, and model system dynamics, automation, and feedback mechanisms to improve efficiency in engineering fields such as power systems, medical technology, robotics, and automation                                                                                                                          |                                                                                              |   |   |       |   |
| 1                                                                                                                                                                                                                                                                                                                         | To derive the transfer function models of mechanical and electrical systems.                 |   |   |       |   |
| 2                                                                                                                                                                                                                                                                                                                         | To develop adequate knowledge in the time response of systems and steady stat error analysis |   |   |       |   |
| 3                                                                                                                                                                                                                                                                                                                         | To analyse the open loop and closed loop frequency response of linear systems.               |   |   |       |   |
| 4                                                                                                                                                                                                                                                                                                                         | To analyse stability and design of compensators and controller of linear systems.            |   |   |       |   |
| 5                                                                                                                                                                                                                                                                                                                         | To derive state variable representation of physical systems.                                 |   |   |       |   |
| UNIT 1 MODELING OF LINEAR TIME INVARIANT (LTIV) SYSTEMS                                                                                                                                                                                                                                                                   |                                                                                              |   |   | 9 + 3 |   |
| Basic elements in control systems - Open loop and Closed loop systems – First principle modeling: Mechanical, Electrical and Electromechanical systems – Electrical analogy of mechanical systems - Transfer function representations: Block diagram and Signal flow graph.                                               |                                                                                              |   |   |       |   |
| <a href="#">Experiential Learning (Activity Based Learning): case study on Transfer Function of a Human Leg</a><br><a href="#">Industrial Application : Synchro- Transmitter- Receiver</a><br><a href="#">Content Beyond Syllabus : Determine the transfer function of Thermal System</a>                                 |                                                                                              |   |   |       |   |
| <b>Practical:</b><br>1. Mathematical modelling and simulation of Mechanical and Electrical systems using transfer function approach                                                                                                                                                                                       |                                                                                              |   |   |       |   |
| UNIT 2 TIME DOMAIN ANALYSIS                                                                                                                                                                                                                                                                                               |                                                                                              |   |   | 9 + 6 |   |
| Standard test inputs –Time responses I and II order system – Time domain specifications– Error coefficients – Generalized error series - Steady state error - Root locus: Construction and Interpretation. Effect of adding poles and zeros.                                                                              |                                                                                              |   |   |       |   |
| <a href="#">Experiential Learning (Activity Based Learning): Case Study on Unmanned Free-Swimming Submersible (UFSS) Vehicle: Transient Design via Gain</a><br><a href="#">Industrial Application : Process of Temperature control (First order system)</a><br><a href="#">Content Beyond Syllabus : Adaptive Control</a> |                                                                                              |   |   |       |   |
| <b>Practical:</b><br>1. Time domain analysis of second order systems in simulation platforms.<br>2. Root locus technique based stability analysis in simulation platform.                                                                                                                                                 |                                                                                              |   |   |       |   |
| UNIT 3 FREQUENCY RESPONSE ANALYSIS                                                                                                                                                                                                                                                                                        |                                                                                              |   |   | 9 + 6 |   |
| Frequency domain specifications, Bode plot, Polar plot and Nyquist plot - Correlation between frequency domain and time domain specifications. Introduction to closed loop Frequency Response                                                                                                                             |                                                                                              |   |   |       |   |



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Experiential Learning (Activity Based Learning): Case Study on Unmanned Free-Swimming Submersible (UFSS) Vehicle: Pitch-Angle Control Representation  
Industrial Application: Machinery fault diagnosis from vibration signals  
Content Beyond Syllabus : Noise cancellation technique

**Practical:**

1. Frequency response and stability analysis using Bode plot in simulation platform.
2. Frequency response and stability analysis using Polar plot in simulation platform.

**UNIT 4 STABILITY ANALYSIS AND DESIGN OF COMPENSATOR AND CONTROLLER**

**9 + 9**

Concept of stability –Routh Hurwitz stability criterion - Design specifications – Lead, Lag and Lag-lead compensators using Bode plot –Effect of adding lag and lead compensators.- PID controller-Design using reaction curve and Ziegler-Nichols technique -Effects of P,PI and PID modes of feedback control.

Experiential Learning (Activity Based Learning): Case Study on Antenna Control: Cascade Compensation Design

Industrial Application: Voltage stability analysis of Power System

Content Beyond Syllabus : Design specifications – Lag-lead compensators using Root Locus plot

**Practical:**

1. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
- 2.Design of compensators using Bode plot in simulation platform.
3. Design and simulation of P, PI, PD and PID controllers and evaluation of closed loop system performance for a second order system

**UNIT 5 STATE VARIABLE ANALYSIS AND STATE SPACE MODELLING**

**9 + 6**

State variable formulation – Non uniqueness of state space model – State transition matrix – solution of state equation and output equation -Eigen values – Eigen vectors –Controllability – Observability.

Experiential Learning (Activity Based Learning): Case Study on State space Approach of Pharmaceutical Drug Absorption

Industrial Application: State-space models to simulate the transient behavior of power systems.

Content Beyond Syllabus : Model Predictive Control

**Practical:**

1. State feedback and state observer design and evaluation of closed loop performance in simulation platform.
2. Test of controllability and observability in continuous and discrete domain in simulation platform.

**TOTAL PERIODS**

**75**





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**COURSE OUTCOME**

**At the end of the course, the student will be able to**

|            |                                                                              |
|------------|------------------------------------------------------------------------------|
| <b>CO1</b> | Represent the physical systems using transfer function approach.             |
| <b>CO2</b> | Analyse and evaluate the performance of systems in time domain.              |
| <b>CO3</b> | Analyse and evaluate the performance of systems in frequency domain.         |
| <b>CO4</b> | Analyse the simple systems using state space approach.                       |
| <b>CO5</b> | Design and evaluate the performance of closed loop systems with compensators |

**TEXT BOOKS**

|   |                                                                                                           |
|---|-----------------------------------------------------------------------------------------------------------|
| 1 | Nagrath.I.J & Gopal.M, "Control Systems Engineering", New Age International Pvt. Ltd., 7th Edition, 2021. |
| 2 | Katsuhiko Ogata, "Modern Control Engineering", Pearson, 5th Edition, 2015.                                |
| 3 | Nise, N.S., Control Systems Engineering, Wiley, 7th Edition, 2015.                                        |

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|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Education Pearson, 13th Edition, 2017.                                                         |
| 2 | John J.D., Azzo Constantine, H. and Houpis Stuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor & Francis Reprint 2009. |
| 3 | Farid Golnaraghi & Benjamin C. Kuo, "Automatic Control System", Wiley, 9th Edition, 2010.                                                                 |
| 4 | M.Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.                                                                             |
| 5 | NPTEL Video Lecture Notes on "Control Engineering" by Prof.S.D.Agashe, IIT Bombay.                                                                        |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/<br>PO  | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO2</b> | 3   | 3   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO3</b> | 3   | 3   | 2   | 2   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO4</b> | 3   | 3   | 2   | 3   | 3   | 2   | –   | 2   | 2   | 2    | 2    | 3    | 2    | –    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 3   | 2   | –   | 2   | 2   | 3    | 2    | 3    | 2    | –    |
| <b>AVG</b> | 3.0 | 2.8 | 2.2 | 2.4 | 3.0 | 2.0 | –   | 2.0 | 2.0 | 2.2  | 2.0  | 3.0  | 2.0  | –    |

**Product based Projects ( in Team)**

|   |                                                                                    |
|---|------------------------------------------------------------------------------------|
| 1 | Design a controller for Prosthetic Leg                                             |
| 2 | Implement a Autopilot system that follows a pre-defined trajectory.                |
| 3 | Vibration and stability analysis of a Submersible vehicle using Frequency response |
| 4 | Stabilization of Antenna Servo System using Phase Lead Compensators.               |



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|   |                                                                                                                           |
|---|---------------------------------------------------------------------------------------------------------------------------|
| 5 | State-space modeling of Drug Absorption and distribution in the Human Body                                                |
| 6 | AI adjusts control signals in a robotic arm using an electrical analogy of mechanical movement, ensuring smoother motion. |



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| U24RM512                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                      | DOMAIN SPECIFIC<br>EXPERIMENTS/METHODOLOGY/ALGORITHMS |  | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|--|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |                                                       |  | 0 | 0 | 2 | 1 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                      |                                                       |  |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                    | Analyze different research paradigms and experimental design types to select appropriate methodologies for domain-specific research. |                                                       |  |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                    | Apply experimental methodologies and instrumentation techniques in laboratory and simulation contexts for engineering research.      |                                                       |  |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                    | Analyze and implement domain-specific algorithms and optimization techniques using computational tools.                              |                                                       |  |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                    | Analyze qualitative research methodologies and tools for social science data collection and analysis.                                |                                                       |  |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                    | Evaluate interdisciplinary research approaches and emerging technologies to enhance research quality and reproducibility.            |                                                       |  |   |   |   |   |
| UNIT1 Introduction to Research Methodologies and Experimental Design                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                      |                                                       |  |   |   | 6 |   |
| Overview of research paradigms (qualitative, quantitative, mixed methods), Types of experimental designs (true, quasi, and non-experimental), Domain-specific needs: controlled vs. field experiments, Key concepts: validity, reliability, reproducibility, Ethical considerations in experimentation                                                                                               |                                                                                                                                      |                                                       |  |   |   |   |   |
| UNIT2 Experimental Methodologies in Science and Engineering                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                      |                                                       |  |   |   | 6 |   |
| Laboratory vs. simulation-based experiments, Design of Experiments (DoE) in engineering, Measurement systems and calibration, Data acquisition and instrumentation techniques, Case studies: electrical circuits, mechanical systems, fluid dynamics, etc.                                                                                                                                           |                                                                                                                                      |                                                       |  |   |   |   |   |
| UNIT3 Algorithms in Computational and Data-Driven Domains                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |                                                       |  |   |   | 6 |   |
| Algorithmic problem-solving in domain-specific contexts (e.g., shortest path in transportation, clustering in biology), Numerical methods and optimization algorithms, AI/ML algorithms and model evaluation strategies, Domain-specific programming and simulation tools (e.g.,MATLAB, Python, R, NS-3, Ansys, etc.), Case studies: image processing, robotics, bioinformatics, cybersecurity, etc. |                                                                                                                                      |                                                       |  |   |   |   |   |
| UNIT4 Methodologies in Social Sciences and Humanities                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                      |                                                       |  |   |   | 6 |   |
| Survey research, interviews, and ethnographic methods, Sampling techniques and field data collection, Case study and content analysis, Tools: SPSS, NVivo, ATLAS.ti, Case studies: behavioral research, education studies, cultural research                                                                                                                                                         |                                                                                                                                      |                                                       |  |   |   |   |   |
| UNIT5 Interdisciplinary Approaches and Emerging Trends                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                      |                                                       |  |   |   | 6 |   |
| Cross-domain methodologies: combining qualitative and quantitative, IoT-based experiments (e.g., smart agriculture, smart health), Simulation-based research and digital twins, Research using big data and cloud platforms, Ethics, reproducibility, and open science trends                                                                                                                        |                                                                                                                                      |                                                       |  |   |   |   |   |
| TOTAL: 30                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |                                                       |  |   |   |   |   |



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| At the end of the course, the student will be able to                   |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1                                                                     | Differentiate research paradigms and experimental designs, evaluating their applicability and ethical considerations in various fields.                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                     | Design and conduct experiments using DoE principles, data acquisition systems, and measurement calibration in engineering applications.                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                     | Solve algorithmic problems using numerical methods and AI/ML models, applying appropriate programming and simulation tools.                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                     | Design and conduct surveys, interviews, and case studies using qualitative tools like SPSS, NVivo, and ATLAS.ti.                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                     | Integrate cross-domain methods, employ IoT and big data tools, and uphold ethical standards in modern research contexts.                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                              |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | R. Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 4th ed. London, UK: SAGE Publications, 2019.                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | D. C. Montgomery, Design and Analysis of Experiments, 9th ed. Hoboken, NJ, USA: Wiley, 2017.                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | S. J. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th ed. Upper Saddle River, NJ, USA: Pearson, 2020.                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                              |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | B. Stroustrup, Programming: Principles and Practice Using C++, 2nd ed. Boston, MA, USA: Addison-Wesley Professional, 2014. (for algorithm implementations) |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | S. S. Rao, Engineering Optimization: Theory and Practice, 5th ed. Hoboken, NJ, USA: Wiley, 2020.                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping                                                      |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                         | PO1                                                                                                                                                        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 3                                                                                                                                                          | 3   | 2   | 3   | 2   | 1   | 1   | 2   | 2   | 1    | 2    |      |      |      |
| CO2                                                                     | 3                                                                                                                                                          | 2   | 3   | 2   | 3   | 1   | 1   | 2   | 3   | 2    | 3    |      |      |      |
| CO3                                                                     | 3                                                                                                                                                          | 3   | 3   | 2   | 3   | 1   | 1   | 3   | 3   | 2    | 3    |      |      |      |
| CO4                                                                     | 2                                                                                                                                                          | 2   | 2   | 3   | 2   | 1   | 1   | 2   | 3   | 3    | 3    |      |      |      |
| CO5                                                                     | 3                                                                                                                                                          | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 3    | 3    |      |      |      |
| AVG                                                                     | 2.8                                                                                                                                                        | 2.6 | 2.6 | 2.6 | 2.6 | 1.2 | 1.2 | 2.4 | 2.8 | 2.2  | 2.8  |      |      |      |



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| U24ED511                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       | PROTOTYPE AND MARKET VALUATION |  | L | T | P | C   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                       |                                |  | 0 | 0 | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                       |                                |  |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand the purpose, process, and transition from ideation to prototyping in the design thinking framework.                     |                                |  |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop the ability to plan and perform testing processes for validating prototypes and iterating for improvement.                 |                                |  |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To analyze and create various forms of rapid and resource-efficient experimentation methods including risk and failure analysis       |                                |  |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To evaluate and incorporate feedback through structured methods for refining the prototype based on stakeholder insights.             |                                |  |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To create a strategic roadmap for evolving prototypes into validated market-ready solutions through metrics and stakeholder planning. |                                |  |   |   |   |     |
| UNIT I PROTOTYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   | 1 |   |     |
| <ul style="list-style-type: none"><li>Transitioning from Ideate Mode</li><li>What is the Prototype mode?</li><li>Why Prototype?</li><li>How to Prototype?</li><li>How to seamlessly transition from Prototype to Test?</li></ul>                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   |   |     |
| UNIT II TEST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                       |                                |  |   | 2 |   |     |
| <ul style="list-style-type: none"><li>What is the Test Mode?</li><li>How to Test?</li><li>How to iterate for continuous improvements?</li><li>Deciding how to move forward (Persevere or Pivot)</li><li>How to make the process to repetitively lead to product / service improvements</li></ul>                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   |   |     |
| UNIT III EXPERIMENTATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       |                                |  |   | 4 |   |     |
| <ul style="list-style-type: none"><li>Make prototypes (Fast &amp; Cheap / Simulate &amp; Stimulate)</li><li>Create and Try, Experience Prototypes by shrinking big things down</li><li>Rapid Concept Development</li><li>Assumptions, Constraints, Limitations, Potential point of failures and Risk Analysis</li><li>Test prototypes by Customer Co-Creation</li></ul>                                                                                                                                                                |                                                                                                                                       |                                |  |   |   |   |     |
| UNIT IV FEEDBACK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   | 4 |   |     |
| <ul style="list-style-type: none"><li>Identify potential sources of feedback</li><li>Obtain feedback from select participants (Client / Customer / Consumer / Stakeholder)</li><li>Build a questionnaire guide by starting specific to moving broad</li><li>Probe deep, facilitate feedback prompts, capture input and integrate overall feedback</li><li>Identify costs, resources, infrastructure, features and functionalities to iterate based on what is available vs. needed at the institution to decide buying needs</li></ul> |                                                                                                                                       |                                |  |   |   |   |     |
| UNIT V EVOLUTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   | 4 |   |     |
| <ul style="list-style-type: none"><li>Track learnings and establish Learning Launches</li><li>Define success with Impact Guidance</li><li>Identify methods of tracking (Measures / Metrics – Lag or Lead)</li><li>Document progress and asset needs iteratively by effective stakeholder engagement to plan next steps</li></ul>                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   |   |     |



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- Define RASCI / RACI Chart to prepare and pitch product or service concept for Market Valuation by Storytelling

|                      |           |
|----------------------|-----------|
| <b>TOTAL PERIODS</b> | <b>15</b> |
|----------------------|-----------|

**Course Outcomes**

**At the end of the course students will be able to**

|          |                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Explain the importance of prototyping and describe how to create and transition from ideate to prototype and then to test mode. |
| <b>2</b> | Apply appropriate testing techniques to evaluate prototypes and determine whether to persevere or pivot based on test results.  |
| <b>3</b> | Analyze assumptions, constraints, and risks in experimental prototypes and develop effective rapid concept models.              |
| <b>4</b> | Evaluate feedback using probing tools like questionnaires and integrate the insights to modify their solution.                  |
| <b>5</b> | Design a market-pitch-ready concept using tools like RASCI/RACI, impact tracking, and storytelling.                             |

**TEXTBOOKS**

|          |                                                                                                                                |
|----------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | An Introduction to Design Thinking PROCESS GUIDE, Hasso Plattner, d. School                                                    |
| <b>2</b> | Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Publications, 2009 |
| <b>3</b> | Don Norman, "The Design of Everyday Things", Basic Books, 2013                                                                 |
| <b>4</b> | Tom Kelley, David Kelley, "Creative Confidence: Unleashing the Creative Potential Within Us All", Currency, 2013               |

**REFERENCE BOOKS**

|          |                                                                                                                                            |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Hasso Plattner, Christoph Meinel, Larry Leifer, "Design Thinking: Understand – Improve – Apply (Understanding Innovation)", Springer, 2011 |
| <b>2</b> | Jakob Schneider, Marc Stickdorn, "This Is Service Design Thinking: Basics, Tools, Cases", John Wiley & Sons, 2011                          |
| <b>3</b> | Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency, 2001                          |

**CO/PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO1</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO2</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO3</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO4</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO5</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>AVG</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |



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|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                          |   |   |   |   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE601                                                                                                                                                                                                                                                                                                                                                                                 | POWER SYSTEM ANALYSIS                                                                                                                                                                    | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                          | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                        | To enable students to model and represent complex power system networks using matrices and single-line diagrams, forming the basis for system-wide simulations and intelligent analysis. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                        | To solve power flow problems using numerical and AI-based techniques, supporting efficient and real-time grid operation.                                                                 |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                        | To provide analytical tools for identifying and evaluating symmetrical faults using system matrices, and to develop fault management systems enhanced by AI.                             |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                        | To rectify unsymmetrical faults and develop real-time diagnosis systems using sequence networks and intelligent classifiers.                                                             |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                        | To model and analyze system stability under various disturbances and design AI-driven systems for improving dynamic performance.                                                         |   |   |   |   |
| UNIT 1 POWER SYSTEM OVERVIEW                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                          |   |   |   | 9 |
| Need for system planning and operational studies - Power scenario in India - Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Network graph Theory -Bus incidence matrices, Primitive parameters - Formation of bus admittance matrix - Direct inspection method - Singular Transformation method. |                                                                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning: AI-based Fault Classification using Graph Neural Networks</a><br><a href="#">Industrial Application: Network Modelling using ETAP.</a><br><a href="#">Content Beyond Syllabus: Representation of off-nominal transformer - Formation of bus admittance matrix of large power network.</a>                                                             |                                                                                                                                                                                          |   |   |   |   |
| UNIT 2 POWER FLOW ANALYSIS                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                          |   |   |   | 9 |
| Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow-solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow - Solution by Newton Raphson method - Flow charts -Comparison of methods                                                                                                                                 |                                                                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning: Neural Network-Based Power Flow Predictor</a><br><a href="#">Content Beyond Syllabus: Fast Decoupled Method, DC Load Flow.</a><br><a href="#">Industrial Application: Load Flow Analysis using ETAP.</a>                                                                                                                                              |                                                                                                                                                                                          |   |   |   |   |
| UNIT 3 SYMMETRICAL FAULT ANALYSIS                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                          |   |   |   | 9 |
| Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling )- Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors                                                                                    |                                                                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning: AI-Powered Fault Prediction using Historical Grid Data</a><br><a href="#">Content Beyond Syllabus: Relay Coordination.</a><br><a href="#">Industrial Application: Symmetrical Fault Analysis using ETAP.</a>                                                                                                                                          |                                                                                                                                                                                          |   |   |   |   |





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|                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| UNIT 4 UNSYMMETRICAL FAULT ANALYSIS                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                  | 9  |
| Symmetrical components - Sequence impedances -Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG -unsymmetrical fault occurring at any point in a power system.                                                                                                                          |                                                                                                                                                                                  |    |
| <a href="#">Experiential Learning: CNN-based Fault Classification from Voltage Waveforms</a><br><a href="#">Industrial Application: Unsymmetrical Fault Analysis using ETAP.</a><br><a href="#">Content Beyond Syllabus: Simulation of Fault Analysis using Matlab.</a>                                                           |                                                                                                                                                                                  |    |
| UNIT 5 POWER SYSTEM STABILITY                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                  | 9  |
| Classification of power system stability - Rotor angle stability - Power-Angle equation - Steady state stability - Swing equation - Swing equation and its solution method (Runge – Kutta Method) - Swing curve, Equal area criterion -Critical clearing angle and time, Multi-machine stability analysis - modified Euler method |                                                                                                                                                                                  |    |
| <a href="#">Experiential Learning Reinforcement Learning for Dynamic Load Shedding &amp; Stability Control</a><br><a href="#">Industrial Application: Stability analysis using EMTP-RV.</a><br><a href="#">Content Beyond Syllabus: Solution of swing equation using Runge-kutta fourth order method.</a>                         |                                                                                                                                                                                  |    |
| TOTAL Periods                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                  | 45 |
| Course Outcomes                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                  |    |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                             |                                                                                                                                                                                  |    |
| CO1                                                                                                                                                                                                                                                                                                                               | Ability to model the power system under steady state operating conditions.                                                                                                       |    |
| CO2                                                                                                                                                                                                                                                                                                                               | Ability to carry out power flow analysis using.                                                                                                                                  |    |
| CO3                                                                                                                                                                                                                                                                                                                               | Ability to infer the significance of short circuit studies in designing circuit breakers                                                                                         |    |
| CO4                                                                                                                                                                                                                                                                                                                               | Ability to analyze the state of the power system for various unsymmetrical faults.                                                                                               |    |
| CO5                                                                                                                                                                                                                                                                                                                               | Ability to analyze the stability of the power system using different methods.                                                                                                    |    |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                  |    |
| 1                                                                                                                                                                                                                                                                                                                                 | John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.                                            |    |
| 2                                                                                                                                                                                                                                                                                                                                 | Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2019.                                                                     |    |
| 3                                                                                                                                                                                                                                                                                                                                 | Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.                                                                       |    |
| REFERENCES                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                  |    |
| 1                                                                                                                                                                                                                                                                                                                                 | Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007                                              |    |
| 2                                                                                                                                                                                                                                                                                                                                 | P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition - 2017 |    |



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|   |                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------|
| 3 | J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012. |
| 4 | Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, 2001.                                                     |
| 5 | Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.            |

**CO/PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1        | PO2        | PO3        | PO4        | PO5        | PO6        | PO7 | PO8 | PO9        | PO10 | PO11       | PSO1       | PSO2       | PSO3       |  |
|------------|------------|------------|------------|------------|------------|------------|-----|-----|------------|------|------------|------------|------------|------------|--|
| <b>CO1</b> | 3          | 2          | 2          | 3          | 3          | —          | —   | —   | 2          | —    | 1          | 3          | 2          | 1          |  |
| <b>CO2</b> | 3          | 2          | 2          | 3          | 3          | —          | —   | —   | 2          | —    | 2          | 3          | 3          | 1          |  |
| <b>CO3</b> | 3          | 2          | 2          | 3          | 3          | 1          | —   | —   | 2          | —    | 1          | 3          | 2          | 1          |  |
| <b>CO4</b> | 3          | 2          | 2          | 3          | 3          | 1          | —   | —   | 2          | —    | 2          | 3          | 2          | 2          |  |
| <b>CO5</b> | 3          | 2          | 2          | 3          | 3          | 1          | —   | —   | 2          | —    | 2          | 3          | 3          | 2          |  |
| <b>AVG</b> | <b>3.0</b> | <b>2.0</b> | <b>2.0</b> | <b>3.0</b> | <b>3.0</b> | <b>0.6</b> | —   | —   | <b>2.0</b> | —    | <b>1.6</b> | <b>3.0</b> | <b>2.4</b> | <b>1.4</b> |  |

**Product Based Projects**

|                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Smart Power System Network Modeling Tool- A desktop or web application that allows users to draw single-line diagrams and auto-generate bus admittance matrices. |
| 2. AI-Optimized Load Flow Analyzer - Software that compares traditional vs. AI-predicted load flow results for complex systems.                                     |
| 3. Real-Time Fault Detection and Alerting System - Embedded system or simulation that detects symmetrical faults and sends alerts via IoT protocols.                |
| 4. Smart Fault Diagnosis Assistant - A mobile/web application for diagnosing types of unsymmetrical faults with user input or real-time data feed.                  |
| 5. Stability Analyzer for Renewable-Integrated Power Grids - A tool to study transient and steady-state stability with RES (like solar/wind) integration.           |



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|                                                                                                                                                                                                                                                                                                                            |                                                                                                              |   |   |   |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EE602                                                                                                                                                                                                                                                                                                                   | DISCRETE TIME SYSTEMS AND<br>SIGNAL PROCESSING                                                               | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                            |                                                                                                              | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                          |                                                                                                              |   |   |   |   |
| Students are able to develop solutions for real-world applications such as signal processing ,Audio & Image Processing, Digital Communication Systems, Biomedical Signal Processing and Control & Automation.                                                                                                              |                                                                                                              |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                          | To develop a mathematical representation of a signal and system in time/frequency domain.                    |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                          | To develop discrete time systems using Z-transform and Inverse Z-transform.                                  |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                          | To implement the discrete time systems in Discrete Fourier Transform using Fast Fourier Transform algorithm. |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                          | To design FIR filters with its response and obtaining its realization structure.                             |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                          | To design IIR filters with its response and obtaining its realization structure.                             |   |   |   |   |
| UNIT I SIGNALS AND SYSTEMS                                                                                                                                                                                                                                                                                                 |                                                                                                              |   |   |   | 9 |
| classification of signals: Discrete - energy and power; Classification of Systems: Discrete- Linear, Causal, Stability, Dynamic, Recursive, Time Variance Systems Sampling Theorem, Sampling techniques Quantization - quantization error Nyquist rate - aliasing effect.                                                  |                                                                                                              |   |   |   |   |
| Experiential Learning :To determine impulse and step response of two vectors using MATLAB<br>Industrial Application : Applications of Digital Signal Processing - ECG using MATLAB<br>Content Beyond Syllabus : Study about the continuous systems using MATLAB                                                            |                                                                                                              |   |   |   |   |
| UNIT II DISCRETE TIME SYSTEM ANALYSIS                                                                                                                                                                                                                                                                                      |                                                                                                              |   |   |   | 9 |
| Z-transform and its properties,ROC,inverse z-transforms; difference equation – Solution by z-transform,application to discrete systems - Stability analysis, Frequency response - Convolution Discrete Time Fourier transform - Magnitude and Phase representation.                                                        |                                                                                                              |   |   |   |   |
| Experiential Learning :To perform convolution between two vectors.<br>Industrial Application : Analyzing and designing discrete-time control systems, such as those used in automation.<br>Content Beyond Syllabus : Analyze discrete-time signals in power systems, such as voltage and current waveforms in smart grids. |                                                                                                              |   |   |   |   |
| UNIT III DISCRETE FOURIER TRANSFORM                                                                                                                                                                                                                                                                                        |                                                                                                              |   |   |   | 9 |
| Discrete Fourier Transform- properties, magnitude and phase representation, Computation of DFT using FFT algorithm using radix 2 – Butterfly structure - DIT and DIF.                                                                                                                                                      |                                                                                                              |   |   |   |   |
| Experiential Learning :To compute DFT and IDFT of a given sequence using MATLAB<br>Industrial Application : FFT used to analyze harmonics in electrical power systems.<br>Content Beyond Syllabus : FFT aids in analyzing and optimizing energy harvesting systems.                                                        |                                                                                                              |   |   |   |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>UNIT IV DESIGN OF DIGITAL FILTERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>9</b> |
| Realization of FIR & IIR filter using direct & Cascade structure, Finite Impulse Response (FIR) design - Need and choice of windows, Windowing Techniques: Rectangular, Hamming and Hanning; Linear phase characteristics - IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation, Warping, pre-warping.<br><br>Experiential Learning : Design and Implementation of IIR Filter<br>Industrial Application : Active filters to suppress unwanted harmonics in power converters.<br>Content Beyond Syllabus : Sparse FIR filters for applications in low-power embedded systems |          |
| <b>UNIT V DIGITAL SIGNAL PROCESSORS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b> |
| Introduction – Architecture of one DSP processor for motor control -Features- Addressing Formats - Functional modes. Introduction to Commercial Processors.<br><br>Experiential Learning : DSP processors based Mini project.<br>Industrial Application : DSP processors servomotor control.<br>Content Beyond Syllabus : DSPs analyze motor signals to detect faults and provide diagnostic information                                                                                                                                                                                                                                                                |          |
| <b>TOTAL PERIODS:45</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |

## COURSE OUTCOME

| At the end of the course, the student will be able to |                                                                                           |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>CO1</b>                                            | Analyze different types of Signals and Systems with its performance                       |
| <b>CO2</b>                                            | Analyze the given discrete time system using Z-transform                                  |
| <b>CO3</b>                                            | Apply DFT for a given discrete time system for finding its system characteristics         |
| <b>CO4</b>                                            | Evaluate FIR filter with its response and construct its realization structure             |
| <b>CO5</b>                                            | Evaluate IIR filters for given specifications by following the suitable design procedures |

## TEXT BOOKS

|   |                                                                                                                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | John G. Proakis Northeastern University & Dimitris G Manolakis Massachusetts Institute of Technology "Digital Signal Processing: Principles, Algorithms and Applications", 5th edition Published by Pearson (July 23, 2021) © 2022 |
| 2 | Robert J. Schilling, Sandra L Harris "Digital Signal Processing using MATLAB" Cengage Learning, 3 Edition 1 Jan 2016                                                                                                               |
| 3 | Tarun Kumar Rawat, Digital Signal Processing, Oxford University Press, Dec 19, 2022.                                                                                                                                               |
| 4 | Richard G. Lyons, D. Lee Fugal, The Essential Guide to Digital Signal Processing, Pearson Education, 3rd Edition, 2014.                                                                                                            |

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|   |                                                                                             |
|---|---------------------------------------------------------------------------------------------|
| 1 | S.K. Mitra, 'Digital Signal Processing - A Computer Based Approach', McGraw Hill Edu, 2011. |
|---|---------------------------------------------------------------------------------------------|



|                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| 2                                                                                                                                                                                                                                  | S. Salivahanan, A.Vallavaraj, Gnanapriya, Digital Signal Processing, McGraw-Hill, 2nd Edition, 2011.<br>Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Discrete - Time Signal Processing, Pearson Education, New Delhi, 2015. |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <p align="center"><b>CO/PO, PSO Mapping</b></p> <p align="center">(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</p> <p align="center">Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</p> |                                                                                                                                                                                                                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                                                    | <b>PO1</b>                                                                                                                                                                                                                            | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
| <b>CO1</b>                                                                                                                                                                                                                         | 3                                                                                                                                                                                                                                     | 2          | 1          | 3          | 2          | –          | –          | –          | 2          | –           | 1           | 2           | 3           | 1           |
| <b>CO2</b>                                                                                                                                                                                                                         | 3                                                                                                                                                                                                                                     | 2          | 2          | 3          | 3          | –          | –          | –          | 2          | –           | 1           | 2           | 3           | 1           |
| <b>CO3</b>                                                                                                                                                                                                                         | 3                                                                                                                                                                                                                                     | 2          | 2          | 3          | 3          | –          | –          | –          | 2          | –           | 2           | 2           | 3           | 2           |
| <b>CO4</b>                                                                                                                                                                                                                         | 3                                                                                                                                                                                                                                     | 2          | 3          | 3          | 3          | –          | –          | –          | 2          | –           | 2           | 3           | 3           | 2           |
| <b>CO5</b>                                                                                                                                                                                                                         | 3                                                                                                                                                                                                                                     | 2          | 3          | 3          | 3          | –          | –          | –          | 2          | –           | 2           | 3           | 3           | 2           |
| <b>AVG</b>                                                                                                                                                                                                                         | <b>3.0</b>                                                                                                                                                                                                                            | <b>2.0</b> | <b>2.2</b> | <b>3.0</b> | <b>2.8</b> | –          | –          | –          | <b>2.0</b> | –           | <b>1.6</b>  | <b>2.4</b>  | <b>3.0</b>  | <b>1.6</b>  |
| <b>Product based Projects ( in Team)</b>                                                                                                                                                                                           |                                                                                                                                                                                                                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 1                                                                                                                                                                                                                                  | Develop a DSP-based ECG signal processing system for noise reduction and feature extraction.                                                                                                                                          |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 2                                                                                                                                                                                                                                  | Develop a MATLAB-based convolution tool for signal processing applications.                                                                                                                                                           |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                                  | Implement a MATLAB-based system to compute DFT and IDFT of given sequences.                                                                                                                                                           |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 4                                                                                                                                                                                                                                  | Implement a filter to compare images based on features like color histograms, object detection, or edge detection.                                                                                                                    |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 5                                                                                                                                                                                                                                  | Design a DSP-based system to analyze motor signals and detect faults.                                                                                                                                                                 |            |            |            |            |            |            |            |            |             |             |             |             |             |



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|                                                                                                                                                                                                                                                                                                                                             |                                                                                     |   |   |       |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---|---|-------|---|
| U24EE603                                                                                                                                                                                                                                                                                                                                    | POWER ELECTRONICS                                                                   | L | T | P     | C |
|                                                                                                                                                                                                                                                                                                                                             |                                                                                     | 3 | 0 | 2     | 4 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                           |                                                                                     |   |   |       |   |
| 1                                                                                                                                                                                                                                                                                                                                           | Students are able to design a charger for mobile phones.                            |   |   |       |   |
| 2                                                                                                                                                                                                                                                                                                                                           | To analyze the static and switching characteristics of power semiconductor devices. |   |   |       |   |
| 3                                                                                                                                                                                                                                                                                                                                           | To understand the operation of controlled rectifiers.                               |   |   |       |   |
| 4                                                                                                                                                                                                                                                                                                                                           | To understand and analyze the various types of choppers.                            |   |   |       |   |
| 5                                                                                                                                                                                                                                                                                                                                           | To evaluate the operation, characteristics and performance parameters of Inverters. |   |   |       |   |
| 6                                                                                                                                                                                                                                                                                                                                           | To understand the operation of ac-ac converters.                                    |   |   |       |   |
| UNIT 1 SINGLE PHASE RECTIFIERS                                                                                                                                                                                                                                                                                                              |                                                                                     |   |   | 9 + 6 |   |
| Power Diode – half wave rectifier – mid-point secondary transformer based full wave rectifier – bridge rectifier - distortion factor - LC filters – SCR-Two transistor analogy based turn- ON, Controlled converters (1 pulse, 2 pulse) displacement factor – ripple and harmonic factor effect of source inductance, inverter angle limit. |                                                                                     |   |   |       |   |
| Experiential Learning (Activity Based Learning): Design a mobile charger.                                                                                                                                                                                                                                                                   |                                                                                     |   |   |       |   |
| Industrial Application: DC Power Supplies: Widely used in converting AC to DC in various electronic devices.                                                                                                                                                                                                                                |                                                                                     |   |   |       |   |
| Content Beyond Syllabus: Active Filtering Techniques: Introduction to active filters using operational amplifiers.                                                                                                                                                                                                                          |                                                                                     |   |   |       |   |
| Practical:                                                                                                                                                                                                                                                                                                                                  |                                                                                     |   |   |       |   |
| 1. Characteristics of SCR.                                                                                                                                                                                                                                                                                                                  |                                                                                     |   |   |       |   |
| 2. Simulation of Single-Phase Rectifiers.                                                                                                                                                                                                                                                                                                   |                                                                                     |   |   |       |   |
| UNIT 2 THREE PHASE RECTIFIERS                                                                                                                                                                                                                                                                                                               |                                                                                     |   |   | 9 + 6 |   |
| Three phase diode rectifiers – Concern for power quality, Controlled converters (3 pulse, 6 pulse) Computation of performance parameters                                                                                                                                                                                                    |                                                                                     |   |   |       |   |
| Experiential Learning (Activity Based Learning): Simulate a 3-Phase Rectifier for EV Charger Input.                                                                                                                                                                                                                                         |                                                                                     |   |   |       |   |
| Industrial Application: Renewable Energy Systems: Rectifying output from wind turbines or solar inverters for grid integration.                                                                                                                                                                                                             |                                                                                     |   |   |       |   |
| Content Beyond Syllabus: Harmonic Compensation Methods: Use of devices like Unified Power Quality Conditioners (UPQC) for comprehensive power quality improvement.                                                                                                                                                                          |                                                                                     |   |   |       |   |
| Practical:                                                                                                                                                                                                                                                                                                                                  |                                                                                     |   |   |       |   |
| 1. Simulation of Three Phase Rectifier.                                                                                                                                                                                                                                                                                                     |                                                                                     |   |   |       |   |
| 2. Experimental verification of transfer characteristic of AC to DC fully controlled Converter.                                                                                                                                                                                                                                             |                                                                                     |   |   |       |   |
| UNIT 3 SWITCHING POWER SUPPLIES                                                                                                                                                                                                                                                                                                             |                                                                                     |   |   | 9 + 6 |   |



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IGBT, MOSFET: dynamic behavior - driver and snubber circuits -low power high switching frequency switching Power supplies, buck, boost, buck-boost converters – Isolated topologies – resonant converters switching loss calculations and thermal design.

Experiential Learning (Activity Based Learning): Convert USB 5V to 9V with a Boost Circuit (Bluetooth speakers, small devices)

Industrial Application: Power supplies in laptops and smartphones.

Content Beyond Syllabus: Zero Voltage Switching (ZVS): Techniques to reduce switching losses.

## Practical:

1. Characteristics of MOSFET.
2. Simulation of Switching Power Supplies.

## UNIT 4 INVERTERS

9 + 6

Single phase half bridge and full bridge inverters - VSI :(1phase and three phase inverters square wave operation) - Voltage control of inverters single, multi pulse, sinusoidal, space vector modulation techniques– various harmonic elimination techniques-CSI.

Experiential Learning (Activity Based Learning): Use PWM to Control Light Brightness (Solar lighting systems)

Industrial Application: DC Motor Drives: Use of controlled converters in variable speed drives.

Content Beyond Syllabus: High-Frequency Effects: Study of source inductance impact at high frequencies.

## Practical:

1. Characteristics of IGBT.
2. Simulation of Inverters.

## UNIT 5 AC PHASE CONTROLLERS

9 + 6

TRIAC triggering concept with positive and negative gate pulse triggering, TRIAC based phase controllers various configurations for SCR based single and three phase controllers

Experiential Learning (Activity Based Learning): Build a Phone Charger Circuit (Low-Voltage AC to DC).

Industrial Application: Fan Speed Controllers: Implement TRIACs in ceiling fan regulators to vary speed by phase angle control.

Content Beyond Syllabus: Power Factor Correction: Study methods to improve power factor in SCR-controlled systems, such as using synchronous condensers or active filters.

## Practical:

1. Characteristics of TRIAC.
2. Experimental verification of transfer characteristics of AC Phase Controllers.

TOTAL PERIODS

75

## COURSE OUTCOME

At the end of the course, the student will be able to

CO1

Assess the static and dynamic characteristics of power semiconductor devices with the protection circuits.





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|            |                                                                                            |
|------------|--------------------------------------------------------------------------------------------|
| <b>CO2</b> | Evaluate the input and output parameters of controlled rectifiers with R, RL and RLE Load. |
| <b>CO3</b> | Apply the various converter topologies to design and analyze the switched mode regulators  |
| <b>CO4</b> | Analyze the operation of inverter topologies with different PWM schemes.                   |
| <b>CO5</b> | Analyze the performance parameters of AC- AC converters                                    |

#### TEXT BOOKS

|          |                                                                                                                                                       |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Muhammad H.Rashid, 'Power Electronics Circuits, Devices & Applications', 4th Edition, Pearson India, 2018.                                            |
| <b>2</b> | Ned Mohan, Tore. M. Undeland, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', 3rd Edition Wiley India, NewDelhi, 2012. |
| <b>3</b> | M.D.Singh & K.B Khanchandani, 'Power Electronics', 2nd Edition, Tata Mc Graw Hill Publishing Co.Ltd., New Delhi, 2017.                                |

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|          |                                                                                                                                                                                          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Cyril. W.Lander, Power Electronics, McGraw Hill International, Third Edition, 1993                                                                                                       |
| <b>2</b> | P.S.Bimbhra, Power Electronics, Khanna Publishers, Third Edition 2003                                                                                                                    |
| <b>3</b> | Philip T.Krein, Elements of Power Electronics, Oxford University Press, 2013                                                                                                             |
| <b>4</b> | P.C.Sen, Power Electronics, Tata McGraw-Hill, 30th reprint, 2008.                                                                                                                        |
| <b>5</b> | L. Umanand, Power Electronics Essentials and Applications II, Wiley, 2009.                                                                                                               |
| <b>6</b> | R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.                                                                          |
| <b>7</b> | José Rodríguez, Jih-Sheng Lai, and Fang Zheng Peng, 'Multilevel Inverters: A Survey of Topologies, Controls, and Applications', IEEE Trans. Ind. Electron., Vol. 49, No. 4, August 2002. |

#### CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO /PO     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 1   | 2   | 3   | 3   | 2   | –   | –   | 2   | –    | 1    | 3    | 2    | 1    |
| <b>CO2</b> | 3   | 1   | 2   | 3   | 3   | 2   | –   | –   | 2   | –    | 2    | 3    | 2    | 1    |
| <b>CO3</b> | 3   | 1   | 2   | 3   | 3   | 2   | –   | –   | 2   | –    | 2    | 3    | 3    | 1    |
| <b>CO4</b> | 3   | 1   | 2   | 3   | 3   | 2   | –   | –   | 2   | –    | 2    | 3    | 3    | 1    |
| <b>CO5</b> | 3   | 1   | 2   | 3   | 3   | 2   | –   | –   | 2   | –    | 2    | 3    | 3    | 1    |
| <b>AVG</b> | 3.0 | 1.0 | 2.0 | 3.0 | 3.0 | 2.0 | –   | –   | 2.0 | –    | 1.8  | 3.0  | 2.8  | 1.0  |

#### Product based Projects (in Team)

|          |                                                                               |
|----------|-------------------------------------------------------------------------------|
| <b>1</b> | Build a Phone Charger Circuit (Low-Voltage AC to DC)                          |
| <b>2</b> | Simulate a 3-Phase Rectifier for EV Charger Input                             |
| <b>3</b> | Convert USB 5V to 9V with a Boost Circuit (Bluetooth speakers, small devices) |
| <b>4</b> | Design a PWM based Light Brightness Controller (Solar lighting systems)       |
| <b>5</b> | Build a Fan Regulator Using TRIAC (Ceiling fan speed control)                 |



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| U24RM612                                                                                                                                                                                                                                                                                                                                                                     | DATA COLLECTION, ANALYSIS AND INTERPRETATION                                                                                 | L | T | P | C   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                              | 0 | 0 | 1 | 0.5 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                              |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                            | Analyze different types of data, sources, and sampling methods in research contexts to ensure appropriate data collection.   |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                            | Apply appropriate digital and manual tools for designing and administering data collection instruments across disciplines.   |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                            | Analyze and preprocess raw data using statistical and visualization techniques to prepare it for analysis.                   |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                            | Evaluate statistical methods and domain-specific analysis techniques for their suitability in different research scenarios.  |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                            | Evaluate the significance of data analysis results and effectively communicate findings through structured research outputs. |   |   |   |     |
| UNIT 1 Introduction to Research Data and Collection Techniques                                                                                                                                                                                                                                                                                                               |                                                                                                                              |   |   | 3 |     |
| Types of data: qualitative vs. quantitative; primary vs. secondary, Sources of data: surveys, experiments, sensors, interviews, observations, literature, Tools and techniques for data collection: questionnaires, focus groups, digital sensors, APIs, Sampling methods: probability and non-probability sampling, Data quality: validity, reliability, accuracy, and bias |                                                                                                                              |   |   |   |     |
| UNIT 2 Tools and Methods for Data Collection                                                                                                                                                                                                                                                                                                                                 |                                                                                                                              |   |   | 3 |     |
| Designing data collection instruments: scales, forms, and logs, Using online tools: Google Forms, SurveyMonkey, KoboToolbox, IoT and sensor-based data acquisition in engineering and science, Ethical considerations in data collection: consent, privacy, anonymization, Case studies from various domains                                                                 |                                                                                                                              |   |   |   |     |
| UNIT 3 Data Preparation and Analysis Techniques                                                                                                                                                                                                                                                                                                                              |                                                                                                                              |   |   | 3 |     |
| Data cleaning and preprocessing: handling missing, duplicate, and outlier data, Organizing data: tabulation, coding, categorization, Descriptive statistics: mean, median, mode, standard deviation, variance, Data visualization: charts, graphs, dashboards using Excel, Python, R, Introduction to data analysis tools: SPSS, Excel, Python (Pandas), R                   |                                                                                                                              |   |   |   |     |
| UNIT 4 Statistical and Analytical Methods                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |   |   | 3 |     |
| Inferential statistics: hypothesis testing, confidence intervals, Correlation and regression analysis, ANOVA, chi-square, and non-parametric tests, Multivariate analysis (introductory), Domain-specific analysis techniques (e.g., sentiment analysis in social sciences, FFT in engineering)                                                                              |                                                                                                                              |   |   |   |     |
| UNIT 5 Data Interpretation and Research Reporting                                                                                                                                                                                                                                                                                                                            |                                                                                                                              |   |   | 3 |     |
| Interpreting statistical results in context, Drawing meaningful conclusions and identifying patterns, Reporting and visualizing findings (charts, tables, narrative explanation), Using data to support or refute hypothesis, Writing data-driven research papers, reports, and presentations                                                                                |                                                                                                                              |   |   |   |     |
| TOTAL: 15                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                              |   |   |   |     |



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**At the end of the course, the student will be able to**

|            |                                                                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Distinguish and evaluate data types, sources, and sampling methods to design valid and reliable research strategies.                                    |
| <b>CO2</b> | Design effective data collection tools using platforms like Google Forms, SurveyMonkey, and IoT-based systems, while addressing ethical considerations. |
| <b>CO3</b> | Clean, organize, and summarize datasets using descriptive statistics and visualize results using tools like Excel, Python, or R.                        |
| <b>CO4</b> | Select and apply appropriate statistical and analytical techniques such as regression, ANOVA, and chi-square to interpret research data.                |
| <b>CO5</b> | Interpret analytical outcomes and prepare data-driven research reports and presentations that effectively communicate insights.                         |

**TEXT BOOKS**

|          |                                                                                                                                            |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | A. Field, Discovering Statistics Using SPSS / R / Python, 5th ed. London, UK: SAGE Publications, 2018.                                     |
| <b>2</b> | J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, Multivariate Data Analysis, 8th ed. Andover, UK: Cengage Learning EMEA, 2018.    |
| <b>3</b> | C. R. Kothari and G. Garg, Research Methodology: Methods and Techniques, 4th ed. New Delhi, India: New Age International Publishers, 2019. |

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| <b>2</b> | E. R. Tufte, The Visual Display of Quantitative Information, 2nd ed. Cheshire, CT, USA: Graphics Press, 2001.                                                  |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO1</b> | 2          | 2          | 2          | 2          | 1          | 1          | 2          | 1          | 2          | 1           | 2           |             |             |             |
| <b>CO2</b> | 2          | 2          | 3          | 2          | 3          | 1          | 3          | 2          | 3          | 2           | 3           |             |             |             |
| <b>CO3</b> | 2          | 3          | 2          | 2          | 3          | 1          | 2          | 2          | 3          | 2           | 3           |             |             |             |
| <b>CO4</b> | 3          | 3          | 3          | 3          | 3          | 1          | 2          | 2          | 3          | 3           | 3           |             |             |             |
| <b>CO5</b> | 2          | 2          | 3          | 2          | 2          | 1          | 3          | 2          | 3          | 3           | 3           |             |             |             |
| <b>AVG</b> | 2.2        | 2.4        | 2.6        | 2.2        | 2.4        | 1          | 2.4        | 1.8        | 2.8        | 2.2         | 2.8         |             |             |             |



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| U24ED611                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                    | Business Management: Go-To-Market & Startup Journey |  | L | T  | P | C   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|--|---|----|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    |                                                     |  | 0 | 0  | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                    |                                                     |  |   |    |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                            | To understand the fundamentals of business management and the startup lifecycle from idea to market entry.         |                                                     |  |   |    |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                            | To analyze and design business models and revenue models suitable for innovative products and services.            |                                                     |  |   |    |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                            | To develop go-to-market strategies including marketing, sales, and customer acquisition planning                   |                                                     |  |   |    |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                            | To understand financial planning, funding options, and legal aspects of starting and scaling a venture.            |                                                     |  |   |    |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                            | To prepare students to present and manage a startup journey through effective pitching and stakeholder engagement. |                                                     |  |   |    |   |     |
| UNIT I IDEATE MODE                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |                                                     |  |   | 1  |   |     |
| <ul style="list-style-type: none"><li>• Meaning and scope of business management.</li><li>• Startup lifecycle: idea, validation, launch, growth, and scale.</li><li>• Role of entrepreneurship in economic development.</li><li>• Overview of startup ecosystem: incubators, accelerators, investors, and government initiatives.</li><li>• Ethics and sustainability in business.</li></ul> |                                                                                                                    |                                                     |  |   |    |   |     |
| UNIT II IDEA GENERATION                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                    |                                                     |  |   | 2  |   |     |
| <ul style="list-style-type: none"><li>• Business Model Canvas and value proposition design.</li><li>• Customer segments, channels, and customer relationships.</li><li>• Revenue models: subscription, freemium, licensing, transaction-based models.</li><li>• Cost structure and key resources.</li><li>• Lean startup and effectuation principles.</li></ul>                              |                                                                                                                    |                                                     |  |   |    |   |     |
| UNIT III BRAINSTORMING FACILITATION                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                    |                                                     |  |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Market segmentation, targeting, and positioning.</li><li>• Marketing mix and branding basics.</li><li>• Digital marketing channels and customer acquisition strategies.</li><li>• Sales strategy and distribution channels.</li><li>• Pricing strategies and competitive positioning.</li></ul>                                                      |                                                                                                                    |                                                     |  |   |    |   |     |
| UNIT IV SKETCH TO THINK BEYOND                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                    |                                                     |  |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Basics of financial planning and budgeting.</li><li>• Understanding unit economics and break-even analysis.</li><li>• Sources of funding: bootstrapping, angel investors, venture capital, and government schemes.</li><li>• Legal forms of business organization.</li><li>• Intellectual Property Rights (IPR) and regulatory compliance.</li></ul> |                                                                                                                    |                                                     |  |   |    |   |     |
| UNIT V TRANSLATE SOLUTIONS TO PRODUCTS AND SERVICES                                                                                                                                                                                                                                                                                                                                          |                                                                                                                    |                                                     |  |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Operational planning and team building.</li><li>• Risk management and decision-making.</li><li>• Performance metrics and growth tracking.</li><li>• Storytelling and investor pitch deck preparation.</li><li>• Preparing for market launch and scaling strategy.</li></ul>                                                                          |                                                                                                                    |                                                     |  |   |    |   |     |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                    |                                                     |  |   | 15 |   |     |



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**Course Outcomes**

**At the end of the course, students will be able to**

- |   |                                                                                      |
|---|--------------------------------------------------------------------------------------|
| 1 | Explain the concepts of business management and the stages of the startup journey.   |
| 2 | Design appropriate business and revenue models for innovative products and services. |
| 3 | Develop effective go-to-market strategies including marketing and sales plans.       |
| 4 | Apply financial planning and legal knowledge to assess venture feasibility.          |
| 5 | Prepare and present a structured business pitch for launching and scaling a startup. |

**TEXTBOOKS**

- |   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 1 | Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, <i>Entrepreneurship</i> , McGraw Hill Education, 11th Edition, 2020 |
|---|-----------------------------------------------------------------------------------------------------------------------------|

**REFERENCE BOOKS**

- |   |                                                                             |
|---|-----------------------------------------------------------------------------|
| 1 | Kotler, P. & Keller, K. L., <i>Marketing Management</i> , Pearson Education |
|---|-----------------------------------------------------------------------------|

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO2 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO3 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO4 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO5 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| AVG | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |



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**SEMESTER VII**

| SL. NO.                     | COURSE CODE | COURSE TITLE                                 | CATEGORY | TCP        | PERIODS PER WEEK |          |          | CREDITS     |
|-----------------------------|-------------|----------------------------------------------|----------|------------|------------------|----------|----------|-------------|
|                             |             |                                              |          |            | L                | T        | P        |             |
|                             |             | VAC                                          |          | 30         |                  |          |          |             |
| <b>THEORY</b>               |             |                                              |          |            |                  |          |          |             |
| 1                           | U24MG701    | Engineering Economics and Finance Management | HSMC     | 45         | 3                | 0        | 0        | 3           |
| 2                           |             | Open Elective II                             | OEC      | 45         | 3                | 0        | 0        | 3           |
| 3                           |             | Open Elective III                            | OEC      | 45         | 3                | 0        | 0        | 3           |
| 4                           |             | Professional Elective V                      | PEC      | 45         | 3                | 0        | 0        | 3           |
| 5                           |             | Professional Elective VI                     | PEC      | 45         | 3                | 0        | 0        | 3           |
| 6                           |             | Constitution Of India                        | MC       | 30         | 2                | 0        | 0        | 0           |
| <b>THEORY CUM PRACTICAL</b> |             |                                              |          |            |                  |          |          |             |
| 7                           | U24EE701    | Renewable Energy Systems                     | PCC      | 75         | 3                | 0        | 2        | 4           |
| 8                           | U24EE702    | Power System Operation and Control           | PCC      | 75         | 3                | 0        | 2        | 4           |
| <b>PRACTICAL</b>            |             |                                              |          |            |                  |          |          |             |
| 9                           | U24EE703    | Summer Internship*                           | EEC      |            |                  |          |          | 1           |
| 10                          | U24RM712    | Technical Writing And Research Ethics        | RMC      | 15         | 0                | 0        | 1        | 0.5         |
| <b>TOTAL</b>                |             |                                              |          | <b>420</b> | <b>23</b>        | <b>0</b> | <b>5</b> | <b>24.5</b> |

**\*Two weeks Summer Internship carries one credit and it will be done during VI semester summer vacation and same will be evaluated in VII semester.**



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| U24EE702                                                                                                                                                                                                                                                                                                                                                                                                                            | Power System Operation and Control                                                                                                                                          | L | T | P     | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|-------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                             | 3 | 0 | 2     | 4 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                             |   |   |       |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                   | To investigate the fundamental structure and operational goals of modern power systems and design a system that monitors and manages grid performance using real-time data. |   |   |       |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                   | To analyse real power and frequency dynamics of a power system and develop intelligent control strategies for maintaining system stability.                                 |   |   |       |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                   | To evaluate reactive power control techniques and create intelligent systems for voltage regulation in smart grids.                                                         |   |   |       |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                   | To study economic aspects of power generation and implement optimization algorithms to minimize generation costs while meeting demand.                                      |   |   |       |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                   | To explore computer-aided techniques in power system control and integrate AI-based solutions for predictive maintenance and automated fault analysis.                      |   |   |       |   |
| UNIT 1 INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                             |   |   | 9 + 6 |   |
| Power scenario in Indian grid - National and Regional load dispatching centres - Requirements of good power system -Necessity of voltage and frequency regulation real power vs frequency and reactive power vs voltage control loops - System load variation, load curves,Load forecasting - Computational methods in load forecasting Load shedding and Islanding - Basics of electrical energy tariff.                           |                                                                                                                                                                             |   |   |       |   |
| Experiential learning : Load curve for power consumption in one day in their house<br>Industrial Application : Load Forecasting using ETAP.<br>Content Beyond Syllabus: Time series based Load Forecasting.                                                                                                                                                                                                                         |                                                                                                                                                                             |   |   |       |   |
| Lab components:<br>1. Load forecasting using curve fitting techniques<br>2. Determination of MCP in deregulated power system.                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                             |   |   |       |   |
| UNIT 2 REAL POWER FREQUENCY CONTROL                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                             |   |   | 9 + 6 |   |
| Basics of speed governing mechanisms and modelling - Speed regulation of two generators in parallel Load Frequency Control (LFC) of single area system- Static and dynamic analysis - LFC of two area system --Tie line modelling – Block diagram representation of two area system - Static and dynamic analysis - Tie line with frequency bias control - State variable model - Integration of economic dispatch control with LFC |                                                                                                                                                                             |   |   |       |   |
| Experiential learning : frequency variation from solar to ac grid.<br>Industrial application : Impact of Distributed Generation on LFC.<br>Content beyond syllabus : Automatic generation control (AGC)                                                                                                                                                                                                                             |                                                                                                                                                                             |   |   |       |   |
| Lab components:<br>1. Load Frequency Control of single area system.<br>2. Load Frequency Control of Two area system.                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                             |   |   |       |   |





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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT 3 REACTIVE POWER – VOLTAGE CONTROL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9 + 6</b> |
| <p>Generation and absorption of reactive power – Basics of reactive power control-Automatic Voltage Regulator (AVR) – Brushless AC excitation system - Block diagram representation of AVR loop static and dynamic analysis - Stability compensation – Voltage drop in transmission line - Methods of reactive power injection - Tap changing transformer - SVC and STATCOM for voltage control</p> <p>Experiential learning: visit to Kodambakkam power house.</p> <p>Industrial application: Power factor correction using reactive power.</p> <p>Content beyond syllabus : FACTS devices for voltage control.</p> <p><b>Lab components:</b><br/>Simulation / Development of source code for</p> <ol style="list-style-type: none"><li>1. Stability analysis of AVR.</li><li>2. Sizing of SVC/STATCOM for voltage control of a HVAC bus.</li></ol>                                           |              |
| <b>UNIT 4 ECONOMIC OPERATION OF POWER SYSTEM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>9 + 6</b> |
| <p>Statement of economic dispatch problem - Input and output characteristics of thermal plant, incremental cost curve- Optimal operation of thermal units without and with transmission losses - (no derivation of transmission loss coefficients) - Lambda–iteration method - Base point and participation factors method Statement of Unit Commitment (UC) problem – Constraints on UC problem - Solution of UC problem using priority list</p> <p>Experiential learning Apply genetic algorithms or neural networks for optimal power generation cost - AI</p> <p>Content beyond syllabus: Kron's Loss equation.</p> <p>Industrial application: Unit commitment with renewable energy resources.</p> <p>Lab components:<br/>Simulation / Development of source code for</p> <ol style="list-style-type: none"><li>1. Economic Dispatch problem</li><li>2. Unit Commitment problem</li></ol> |              |
| <b>UNIT 5 COMPUTER AIDED CONTROL OF POWER SYSTEM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>9 + 6</b> |
| <p>Need of computer control of power system - Concept of energy control centers and functions – PMU system monitoring - Data acquisition and controls – System hardware configurations -SCADA and EMS functions - State estimation - Measurements and errors - Weighted least square estimation - Various operating states – State transition diagram.</p> <p>Experiential learning: EMS in college.</p> <p>Industrial application: Phasor Measurement Unit.</p> <p>Content beyond syllabus : State Estimation using Matlab.</p> <p>Lab components:<br/>Simulation / Development of source code for</p> <ol style="list-style-type: none"><li>1. State estimation using weighted least square estimation technique.</li><li>2. Energy management in power system.</li></ol>                                                                                                                    |              |
| <b>TOTAL Periods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>75</b>    |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |



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| At the end of the course, the student will be able to                                                                                                            |                                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| CO1                                                                                                                                                              | Understand the day – to – day operation of power system.                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO2                                                                                                                                                              | Model and analyse the control actions that are implemented to meet the minute-to minute variation of system real power demand.                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO3                                                                                                                                                              | Model and analyze the compensators for reactive power control and various devices used for voltage control.                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO4                                                                                                                                                              | Prepare day ahead and real time economic generation scheduling                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO5                                                                                                                                                              | Understand the necessity of computer control of power systems.                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| TEXT BOOKS                                                                                                                                                       |                                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                                | Olle. I. Elgerd, ‘Electric Energy Systems theory – An introduction’, McGraw Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2017.            |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                                | Allen. J. Wood and Bruce F. Wollen berg, ‘Power Generation, Operation and Control’, John Wiley & Sons, Inc., 3rd edition, 2013.                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                                | Abhijit Chakrabarti and Sunita Halder, ‘Power System Analysis Operation and Control’, PHI learning Pvt. Ltd., New Delhi, Fourth Edition, 2018. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| REFERENCES                                                                                                                                                       |                                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                                | Kothari D.P. and Nagrath I.J., ‘Power System Engineering’, Tata McGraw– Hill Education, Second Edition, Reprint 2018.                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                                | Hadi Saadat, ‘Power System Analysis’, McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                                | Kundur P., ‘Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                                | B.M. Weedy, B.J. Cory et al, ‘Electric Power systems’, Wiley, Fifth Edition, 2012.                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1- Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO/PO                                                                                                                                                            | PO1                                                                                                                                            | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                              | 3                                                                                                                                              | 2   | 1   | 1   | 2   | 2   | –   | –   | –   | –    | 2    | 3    | 2    | 1    |  |
| CO2                                                                                                                                                              | 3                                                                                                                                              | 3   | 2   | 2   | 3   | 2   | –   | –   | –   | –    | 2    | 3    | 3    | 1    |  |
| CO3                                                                                                                                                              | 3                                                                                                                                              | 3   | 2   | 2   | 3   | 3   | –   | –   | –   | –    | 2    | 3    | 3    | 1    |  |
| CO4                                                                                                                                                              | 3                                                                                                                                              | 3   | 3   | 2   | 2   | 2   | –   | –   | –   | 2    | 2    | 3    | 3    | 2    |  |
| CO5                                                                                                                                                              | 3                                                                                                                                              | 2   | 2   | 3   | 3   | 2   | 1   | 2   | 2   | 2    | 3    | 3    | 3    | 3    |  |
| AVG                                                                                                                                                              | 3.0                                                                                                                                            | 2.6 | 2.0 | 2.0 | 2.6 | 2.2 | 1.0 | 2.0 | 2.0 | 2.0  | 2.2  | 3.0  | 2.8  | 1.6  |  |



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| S.NO | Product Based Projects                                                                                                               |
|------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Smart Grid Health Monitoring Dashboard - A web/mobile dashboard that visualizes real-time data from the grid.                        |
| 2    | AI-Powered Load Frequency Stabilizer - A simulation-based control system that dynamically adjusts generator output.                  |
| 3    | Intelligent Voltage Regulator using IoT and AI - An embedded system that adjusts tap changers and capacitors for voltage regulation. |
| 4    | AI-Based Economic Load Dispatcher - A software tool that simulates economic dispatch with constraints.                               |
| 5    | AI-Integrated SCADA System for Fault Prediction - An enhanced SCADA interface with AI-driven alerts and recommendations              |



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|                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                   |   |   |   |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-------|
| U24EE701                                                                                                                                                                                                                                                                                                                                                                                           | Renewable Energy Systems                                                                                                                                          | L | T | P | C     |
|                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                   | 3 | 0 | 2 | 4     |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                   |   |   |   |       |
| Students are able to critically analyze, innovate, and apply renewable energy solutions in industrial and research settings.                                                                                                                                                                                                                                                                       |                                                                                                                                                                   |   |   |   |       |
| 1                                                                                                                                                                                                                                                                                                                                                                                                  | Analyse the feasibility and integration of various renewable energy technologies, including co-generation and distributed generation, in sustainable development. |   |   |   |       |
| 2                                                                                                                                                                                                                                                                                                                                                                                                  | Evaluate critical issues in harnessing renewable energy, considering environmental, economic, and technological challenges.                                       |   |   |   |       |
| 3                                                                                                                                                                                                                                                                                                                                                                                                  | Assess the current and future role of renewable energy sources in global energy systems and policy frameworks.                                                    |   |   |   |       |
| 4                                                                                                                                                                                                                                                                                                                                                                                                  | Investigate emerging technologies in renewable energy systems to enhance efficiency and sustainability.                                                           |   |   |   |       |
| UNIT 1 RENEWABLE ENERGY SOURCES                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                   |   |   |   | 9 + 6 |
| Types of RE sources - Concept of co-generation and distributed generation - Environmental consequences of fossil fuel use - Importance of renewable sources of energy- Sustainable Design and development - Limitations of RE sources - Present Indian and international energy scenario of conventional and RE sources.                                                                           |                                                                                                                                                                   |   |   |   |       |
| <a href="#">Experiential Learning (Activity Based Learning): Navigating the Future: India's and the World's Energy Transition in Conventional &amp; Renewable Sources</a><br><a href="#">Industrial Application : Bio-energy with carbon capture and storage (BECCS)</a><br><a href="#">Content Beyond Syllabus : Deregulation and restructured electricity market.</a>                            |                                                                                                                                                                   |   |   |   |       |
| Lab Components                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                   |   |   |   |       |
| 1. Simulation and Comparative Analysis of Conventional and Renewable Energy Sources with Co-Generation and Distributed Generation<br>2. Experiment on VI characteristics & Efficiency of 1 Kwp solar PV system                                                                                                                                                                                     |                                                                                                                                                                   |   |   |   |       |
| UNIT 2 WIND ENERGY                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                   |   |   |   | 9 + 6 |
| Power in the Wind – Types of Wind Power Plants (WPPs) – Components of WPPs - Working of WPPs - Siting of WPPs-Grid integration issues of WPPs.                                                                                                                                                                                                                                                     |                                                                                                                                                                   |   |   |   |       |
| <a href="#">Experiential Learning (Activity Based Learning): Study on World's wind energy projects with significant impact.</a><br><a href="#">Industrial Application : SCADA systems help industries monitor and control wind farm operations.</a><br><a href="#">Content Beyond Syllabus : Airborne Wind Energy Systems (AWES) – Uses drones and kites to harness high-altitude wind energy.</a> |                                                                                                                                                                   |   |   |   |       |
| Lab Components                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                   |   |   |   |       |
| 1. Grid Integration Issues of Wind Power Plants<br>2. Experiment on performance assessment of micro wind energy generator.                                                                                                                                                                                                                                                                         |                                                                                                                                                                   |   |   |   |       |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT 3 SOLAR PV AND THERMAL SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>9 + 6</b> |
| <p>Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds - Thermal Energy storage system with PCM- Solar Photovoltaic systems: Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array</p> <p>,PV Module I-V Characteristics, Efficiency &amp; Quality of the Cell, series and parallel connections, maximum power point tracking, Applications</p> <p>Experiential Learning (Activity Based Learning): Usage of Geographic Information Systems (GIS) to map solar potential.</p> <p>Industrial Application : Solar farms supply electricity to manufacturing plants and industrial complexes.</p> <p>Content Beyond Syllabus : Maximum power point tracking in Solar system</p> <p><b>Lab Components</b></p> <ol style="list-style-type: none"><li>1. Experiment on shadowing effect &amp; diode-based solution in 1 Kwp solar PV system.</li><li>2. Experiment on performance assessment of grid connected and standalone 1 Kwp solar power system.</li></ol> |              |
| <b>UNIT 4 BIOMASS ENERGY AND HYDEL ENERGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>9 + 6</b> |
| <p>Introduction-Biomass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration- Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.</p> <p>Experiential Learning (Activity Based Learning): Study biogas production from organic waste in rural communities.</p> <p>Industrial Application : Mini and micro hydropower plants generate renewable electricity for local industries and rural manufacturing units.</p> <p>Content Beyond Syllabus : Hydrothermal Liquefaction (HTL): Converts algae and waste biomass into bio- crude oil.</p> <p><b>Lab Components</b></p> <ol style="list-style-type: none"><li>1. Simulation study on hydel power plant</li><li>2. Simulation study on hybrid (solar + wind) power system</li></ol>                                                                                                                                       |              |
| <b>UNIT 5 OTHER ENERGY SOURCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>9 + 6</b> |
| <p>Tidal Energy: Energy from the tides, Barrage and Non-Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell: Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.</p> <p><b>Lab Components</b></p> <ol style="list-style-type: none"><li>1. Experiment on performance assessment of 100 W fuel cell.</li></ol> <p>Experiment on performance assessment hybrid (solar + wind) power system</p> <p>Experiential Learning (Activity Based Learning): Green Hydrogen Production Projects.</p> <p>Industrial Application : OTEC Power Plants generate electricity for island industries.</p> <p>Content Beyond Syllabus : Magneto hydro dynamic power (MHD)</p>                                                                                                                                                                                                                                                       |              |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>75</b>    |

**COURSE OUTCOME**



**Meenakshi Sundararajan Engineering College**  
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| At the end of the course, the student will be able to |                                                                                             |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>CO1</b>                                            | Ability to promote hands-on experience with renewable energy sources and technologies.      |
| <b>CO2</b>                                            | Deal with various issues associated with wind energy generation and operation.              |
| <b>CO3</b>                                            | Handle various issues related to performance improvement of solar energy harnessing.        |
| <b>CO4</b>                                            | Develop good understanding of biomass geothermal and Hydel energy principles and operation. |
| <b>CO5</b>                                            | Propose an appropriate renewable energy system for a given application.                     |

**TEXT BOOKS**

|   |                                                                                                                                     |
|---|-------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, second Edition 2017.    |
| 2 | D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging technologies", PHI Learning Pvt.Ltd, New Delhi, 2013. |
| 3 | Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA,2016.                                                |
| 4 | Gupta, B.R., Generation of Electrical Energy, S. Chand (2017).                                                                      |
| 5 | Frede Blasbjerg and Dan M. Ionel, "Renewable Energy Devices and Systems with Simulation in MATLAB and ANSYS" CRC Press,2017         |

**REFERENCES**

|   |                                                                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011                                                       |
| 2 | Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.                                                                                       |
| 3 | Chetan Singh Solanki, " Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, third Edition 2015                            |
| 4 | Bradley A. Striebig,Adebayo A.Ogundipe and Maria Papadakis," Engineering Applications in Sustainable Design and Development", Cengage Learning India Private Limited, Delhi, 2016. |
| 5 | Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004.                                                         |
| 6 | Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education ,2015.                                                                                                     |
| 7 | Wood, A.J. and Wollenberg, B.F., Power Generation and Control, John Wiley (2004).                                                                                                  |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | 2   | 2   | 2   | 3   | –   | –   | –   | –    | 2    | 3    | 2    | 1    |
| <b>CO2</b> | 3   | 3   | 2   | 2   | 2   | 2   | –   | –   | –   | –    | 2    | 3    | 2    | 1    |
| <b>CO3</b> | 3   | 3   | 3   | 2   | 3   | 2   | –   | –   | –   | –    | 2    | 3    | 3    | 2    |



|                                   |                                                                        |     |     |     |     |     |     |     |     |     |     |     |     |  |
|-----------------------------------|------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO4                               | 3                                                                      | 2   | 2   | 2   | 2   | 3   | –   | –   | –   | 2   | 3   | 2   | 1   |  |
| CO5                               | 3                                                                      | 3   | 3   | 2   | 3   | 3   | 1   | 2   | 2   | 2   | 3   | 3   | 3   |  |
| AVG                               | 3.0                                                                    | 2.6 | 2.4 | 2.0 | 2.4 | 2.6 | 1.0 | 2.0 | 2.0 | 2.0 | 2.2 | 3.0 | 2.4 |  |
| Product based Projects ( in Team) |                                                                        |     |     |     |     |     |     |     |     |     |     |     |     |  |
| 1                                 | Smart Solar-Powered IoT System for Carbon Emission Monitoring          |     |     |     |     |     |     |     |     |     |     |     |     |  |
| 2                                 | Intelligent Control Algorithm for Wind Energy Optimization             |     |     |     |     |     |     |     |     |     |     |     |     |  |
| 3                                 | Smart IoT-Enabled Solar Water Filtration System                        |     |     |     |     |     |     |     |     |     |     |     |     |  |
| 4                                 | Develop a simulation model for bio mass generation                     |     |     |     |     |     |     |     |     |     |     |     |     |  |
| 5                                 | Develop a simulation model for a small-scale hydrogen-powered vehicle. |     |     |     |     |     |     |     |     |     |     |     |     |  |





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| U24RM712                                                                                                                                                                                                                                                                                                                                                    | TECHNICAL WRITING AND RESEARCH ETHICS                                                                                                        | L | T | P | C   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              | 0 | 0 | 1 | 0.5 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                              |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                           | Apply the principles of clarity, conciseness, coherence, and correctness in technical writing tasks.                                         |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                           | Analyze the structure and components of various research and technical documents using the IMRaD format.                                     |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                           | Apply principles of formal, objective, and precise language in crafting professional technical documents.                                    |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                           | Evaluate the effectiveness of visual elements (tables, charts, graphs) in technical documentation and revise them for clarity and precision. |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                           | Analyze ethical issues related to research publication, data integrity, authorship, and collaborative writing.                               |   |   |   |     |
| UNIT 1 Fundamental of Technical Writing                                                                                                                                                                                                                                                                                                                     |                                                                                                                                              |   |   | 3 |     |
| Nature and scope of technical writing vs. academic writing, Characteristics of effective technical writing: clarity, conciseness, coherence, correctness, Audience analysis and purpose identification, Writing process: planning, drafting, revising, editing, Common technical documents: manuals, reports, proposals, research papers                    |                                                                                                                                              |   |   |   |     |
| UNIT 2 Writing Research and Technical Documents                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |   |   | 3 |     |
| Structure and format of research papers (IMRaD structure), Writing abstracts, introductions, literature reviews, methodologies, results, and conclusions, Writing technical reports, project documentation, lab reports, Research proposals and funding applications, Case studies of well-written technical documents                                      |                                                                                                                                              |   |   |   |     |
| UNIT 3 Language and Style in Technical Writing                                                                                                                                                                                                                                                                                                              |                                                                                                                                              |   |   | 3 |     |
| Use of formal, objective, and precise language, Active vs. passive voice; tone and style, Grammar, punctuation, and sentence construction, Avoiding jargon, redundancy, and ambiguity, Consistency in units, terminology, and symbols                                                                                                                       |                                                                                                                                              |   |   |   |     |
| UNIT 4 Data Presentation and Visual Communication                                                                                                                                                                                                                                                                                                           |                                                                                                                                              |   |   | 3 |     |
| Integrating tables, charts, graphs, and diagrams effectively, Captioning, labelling, and referencing visuals, Tools for creating visuals (Excel, Python, R, LaTeX), Guidelines for formatting figures and tables (APA, IEEE, etc.), Visual abstracts and infographics in technical communication                                                            |                                                                                                                                              |   |   |   |     |
| UNIT 5 Ethics, Review, and Publishing                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |   |   | 3 |     |
| Plagiarism, citation styles (APA, MLA, IEEE), and referencing tools (Zotero, Mendeley), Ethics in authorship, collaborative writing, and data reporting, Ethical issues in Research planning and design, Ethics in data collection, analysis and interpretation, Publication ethics and professional conduct, Contemporary and Emerging ethical challenges. |                                                                                                                                              |   |   |   |     |
| TOTAL: 15                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                              |   |   |   |     |



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**At the end of the course, the student will be able to**

|            |                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Draft effective technical documents that demonstrate clarity, coherence, and appropriateness for a specified audience and purpose.                         |
| <b>CO2</b> | Deconstruct well-written technical documents and identify effective strategies in structuring abstracts, literature reviews, and methodologies.            |
| <b>CO3</b> | Produce grammatically accurate and stylistically appropriate texts while minimizing ambiguity and redundancy.                                              |
| <b>CO4</b> | Design and integrate well-labeled, correctly formatted visuals to support technical arguments in reports and presentations.                                |
| <b>CO5</b> | Critically assess research practices for ethical compliance, and apply appropriate citation and referencing standards using tools like Zotero or Mendeley. |

**TEXT BOOKS**

|          |                                                                                                                      |
|----------|----------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | M. Alley, The Craft of Scientific Writing, 3rd ed. New York, NY, USA: Springer, 1996.                                |
| <b>2</b> | A. Eisenberg, Guide to Technical Writing, New York, NY, USA: Macmillan, 1978.                                        |
| <b>3</b> | W. Strunk Jr. and E. B. White, The Elements of Style, 4th ed. Boston, MA, USA: Pearson, 2022.                        |
| <b>4</b> | D. B. Resnik, The Ethics of Science: An Introduction, 2nd ed. New York, NY, USA: Routledge, 2018.                    |
| <b>5</b> | A. E. Shamoo and D. B. Resnik, Responsible Conduct of Research, 4th ed. New York, NY, USA: Oxford Univ. Press, 2022. |

**REFERENCES**

|          |                                                                                                                 |
|----------|-----------------------------------------------------------------------------------------------------------------|
| <b>1</b> | J.-L. Lebrun, Scientific Writing: A Reader and Writer's Guide, Singapore: World Scientific, 2007.               |
| <b>2</b> | S. Bailey, Academic Writing: A Handbook for International Students, 5th ed. New York, NY, USA: Routledge, 2018. |

**CO/PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 2   | 3   | 1    | 2    |      |      |      |
| <b>CO2</b> | 2   | 3   | 2   | 3   | 2   | 1   | 2   | 2   | 3   | 2    | 3    |      |      |      |
| <b>CO3</b> | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2   | 3   | 2    | 3    |      |      |      |
| <b>CO4</b> | 2   | 2   | 3   | 2   | 3   | 1   | 1   | 2   | 3   | 3    | 3    |      |      |      |
| <b>CO5</b> | 2   | 2   | 1   | 2   | 2   | 2   | 3   | 2   | 3   | 2    | 3    |      |      |      |
| <b>AVG</b> | 2   | 2   | 2   | 1.8 | 1.8 | 1.2 | 1.8 | 2   | 3   | 2    | 2.8  |      |      |      |



# Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University,  
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## PROFESSIONAL ELECTIVE COURSES: VERTICALS

### VERTICAL I: POWER ENGINEERING

| SI.<br>NO. | COURS<br>E CODE | COURSE TITLE                                        | CATEGORY | TCP | PERIODS<br>PER<br>WEEK |   |   | CREDITS |
|------------|-----------------|-----------------------------------------------------|----------|-----|------------------------|---|---|---------|
|            |                 |                                                     |          |     | L                      | T | P |         |
| 1          | U24EEP11        | UTILISATION & CONVERSION<br>OF ELECTRICAL ENERGY    | PEC      | 3   | 3                      | 0 | 0 | 3       |
| 2          | U24EEP12        | HVDC & FACTS                                        | PEC      | 4   | 2                      | 0 | 2 | 3       |
| 3          | U24EEP13        | APPLICATION OF AI<br>TECHNIQUES TO POWER<br>SYSTEMS | PEC      | 3   | 3                      | 0 | 0 | 3       |
| 4          | U24EEP14        | POWER QUALITY                                       | PEC      | 4   | 2                      | 0 | 2 | 3       |
| 5          | U24EEP15        | SMART GRID                                          | PEC      | 3   | 3                      | 0 | 0 | 3       |
| 6          | U24EEP16        | POWER SYSTEM<br>TRANSIENTS                          | PEC      | 3   | 3                      | 0 | 0 | 3       |



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Chennai) Department: Electrical and Electronics Engineering,

|                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                           |        |        |          |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------|--------|----------|--------|
| U24EEP11                                                                                                                                                                                                                                                                                                                                                                                                                               | UTILIZATION AND CONSERVATION<br>OF ELECTRICAL ENERGY                                                                                      | L<br>3 | T<br>0 | P<br>0   | C<br>3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                           |        |        |          |        |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                      | Introduce fundamentals of electric drives, traction systems, motor selection, and control for industrial and railway applications.        |        |        |          |        |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                      | Develop understanding of illumination engineering, light sources, design of lighting systems, and energy-efficient lighting technologies. |        |        |          |        |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                      | Explain principles, methods, and industrial applications of electric heating and welding systems.                                         |        |        |          |        |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                      | Impart knowledge of energy conservation techniques, industrial energy management, and simulation of power factor improvement.             |        |        |          |        |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                      | Provide knowledge on domestic electrical installations, UPS systems, appliances, and power quality considerations.                        |        |        |          |        |
| <b>UNIT I ELECTRIC DRIVES AND TRACTION</b>                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                           |        |        | <b>9</b> |        |
| Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.                                                   |                                                                                                                                           |        |        |          |        |
| Experiential Learning (Activity Based Learning): Use MATLAB software to plot torque-speed curves of DC series motors.                                                                                                                                                                                                                                                                                                                  |                                                                                                                                           |        |        |          |        |
| Industrial Application : Electric drives in cement plants.                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                           |        |        |          |        |
| Content Beyond Syllabus : Use of Variable Frequency Drives (VFDs) in industrial automation.                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           |        |        |          |        |
| <b>UNIT II ILLUMINATION</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           |        |        | <b>9</b> |        |
| Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting – UPS- energy saving lamps, LED – working principle of air conditioning system. |                                                                                                                                           |        |        |          |        |
| Experiential Learning (Activity Based Learning): Simulate UPS inverter output waveform, efficiency, and harmonic distortion using MATLAB/Simulink.                                                                                                                                                                                                                                                                                     |                                                                                                                                           |        |        |          |        |
| Industrial Application :Comparison of Different Light Sources (Incandescent, Fluorescent, LED)                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                           |        |        |          |        |
| Content Beyond Syllabus : Renewable Energy Integration                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                           |        |        |          |        |
| <b>UNIT III HEATING AND WELDING</b>                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                           |        |        | <b>9</b> |        |
| Introduction - advantages of electric heating – modes of heat transfer - methods of electric heating - resistance heating - arc furnaces - induction heating - dielectric heating - electric welding – types - resistance welding - arc welding - power supply for arc welding - radiation welding.                                                                                                                                    |                                                                                                                                           |        |        |          |        |
| Experiential Learning (Activity Based Learning): Modeling of Resistance Heating System-Create MATLAB/Simulink circuit to simulate heating coil power dissipation.                                                                                                                                                                                                                                                                      |                                                                                                                                           |        |        |          |        |
| Industrial Application : Dielectric and Induction Heating-Plastic and Wood Processing                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                           |        |        |          |        |
| Content Beyond Syllabus : Automation in Welding (Robotic Welding Systems)                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                           |        |        |          |        |



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|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                       |                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>Unit IV ENERGY CONSERVATION AND ITS IMPORTANCE</b>                                                                                                                                                                                                                                                                                           |                                                                                                                                                       | <b>9</b>          |
| Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor)                                                                          |                                                                                                                                                       |                   |
| Experiential Learning (Activity Based Learning): Simulation of Three-Phase Circuit with and without Capacitor Bank (Power Factor Controller) and also calculate Active and Reactive Power<br>Industrial Application: Energy management systems (EMS) and smart metering.<br>Content Beyond Syllabus: Smart Grid and IoT-based Energy Monitoring |                                                                                                                                                       |                   |
| <b>UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY</b>                                                                                                                                                                                                                                                                                         |                                                                                                                                                       | <b>9</b>          |
| House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.                                                                                                   |                                                                                                                                                       |                   |
| Experiential Learning (Activity Based Learning): To Simulation of offline UPS<br>Industrial Application: House wiring and lighting systems<br>Content Beyond Syllabus: IoT and AI-Based Load Monitoring                                                                                                                                         |                                                                                                                                                       |                   |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                       | <b>45 Periods</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                       |                   |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                    |                                                                                                                                                       |                   |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                      | Analyze electric drive systems and traction motors, and evaluate their performance for industrial and railway applications.                           |                   |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                      | Design and demonstrate illumination systems using different light sources and assess their energy efficiency.                                         |                   |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                      | Apply principles of electric heating and welding to model and implement industrial heating and welding processes.                                     |                   |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                      | Implement and assess energy conservation techniques, including power factor correction, in three-phase electrical systems.                            |                   |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                      | Construct and test domestic electrical systems and UPS operations, and analyze power quality under nonlinear and domestic load conditions.            |                   |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                       |                   |
| 1                                                                                                                                                                                                                                                                                                                                               | N.V. Suryanarayana, “Utilisation of Electric Power”, Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.            |                   |
| 2                                                                                                                                                                                                                                                                                                                                               | J.B.Gupta, “Utilisation Electric power and Electric Traction”, S.K.Kataria and sons, 2000.                                                            |                   |
| 3                                                                                                                                                                                                                                                                                                                                               | G.D.Rai,”Non-Conventional Energy sources”, Khanna publications Ltd., New Delhi 1998.                                                                  |                   |
| 4                                                                                                                                                                                                                                                                                                                                               | D.P.Kothari, K.C.Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, 3rd Edition 2022.         |                   |
| 5                                                                                                                                                                                                                                                                                                                                               | Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy conservation and Management by Akshay A pujara1st edition, June 2018. |                   |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                       |                   |
| 1                                                                                                                                                                                                                                                                                                                                               | R.K.Rajput, Utilisation of Electric Power, Laxmi publications 2nd Edition 2016.                                                                       |                   |
| 2                                                                                                                                                                                                                                                                                                                                               | H.Partab, Art and Science of Utilisation of Electrical Energy”, Edition, Dhanpat Rai and Co., New Delhi-2004.                                         |                   |
| 3                                                                                                                                                                                                                                                                                                                                               | C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age international Pvt.Ltd., 3rd Edition, 2015 January.               |                   |

| <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b><br><b>Programme Outcomes (POs) and Programme Specific Outcomes</b><br><b>PSOs'</b> |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                                                | PO1                                                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| <b>CO1</b>                                                                                                                                                                                     | 3                                                                                                                 | 3   | 2   | 1   | -   | 1   | 1.5 | -   | -   | -    | -    | 3    | -    | -    |
| <b>CO2</b>                                                                                                                                                                                     | 2                                                                                                                 | 1   | 3   | -   | -   | -   | 1.5 | -   | -   | -    | -    | 3    | -    | -    |
| <b>CO3</b>                                                                                                                                                                                     | 3                                                                                                                 | 2   | 2   | -   | -   | 1   | 1.5 | -   | -   | -    | -    | 3    | -    | -    |
| <b>CO4</b>                                                                                                                                                                                     | 1                                                                                                                 | 2   | 3   | -   | -   | -   | 1.5 | -   | -   | -    | -    | 3    | -    | -    |
| <b>CO5</b>                                                                                                                                                                                     | 1                                                                                                                 | 1   | 3   | -   | -   | 1   | 1.5 | -   | -   | -    | -    | 3    | 3    | 2    |
| <b>CO6</b>                                                                                                                                                                                     | 3                                                                                                                 | 3   | 3   | -   | -   |     | 1.5 | -   | -   | -    | -    | 3    | 3    | 3    |
| <b>AVG</b>                                                                                                                                                                                     | 2.2                                                                                                               | 2   | 2.6 | 1   | -   | 1   | 1.5 | -   | -   | -    | -    | 3    | 3    | 2.5  |
| <b>Product Based Outcomes</b>                                                                                                                                                                  |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of the course, the student will be able to                                                                                                                                          |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                              | Identify real-world power quality issues                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                              | Design and prototype functional models                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                              | Integrate control algorithms, sensors, and power electronic converters                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                              | Demonstrate innovative applications such as smart monitoring, AI-based PQ prediction, or IoT-enabled PQ analytics |     |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>Product Based Projects ( in Team)</b>                                                                                                                                                       |                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                              | Smart LED Illumination Control System                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                              | Automated Street Lighting System with Energy Analytics                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                              | Temperature-Controlled Induction Heating System                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                                              | Automated Arc Welding Power Supply with Safety Monitoring                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                                              | Smart Energy Conservation Analyzer (Power Factor + Load Study)                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                                              | IoT-Based Smart Energy Meter with Analytics                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                                              | Smart Home Electrical Safety & Monitoring System                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                                                              | Online/Offline UPS Design with Automatic Load Shifting                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                                                                                                                                              | AI-Enabled Smart Home Energy Hub                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                                                                                                                                             | Human-Centric Lighting System (Circadian Rhythm Control)                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24EEP12                                                                                                                                                                                                                                                                                                                                                                                                                                                                | HVDC & FACTS                                                                    | L | T | P         | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---|---|-----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                 | 2 | 0 | 2         | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                 |   |   |           |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Explain and analyze reactive power compensation and HVDC transmission concepts. |   |   |           |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Design and study SVC and TCSC for voltage and reactive power control.           |   |   |           |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Apply VSC-based FACTS devices for power flow and stability improvement.         |   |   |           |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Analyze LCC-HVDC operation and power flow control.                              |   |   |           |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Model and implement VSC-HVDC systems for four-quadrant power control.           |   |   |           |   |
| <b>UNIT I INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                 |   |   | <b>12</b> |   |
| Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, , Types of HVDC transmission System.                                                                                                                                                                                                      |                                                                                 |   |   |           |   |
| <b>Lab Component:</b><br>1. Simulation of FC+TSR connected to IEEE 5 bus system<br><br>Experiential Learning (Activity Based Learning): Simulation of uncompensated vs compensated transmission line using MATLAB/Simulink to observe voltage profile and reactive power flow.<br>Industrial Application: Reactive power planning in EHV/UHV transmission networks.<br>Content Beyond Syllabus: Digital substations and AI-assisted planning of transmission corridors. |                                                                                 |   |   |           |   |
| <b>UNIT II STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC)</b>                                                                                                                                                                                                                                                                                                                                                                          |                                                                                 |   |   | <b>12</b> |   |
| VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC– Different modes of operation, Applications.                                                                                                                                                    |                                                                                 |   |   |           |   |
| <b>Lab Component:</b><br>1. Realization of reactive power, support by SVC in open loop and closed loop control in simulation.<br><br>Experiential Learning (Activity Based Learning): MATLAB simulation of SVC voltage control under load variation.<br>Industrial Application: Voltage stabilization in weak grids and industrial power systems.<br>Content Beyond Syllabus: Role of SVC/TCSC in smart grids.                                                          |                                                                                 |   |   |           |   |
| <b>UNIT III VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS</b>                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                 |   |   | <b>12</b> |   |
| Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability –, UPFC – Operation Principle Applications.                                                                                                                                    |                                                                                 |   |   |           |   |
| <b>Lab Component:</b><br>1. Regulation of line flows employing TCSC and TSSC in closed loop control in simulation<br><br>Experiential Learning (Activity Based Learning): Simulation of STATCOM V–I characteristics under sag and swell conditions.<br>Industrial Application: Power quality improvement in renewable-rich grids.<br>Content Beyond Syllabus: Cyber-physical security challenges in FACTS controllers.                                                  |                                                                                 |   |   |           |   |





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|                                                                                                                                                                                                                                    |                                                                                                                                                            |                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>UNIT IV LINE COMMUTATED HVDC TRASMISSION</b>                                                                                                                                                                                    |                                                                                                                                                            | <b>12</b>         |
| Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit, Basic concept of HVDC transmission. Modes of operations and control of power flow, CC and CIA mode of operation. |                                                                                                                                                            |                   |
| <b>Lab Component:</b>                                                                                                                                                                                                              |                                                                                                                                                            |                   |
| 1. Simulation of two terminal HVDC Link, closed loop control in CC and CIA mode in simulation.                                                                                                                                     |                                                                                                                                                            |                   |
| Experiential Learning (Activity Based Learning): MATLAB simulation of Graetz bridge rectifier and inverter operation.                                                                                                              |                                                                                                                                                            |                   |
| Industrial Application: Power exchange between regional grids.                                                                                                                                                                     |                                                                                                                                                            |                   |
| Content Beyond Syllabus: Hybrid LCC–VSC HVDC systems.                                                                                                                                                                              |                                                                                                                                                            |                   |
| <b>UNIT V VSC BASED HVDC TRANSMISSION</b>                                                                                                                                                                                          |                                                                                                                                                            | <b>12</b>         |
| Basic 2 level IGBT inverter operation- 4 Quadrant operation- phase angle control- dq Control- Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system.                                                     |                                                                                                                                                            |                   |
| <b>Lab Component:</b>                                                                                                                                                                                                              |                                                                                                                                                            |                   |
| 1. Realization of four quadrant operation of VSC in open loop mode in simulation.                                                                                                                                                  |                                                                                                                                                            |                   |
| Experiential Learning (Activity Based Learning): Simulation of dq control of VSC-HVDC for independent P–Q control.                                                                                                                 |                                                                                                                                                            |                   |
| Industrial Application: Offshore wind power evacuation.                                                                                                                                                                            |                                                                                                                                                            |                   |
| Content Beyond Syllabus: Role of AI in HVDC control and monitoring.                                                                                                                                                                |                                                                                                                                                            |                   |
| <b>TOTAL</b>                                                                                                                                                                                                                       |                                                                                                                                                            | <b>60 Periods</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                             |                                                                                                                                                            |                   |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                       |                                                                                                                                                            |                   |
| <b>CO1</b>                                                                                                                                                                                                                         | Analyze voltage profile and reactive power flow in compensated and uncompensated transmission lines.                                                       |                   |
| <b>CO2</b>                                                                                                                                                                                                                         | Design and evaluate SVC and TCSC for voltage regulation and reactive power support.                                                                        |                   |
| <b>CO3</b>                                                                                                                                                                                                                         | Apply and interpret STATCOM, SSSC and UPFC to enhance power transfer and system stability.                                                                 |                   |
| <b>CO4</b>                                                                                                                                                                                                                         | Implement and analyze LCC-HVDC systems under CC and CIA control modes.                                                                                     |                   |
| <b>CO5</b>                                                                                                                                                                                                                         | Execute and validate VSC-HVDC control for independent real and reactive power control.                                                                     |                   |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                  |                                                                                                                                                            |                   |
| 1                                                                                                                                                                                                                                  | R.Mohan Mathur, Rajiv K.Varma,“Thyristor–Based Facts Controllers for Electrical Transmission Systems”, IEEE press andJohnWiley&Sons, Inc,2002.             |                   |
| 2                                                                                                                                                                                                                                  | Narain G.Hingorani,“Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi-110006,2011. |                   |
| <b>REFERENCES</b>                                                                                                                                                                                                                  |                                                                                                                                                            |                   |
| 1                                                                                                                                                                                                                                  | K.R.Padiyar,“FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.                    |                   |
| 2                                                                                                                                                                                                                                  | A.T.John,“FlexibleA.C.TransmissionSystems”, Institution of Electrical and Electronic Engineers (IEEE), 1999.                                               |                   |
| 3                                                                                                                                                                                                                                  | V. K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004, KluwerAcademic Publishers,2004.                        |                   |



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| CO/PO, PSO Mapping                                                      |                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO                                                                   | PO1                                                                                                         | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 2    | 3    | 1    |
| CO2                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 3    | 3    | 2    |
| CO3                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 2    | 3    | 2    |
| CO4                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 2    | 3    | 3    |
| CO5                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 3    | 3    | 3    |
| AVG                                                                     | 3                                                                                                           | 2   | 2   | 2   | 1   | 1   | -   | 2   | 2   | -    | 1    | 2.4  | 3    | 2.2  |
| Product Based Outcomes                                                  |                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Design and simulate FACTS controllers for voltage and stability improvement.                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Analyze HVDC transmission systems for efficient long-distance power transfer.                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Develop control strategies for LCC and VSC based HVDC systems.                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | Apply dq control concepts for independent real and reactive power control.                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Evaluate real-world transmission problems and propose FACTS/HVDC based solutions.                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product Based Projects ( in Team)                                       |                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Mini Hardware Demonstration Model of a Low-Voltage HVDC Link Using Digilent Platform                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | FACTS vs HVDC Decision Matrix for Power Utilities Using PowerWorld Simulator                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | AI-Assisted Adaptive Control of STATCOM for Dynamic Voltage Regulation                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | A Technical Survey on Future Trends in HVDC and FACTS with PSCAD-Based Illustrative Case Studies            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Four-Quadrant Operation of VSC-HVDC for Renewable Energy Integration Using PSCAD                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                       | Design and Simulation of SVC for Voltage Regulation in EHV Transmission Systems using Power world Simulator |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                       | Reactive Power Compensation Using TCSC for Power Flow Enhancement Power World Simulator                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                       | STATCOM Based Voltage Sag and Swell Mitigation for Industrial Loads                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                       | UPFC Based Congestion Management in Interconnected Power Networks                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                      | Performance Analysis of Firing Angle and Commutation Overlap in LCC-HVDC Systems                            |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24EEP13                                                                                                                                                                                                                                                                                                                                                                                        | APPLICATION OF ARTIFICIAL INTELLIGENCE TO<br>POWER SYSTEM                                                           | L | T | P        | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---|---|----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                     | 3 | 0 | 0        | 3 |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                     |   |   |          |   |
| <b>To apply integrated AI tools for decision-making in modern power systems.</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                     |   |   |          |   |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                        | To introduce neuron models, learning paradigms, and ANN architectures used in artificial intelligence applications. |   |   |          |   |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                        | To develop understanding of advanced ANN models and training algorithms for classification and clustering tasks.    |   |   |          |   |
| <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                        | To impart knowledge of fuzzy sets, inference mechanisms, and fuzzy rule-based decision systems.                     |   |   |          |   |
| <b>4</b>                                                                                                                                                                                                                                                                                                                                                                                        | To explain evolutionary optimization techniques and genetic operators for solving engineering problems.             |   |   |          |   |
| <b>5</b>                                                                                                                                                                                                                                                                                                                                                                                        | To expose students to AI-based techniques for power system analysis, control, and forecasting applications.         |   |   |          |   |
| <b>UNIT I ARTIFICIAL NEURAL NETWORKS</b>                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                     |   |   | <b>9</b> |   |
| Introduction Models of Neuron Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks–Learning process – Error correction learning – Hebbian learning– Competitive learning – Boltzmann learning –Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks.                                                               |                                                                                                                     |   |   |          |   |
| Experiential learning :Implement or build a Single Neuron Model (Perceptron)<br>Industrial Application: Network architectures- Fault detection & classification in transmission lines<br>Content beyond syllabus: Modern Deep Learning Extensions -Comparison of classical ANN vs Deep Neural Networks.                                                                                         |                                                                                                                     |   |   |          |   |
| <b>UNIT II ANN Paradigms</b>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                     |   |   | <b>9</b> |   |
| Multi – layer perceptron using Back propagation Algorithm (BPA) – Self – Organizing Map (SOM) – Radial Basis Function Network – Functional Link Network (FLN) – Hopfield Network.                                                                                                                                                                                                               |                                                                                                                     |   |   |          |   |
| Experiential learning: Build an MLP using Back propagation (Python/MATLAB)- design a 3-layer MLP.<br>Industrial Application: SOM -Customer segmentation & tariff design, demand pattern analysis<br>Content beyond Syllabus: Deep MLPs with modern optimizers (Adam, RMS Prop).                                                                                                                 |                                                                                                                     |   |   |          |   |
| <b>UNIT III FUZZY LOGIC</b>                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                     |   |   | <b>9</b> |   |
| Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy Cartesian Product – operations on Fuzzy relations – Fuzzy-logic – Fuzzy Quantifiers–Fuzzy Inference – Fuzzy Rule based system–Defuzzification methods.                                                                                                     |                                                                                                                     |   |   |          |   |
| Experiential learning: Perform fuzzy union, intersection, and complement on sample sets using spreadsheets.<br>Industrial Application: Washing machines using fuzzy logic to adjust water usage based on dirtiness level.<br>Content beyond Syllabus: Fuzzy equivalence relations and fuzzy clustering.                                                                                         |                                                                                                                     |   |   |          |   |
| <b>UNIT IV GENETIC ALGORITHMS</b>                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                     |   |   | <b>9</b> |   |
| Introduction–Encoding – Fitness Function–Reproduction operators–Genetic Modeling – Genetic operators–Cross over – Single site cross over – Two point cross over – Multi point cross over – Uniform cross over – Matrix cross over–Cross over Rate –Inversion & Deletion – Mutation operator– Mutation – Mutation Rate–Bit–wise operators –Generational cycle – convergence of Genetic Algorithm |                                                                                                                     |   |   |          |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Experiential learning : Students solve the “guess the number” or “string matching” problem using a simple GA.</p> <p>Industrial Application: Manufacturing: evolving configurations for robotics arms.</p> <p>Content Beyond Syllabus: Steady-state vs. generational reproduction models.</p>                                                                                                                                                                                                                                                                                              |                                                                                                                                                |
| <b>UNIT V APPLICATIONS OF AI TECHNIQUES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>9</b>                                                                                                                                       |
| <p>Load forecasting – Load flow studies – Economic load dispatch – Load frequency control – Single area system and two area system – Small Signal Stability (Dynamic stability) Reactive power control –speed control of DC and AC Motors.</p> <p>Experiential learning : Implement short-term load forecasting using Python with datasets from regional utilities (e.g., hourly load vs. temperature).</p> <p>Industrial Application: Real-time forecasting in AMR/AMI-based smart meters for load management.</p> <p>Content Beyond Syllabus: Edge AI forecasting in IoT-enabled grids.</p> |                                                                                                                                                |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>45 Periods</b>                                                                                                                              |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Explain and implement basic neuron models and learning rules, and compare classical ANN with deep learning architectures.                      |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Design and implement a multi-layer perceptron using backpropagation and analyze the performance of ANN paradigms such as SOM and RBF networks. |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Construct and evaluate a fuzzy inference system using fuzzy sets, rules, and defuzzification techniques.                                       |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Apply genetic algorithm operators to solve optimization problems and analyze convergence characteristics.                                      |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Implement and evaluate AI-based models for power system applications such as load forecasting and control.                                     |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P. Kundur, Power System Stability & Control, McGraw Hill.                                                                                      |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ali Abur & Antonio Gomez Exposito, Power System State Estimation: Theory & Implementation, Marcel Dekker.                                      |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw-Hill.<br>(Additional references listed in the source document.)           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, 2007.                          |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Joseph Yiu , 'The Definitive Guide to the ARM Cortex-M0' Newnes – Elsevier, 2011.                                                              |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Kenneth Ayala, "The 8051 Microcontroller", Cengage Learning India, 2007, 3rd Edition.                                                          |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Programming With STM32: Getting Started With the Nucleo Board and C/C++                                                                        |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | S.Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, NewDelhi, 2003.                                            |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011                                                                 |

| CO/PO, PSO Mapping                                                      |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                         | PO1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 3                                                                                                                                                               | 2   | 1   | 1   | 1   | 0   | 0   | 0   | 1   | 0    | 1    | 2    | 3    | 1    |
| CO2                                                                     | 3                                                                                                                                                               | 3   | 3   | 2   | 2   | 0   | 0   | 0   | 1   | 0    | 2    | 3    | 3    | 2    |
| CO3                                                                     | 2                                                                                                                                                               | 2   | 2   | 2   | 1   | 0   | 0   | 0   | 1   | 0    | 1    | 2    | 3    | 2    |
| CO4                                                                     | 3                                                                                                                                                               | 3   | 3   | 3   | 2   | 0   | 0   | 0   | 1   | 0    | 2    | 2    | 3    | 3    |
| CO5                                                                     | 3                                                                                                                                                               | 3   | 3   | 2   | 2   | 0   | 0   | 0   | 2   | 1    | 3    | 3    | 3    | 3    |
| Product based outcomes                                                  |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Identify a real-time power system problem, collect relevant datasets                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Design and implement an ANN/Fuzzy/GA model for forecasting, control, or optimization                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Simulate their product model using MATLAB/Python and evaluate performance using measurable metrics                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | Integrate AI algorithms with hardware or virtual systems (microcontrollers, sensors, inverters, smart meters) and demonstrate functional prototype performance. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Demonstrate quantifiable improvement                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product based Projects ( in Team)                                       |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | ANN-Based Transformer Health Monitoring System                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | AI-based Solar Power Output Predictor (ANN Forecasting Device)                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Fuzzy Logic-Based Smart Washing Machine Controller                                                                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | ANN-Based Short-Term Load Forecasting for Smart Meters (AMI Systems)                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Intelligent Load Forecasting System for Micro-Grids                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                       | Fuzzy Logic-Based Smart Inverter (Reactive Power Controller)                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                       | Fuzzy-Based Speed Controller for DC/AC Motor                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                       | ANN-Based Transmission Line Fault Detection & Classification System                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                       | GA-Based Optimal Placement of Renewable Generators (Microgrid Planner)                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                      | AI-Based Solar Power Forecasting Module for Rooftop PV Plants                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24EEP14                                                                                                                                                                                                                                                                                                                                                                                                                                 | POWER QUALITY                                                                                                       | L | T         | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---|-----------|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                     | 2 | 0         | 2 | 3 |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                     |   |           |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                     |   |           |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduce the concepts of electric power quality, disturbances, standards, and industrial power quality issues.     |   |           |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                        | Develop understanding of single-phase and three-phase system behavior under linear and non-linear load conditions.  |   |           |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                        | Provide knowledge of harmonic mitigation techniques using passive and active filtering methods.                     |   |           |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                        | Impart understanding of load compensation principles using DSTATCOM for power quality improvement.                  |   |           |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduce series compensation devices for voltage regulation and power quality enhancement in distribution systems. |   |           |   |   |
| <b>UNIT 1 INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                     |   | <b>12</b> |   |   |
| Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards |                                                                                                                     |   |           |   |   |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                     |   |           |   |   |
| 1. Harmonic analysis of single-phase power converters (Semi converters and Full Converters) with R and RL load via simulation                                                                                                                                                                                                                                                                                                            |                                                                                                                     |   |           |   |   |
| <a href="#">Experiential Learning: Case studies on real-world power quality issues in local industries or substations.</a>                                                                                                                                                                                                                                                                                                               |                                                                                                                     |   |           |   |   |
| <a href="#">Content Beyond Syllabus: Smart Grid impact on power quality.</a>                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                     |   |           |   |   |
| <a href="#">Industrial Application: Power quality audits in industries.</a>                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                     |   |           |   |   |
| <b>UNIT 2 ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM</b>                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                     |   | <b>12</b> |   |   |
| Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.                                                                            |                                                                                                                     |   |           |   |   |
| <b>Lab Component :</b>                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                     |   |           |   |   |
| 1. Harmonic analysis of three phase power converters (Semi converters and Full Converters) with R and RL load via simulation                                                                                                                                                                                                                                                                                                             |                                                                                                                     |   |           |   |   |
| <a href="#">Experiential Learning: Simulation of balanced and unbalanced loads using PSCAD.</a>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                     |   |           |   |   |
| <a href="#">Content Beyond Syllabus: Impact of renewable energy sources on power balance..</a>                                                                                                                                                                                                                                                                                                                                           |                                                                                                                     |   |           |   |   |
| <a href="#">Industrial Application: Energy auditing and load balancing in industrial plants.</a>                                                                                                                                                                                                                                                                                                                                         |                                                                                                                     |   |           |   |   |
| <b>UNIT 3 MITIGATION OF POWER SYSTEM HARMONICS</b>                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                     |   | <b>12</b> |   |   |
| Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.                                                                                                         |                                                                                                                     |   |           |   |   |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                     |   |           |   |   |
| 1. Mitigation of Harmonics using Tuned Filter via simulation                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                     |   |           |   |   |
| <a href="#">Experiential Learning: Digital Twin–Based Voltage Sag and Swell Analysis in Distribution Systems Using PSCAD</a>                                                                                                                                                                                                                                                                                                             |                                                                                                                     |   |           |   |   |
| <a href="#">Content Beyond Syllabus: Comparison of passive vs active filters in modern grids.</a>                                                                                                                                                                                                                                                                                                                                        |                                                                                                                     |   |           |   |   |
| <a href="#">Industrial Application: Design of filters for solar PV inverter-based systems.</a>                                                                                                                                                                                                                                                                                                                                           |                                                                                                                     |   |           |   |   |



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|                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                               |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>UNIT 4 LOAD COMPENSATION USING DSTATCOM</b>                                                                                                                                                                                                                                                                                       |                                                                                                                                                                               | <b>12</b> |
| Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode. |                                                                                                                                                                               |           |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                               |           |
| 1. Harmonic analysis of single-phase inverters with R and RL load via simulation.                                                                                                                                                                                                                                                    |                                                                                                                                                                               |           |
| Experiential Learning: Simulate DSTATCOM operation for different load conditions.<br>Content Beyond Syllabus: Role of FACTS devices in smart distribution systems.<br>Industrial Application: Grid-support functions in microgrids and smart grids.                                                                                  |                                                                                                                                                                               |           |
| <b>UNIT 5 SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM</b>                                                                                                                                                                                                                                                                       |                                                                                                                                                                               | <b>12</b> |
| Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.                                                                                                                                                                               |                                                                                                                                                                               |           |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                               |           |
| 1. Harmonic analysis of three phase inverters with R and RL load via simulation.                                                                                                                                                                                                                                                     |                                                                                                                                                                               |           |
| Experiential Learning: Simulate DVR operation under various fault scenarios.<br>Content Beyond Syllabus: Integration of DVR with battery storage and renewable sources.<br>Industrial Application: Power quality enhancement in EV charging stations.                                                                                |                                                                                                                                                                               |           |
| <b>TOTAL Periods</b>                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                               | <b>60</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                               |           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                         |                                                                                                                                                                               |           |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                           | Analyze electric power quality disturbances and assess compliance with power quality standards using simulation and case studies.                                             |           |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                           | Evaluate single-phase and three-phase systems supplying linear and non-linear loads and evaluate power factor and harmonic performance using simulation tools.                |           |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                           | Design and execute harmonic mitigation techniques using passive and active filters through simulation studies.                                                                |           |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                           | Implement and analyze DSTATCOM-based load compensation techniques using instantaneous power theories to improve power quality under unbalanced and nonlinear load conditions. |           |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                           | Examine and demonstrate series compensation devices such as DVR and UPQC to enhance voltage quality in power distribution systems.                                            |           |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                               |           |
| 1                                                                                                                                                                                                                                                                                                                                    | Arindam Ghosh and Gerard Ledwich “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, First Edition, 2002                                      |           |
| 2                                                                                                                                                                                                                                                                                                                                    | G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, Second Edition, 2011.                                                                                    |           |
| 3                                                                                                                                                                                                                                                                                                                                    | George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019.                                  |           |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                               |           |
| 1                                                                                                                                                                                                                                                                                                                                    | R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.                                                                               |           |
| 2                                                                                                                                                                                                                                                                                                                                    | Arrillga “Power System Harmonics”, John Wiely and Sons, 2003 2nd Edition.                                                                                                     |           |
| 3                                                                                                                                                                                                                                                                                                                                    | Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition                                                                   |           |



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## CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 2    |
| CO2   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 2    |
| CO3   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 2    |
| CO4   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 3    |
| CO5   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 3    |
| AVG   | 3   | 3   | 3   | 3   | –   | –   | 3   | 3   | –   | 3    | 3    | 3    | 3    | 2.4  |

## Product based outcomes

At the end of the course, the student will be able to

|   |                                                 |
|---|-------------------------------------------------|
| 1 | Analyze and Interpret Real-Time Electrical Data |
| 2 | Implement Control & Mitigation Techniques       |
| 3 | Validate System Performance Using Standards     |
| 4 | Design & Develop Power Quality Solutions        |
| 5 | Communicate Engineering Solutions Effectively   |

## Product based Projects (Team)

|    |                                                   |
|----|---------------------------------------------------|
| 1  | Smart Power Quality Analyzer Device (IoT-Enabled) |
| 2  | AI-Based Power Quality Classification System      |
| 3  | DSTATCOM Controller (Hardware or FPGA-based)      |
| 4  | Smart Load Balancing Device for Industrial Panels |
| 5  | Home Harmonic Suppressor Plug-In Device           |
| 6  | Real-Time Power Quality Dashboard for Industries  |
| 7  | Solar Inverter Harmonic Analysis & Mitigation Kit |
| 8  | Voltage Flicker Measurement Device                |
| 9  | Plug-and-Play DSTATCOM for Home/Small Offices     |
| 10 | AI Digital Twin for Power Quality Prediction      |





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| U24EEP15                                                                                                                                                                                                                                                                   | SMART GRID                                                                                                                                 | L | T | P | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                            |                                                                                                                                            | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                          |                                                                                                                                            |   |   |   |   |
| To help students understand and use smart grid technologies for improving the efficiency, reliability, and automation of modern power systems.                                                                                                                             |                                                                                                                                            |   |   |   |   |
| 1                                                                                                                                                                                                                                                                          | To introduce the evolution of energy systems and develop understanding of smart grid concepts, architectures, initiatives, and microgrids. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                          | To familiarize students with smart metering technologies, AMI architecture, communication standards, and real-time monitoring systems.     |   |   |   |   |
| 3                                                                                                                                                                                                                                                                          | To provide knowledge of smart grid technologies used in transmission systems including automation, monitoring, protection, and control.    |   |   |   |   |
| 4                                                                                                                                                                                                                                                                          | To impart understanding of smart distribution technologies, electric vehicles, and advanced distribution management systems.               |   |   |   |   |
| 5                                                                                                                                                                                                                                                                          | To expose students to high-performance computing, communication networks, IoT, big data, and cybersecurity aspects of smart grids.         |   |   |   |   |
| UNIT I INTRODUCTION                                                                                                                                                                                                                                                        |                                                                                                                                            |   |   | 9 |   |
| Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Microgrid, National and International Initiatives in Smart Grid. |                                                                                                                                            |   |   |   |   |
| Experiential learning: Create a timeline chart of energy system evolution from conventional to renewable-integrated systems.                                                                                                                                               |                                                                                                                                            |   |   |   |   |
| Industrial Application: Renewable Energy Integration by utilities like TATA Power and NTPC Green Energy.                                                                                                                                                                   |                                                                                                                                            |   |   |   |   |
| Content beyond syllabus: Digital twin concept for grid simulation.                                                                                                                                                                                                         |                                                                                                                                            |   |   |   |   |
| UNIT II SMART METERING                                                                                                                                                                                                                                                     |                                                                                                                                            |   |   | 9 |   |
| Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).                                                     |                                                                                                                                            |   |   |   |   |
| Experiential learning: Perform a Smart Meter-to-Cloud data simulation using Arduino + ESP8266.                                                                                                                                                                             |                                                                                                                                            |   |   |   |   |
| Industrial Application: Smart billing and load forecasting tools used by DISCOMs.                                                                                                                                                                                          |                                                                                                                                            |   |   |   |   |
| Content beyond Syllabus: Smart prepaid meters integrated with mobile payments (FinTech + EnergyTech).                                                                                                                                                                      |                                                                                                                                            |   |   |   |   |
| UNIT III SMART GRID TECHNOLOGIES (Transmission)                                                                                                                                                                                                                            |                                                                                                                                            |   |   | 9 |   |
| Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.                                                                                          |                                                                                                                                            |   |   |   |   |
| Experiential learning: Simulate Wide Area Monitoring Systems (WAMS) using MATLAB                                                                                                                                                                                           |                                                                                                                                            |   |   |   |   |
| Industrial Application: Substation automation systems implemented by ABB, Siemens, GE.                                                                                                                                                                                     |                                                                                                                                            |   |   |   |   |
| Content beyond Syllabus: AI-based fault detection and predictive maintenance.                                                                                                                                                                                              |                                                                                                                                            |   |   |   |   |
| UNIT IV SMART GRID TECHNOLOGIES (Distribution)                                                                                                                                                                                                                             |                                                                                                                                            |   |   | 9 |   |
| DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.                                                                                  |                                                                                                                                            |   |   |   |   |





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Experiential learning: Develop a home energy management system (HEMS) prototype using sensors.

Industrial Application: EV charging networks – Tata Power EZ Charge, Fortum India.

Content Beyond Syllabus: Vehicle-to-grid (V2G) integration.

|                                                                                                                                                                                                                                                                                |                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS</b>                                                                                                                                                                                                           | <b>9</b>          |
| Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid |                   |
| Experiential learning: Create a simulation of IoT-based grid monitoring (Raspberry Pi + Node-RED). Industrial Application: Big Data and IoT applications in renewable forecasting.<br>Content Beyond Syllabus: Edge-AI for local control and predictive operations.            |                   |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                   | <b>45 Periods</b> |

## Course Outcomes

At the end of the course, the student will be able to

|            |                                                                                                                                                                    |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Explain and analyze the evolution of energy systems and smart grid structures, functions, and challenges with reference to national and international initiatives. |
| <b>CO2</b> | Analyze smart metering and AMI systems, including communication protocols and real-time data management for smart grid applications.                               |
| <b>CO3</b> | Apply smart transmission technologies such as WAMS, EMS, and substation automation for monitoring, protection, and control of power systems.                       |
| <b>CO4</b> | Evaluate smart distribution technologies including DMS, Volt/VAr control, EV integration, and outage management systems.                                           |
| <b>CO5</b> | Examine the role of high-performance computing, IoT, big data, and cybersecurity in enabling reliable and intelligent smart grid operations.                       |

## TEXT BOOKS

|          |                                                                                                                                                |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase, CRC, 2018.                                          |
| <b>2</b> | Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", John Wiley, 2012 |
| <b>3</b> | James Momoh, Smart Grid Fundamentals of Design and Analysis, IEEE press 2012                                                                   |

## REFERENCES

|          |                                                                                                                                                                                                                                     |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018.                                                                                                                            |
| <b>2</b> | C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011. doi: 10.1109/TII.2011.2166794.                        |
| <b>3</b> | X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944-980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087. |
| <b>4</b> | Stuart Borlase "Smart Grid: Infrastructure, Technology and Solutions", CRC Press 2012.                                                                                                                                              |

## CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes  
PSOs'

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | 2   | 2   | 1   | 1   | 1   | 2   | –   | –   | 1   | –    | 1    | 3    | 2    | 1    |
| CO2   | 2   | 2   | 2   | 1   | 2   | 2   | –   | –   | 1   | –    | 1    | 3    | 2    | 2    |
| CO3   | 2   | 2   | 2   | 2   | 3   | 1   | –   | –   | 1   | –    | 1    | 3    | 3    | 2    |
| CO4   | 2   | 2   | 2   | 2   | 2   | 2   | –   | –   | 1   | –    | 1    | 3    | 2    | 2    |
| CO5   | 2   | 3   | 3   | 3   | 3   | 2   | –   | –   | 1   | –    | 2    | 3    | 3    | 3    |
| AVG   | 2   | 2.2 | 2   | 1.8 | 2.2 | 1.8 | –   | –   | 1   | –    | 1.2  | 3    | 2.4  | 2    |

## Product based outcomes

|   |                                                                                                           |
|---|-----------------------------------------------------------------------------------------------------------|
| 1 | To Design simple smart-grid-based electrical products that improve monitoring and control.                |
| 2 | To Create small working prototypes using AMI, smart meters, and basic communication systems.              |
| 3 | To Build mini systems that show smart transmission functions like monitoring, protection, and automation. |
| 4 | To Develop simple distribution-level smart solutions for outage reduction and voltage control.            |
| 5 | To Use computing and network technologies to make small applications for smart grid data handling.        |

### Product based Projects ( in Team)

|    |                                       |
|----|---------------------------------------|
| 1  | Mini Microgrid Model                  |
| 2  | Wi-Fi Based Smart Energy Meter        |
| 3  | Prepaid Energy Meter                  |
| 4  | Real-Time Billing System              |
| 5  | PMU-Based Grid Frequency Monitor      |
| 6  | Automatic Fault Detection & Isolation |
| 7  | EV Fast Charging Station Mini-Model   |
| 8  | Smart Transformer Health Monitor      |
| 9  | Peak Hour Demand Controller           |
| 10 | Renewable Energy Auto-Shifter         |



# Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University,  
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| U24EEP16                                                                                                                                                                                                                                                                                                                                                                                                                                 | POWER SYSTEM TRANSIENTS                                                                                                                  | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                          | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                          |   |   |   |   |
| To understand the generation, propagation, and impact of power system voltage transients due to switching operations, lightning, travelling waves, and fault conditions, and the methods used for their control.                                                                                                                                                                                                                         |                                                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                        | To introduce students to various sources of transients, RLC circuit behavior, and grounding techniques for power systems.                |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                        | To develop understanding of switching transients, their causes, and suppression methods in power systems.                                |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                        | To explain lightning phenomena, protective measures, and line design considerations to minimize transient effects.                       |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                        | To provide knowledge of traveling waves, transient computation techniques, and EMTP-based analysis of transmission lines.                |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                        | To impart understanding of voltage transients in integrated power systems, including fault-induced over voltages and system restoration. |   |   |   |   |
| UNIT I INTRODUCTION AND SURVEY                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                          |   |   | 9 |   |
| Sources of different types of transients - RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients - study of transients in system planning - Importance of grounding.                                                                                                                                                                                             |                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Identify real-life sources of transients in nearby substations and industries.</a>                                                                                                                                                                                                                                                                                          |                                                                                                                                          |   |   |   |   |
| <a href="#">Industrial Application: Grounding design in substations and power plants.</a>                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                          |   |   |   |   |
| <a href="#">Content Beyond Syllabus: Role of digital substations in transient monitoring.</a>                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| UNIT II SWITCHING TRANSIENTS                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                          |   |   | 9 |   |
| Basic concept of switching transients - resistance switching and equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression – current chopping - effective equivalent circuit - capacitance switching with a restrike, with multiple restrikes - ferro resonance. |                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Case study on ferro-resonance in distribution transformers.</a>                                                                                                                                                                                                                                                                                                             |                                                                                                                                          |   |   |   |   |
| <a href="#">Industrial Application: Capacitor bank switching in industries and utilities.</a>                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| <a href="#">Content Beyond Syllabus: IEC standards related to switching overvoltages.</a>                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                          |   |   |   |   |
| UNIT III LIGHTNING TRANSIENTS                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                          |   |   | 9 |   |
| Theories of cloud formation - mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires - tower footing resistance - Interaction between lightning and power system.                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Comparison of shielding methods for transmission lines.</a>                                                                                                                                                                                                                                                                                                                 |                                                                                                                                          |   |   |   |   |
| <a href="#">Industrial Application: Tower footing resistance improvement in EHV systems.</a>                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                          |   |   |   |   |
| <a href="#">Content Beyond Syllabus: Impact of climate change on lightning frequency.</a>                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                          |   |   |   |   |
| UNIT IV TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                          |   |   | 9 |   |
| Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely’s lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves. Computation of over voltages using EMTP.                                                                                                            |                                                                                                                                          |   |   |   |   |



# Meenakshi Sundararajan Engineering College

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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Experiential Learning (Activity Based Learning): Manual computation of overvoltages in simple transmission lines.<br/>Industrial Application: Fault location in transmission lines using travelling wave principles.<br/>Content Beyond Syllabus: Travelling wave-based protection schemes.</p>                                                                                                                                                                                                                                                                                               |                                                                                                                                                    |
| <b>UNIT V TRANSIENTS IN INTEGRATED POWER SYSTEM</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>9</b>                                                                                                                                           |
| <p>The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - overvoltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.</p> <p>Experiential Learning (Activity Based Learning): Analyze voltage transients due to load rejection and reclosing.<br/>Industrial Application: System restoration after faults and blackouts.<br/>Content Beyond Syllabus: Use of AI for transient detection and analysis.</p> |                                                                                                                                                    |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>45 Periods</b>                                                                                                                                  |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                    |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                    |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Analyze sources of electrical transients and evaluate grounding practices in power systems.                                                        |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Evaluate switching transients in power systems and implement suppression techniques for capacitor and load switching.                              |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Explain lightning transient mechanisms and evaluate protection strategies such as grounding and shielding in transmission lines.                   |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Compute transient responses of transmission lines using traveling wave concepts, Bewely's lattice diagram, and EMTP simulations.                   |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Examine voltage transients in integrated power systems and apply transient computation methods to support system restoration and fault mitigation. |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2 <sup>nd</sup> Edition, 1991.                           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009                                  |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, Second Edition, 2010. |
| <b>REFERENCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, 6th Edition, 2020.                                                         |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | R.D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.                                                     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Y.Hase, Handbook of Power System Engineering," Wiley India, 2012.                                                                                  |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | J.L.Kirtley, "Electric Power Principles, Sources, Conversion, Distribution and use," Wiley, 2012.                                                  |

| CO/PO, PSO Mapping                                                      |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                         | PO1                                                                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 3                                                                                                | 2   | 1   | 1   | 1   | –   | –   | 2   | –   | –    | –    | 3    | 2    | 1    |
| CO2                                                                     | 3                                                                                                | 2   | 2   | 2   | 1   | –   | –   | 2   | –   | –    | –    | 3    | 2    | 1    |
| CO3                                                                     | 3                                                                                                | 2   | 2   | 1   | 1   | –   | –   | 2   | –   | –    | –    | 3    | 2    | 1    |
| CO4                                                                     | 3                                                                                                | 3   | 2   | 2   | 2   | –   | –   | 2   | –   | –    | –    | 3    | 3    | 2    |
| CO5                                                                     | 3                                                                                                | 2   | 2   | 2   | 3   | –   | –   | 2   | –   | –    | –    | 3    | 2    | 3    |
| AVG                                                                     | 3                                                                                                | 2.2 | 1.8 | 1.6 | 1.6 | –   | –   | 2   | –   | –    | –    | 3    | 2.2  | 1.6  |
|                                                                         |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product Based Outcomes                                                  |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Identify and classify power system transients occurring due to switching, lightning, and faults. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Compute voltage and current transients in lumped and distributed power system models.            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Analyze travelling wave phenomena including reflection and refraction in transmission lines.     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | Assess overvoltage impacts on integrated power systems and grounding schemes.                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Develop practical reference artifacts for transient mitigation and system protection.            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product Based Projects ( in Team)                                       |                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Switching Transients Equivalent Circuit Compilation                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Lightning Protection Design File for Transmission Lines                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Overvoltage Mitigation Decision Matrix                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | Equivalent Circuit Chart for Switching Transients                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                       | Lightning Stroke and Surge Path Diagram                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                       | Grounding Importance and Methods Poster                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                       | Overvoltage Causes vs Protection Table                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                       | Fault-Induced Voltage Transients Flowchart                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                       | Travelling Waves Reflection–Refraction Sketch Book                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                      | Circuit Breaker Switching Transient Illustration                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |



**Meenakshi Sundararajan Engineering College**  
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Department: Electrical and Electronics Engineering, R2024, CBCS

**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

**VERTICAL II : CONVERTERS AND DRIVES**

| SI. NO. | COURSE CODE | COURSE TITLE                                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                |          |     | L                | T | P |         |
| 1       | U24EEP21    | ANALYSIS OF ELECTRICAL MACHINES                | PEC      | 4   | 2                | 0 | 2 | 3       |
| 2       | U24EEP22    | SPECIAL ELECTRICAL MACHINES                    | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP23    | MULTILEVEL POWER CONVERTER CIRCUITS            | PEC      | 4   | 2                | 0 | 2 | 3       |
| 4       | U24EEP24    | ELECTRICAL DRIVES                              | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP25    | POWER ELECTRONICS FOR RENEWABLE ENERGY SOURCES | PEC      | 4   | 2                | 0 | 2 | 3       |
| 6       | U24EEP26    | CONTROL OF POWER ELECTRONIC CIRCUITS           | PEC      | 4   | 2                | 0 | 2 | 3       |



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| U24EEP21                                                                                                                                                                                                                                                                                   | ANALYSIS OF ELECTRICAL MACHINES                                                                        | L | T | P  | C |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                                            |                                                                                                        | 2 | 0 | 2  | 3 |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                   |                                                                                                        |   |   |    |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                |                                                                                                        |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                          | Analyze and model brushed DC motors using state-space equations for shunt, series, and compound types. |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                          | Apply and understand reference frame theory for transforming machine variables.                        |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                          | Analyze three-phase induction machines under load and no-load conditions.                              |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                          | Model and evaluate synchronous machines using rotor reference frame and d-q equations.                 |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                          | Analyze multiphase machines for high-reliability industrial and aerospace applications.                |   |   |    |   |
| <b>UNIT 1 MODELING OF BRUSHED-DC ELECTRIC MACHINERY</b>                                                                                                                                                                                                                                    |                                                                                                        |   |   | 18 |   |
| Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound.                                           |                                                                                                        |   |   |    |   |
| <b>Lab Component :</b>                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |    |   |
| 1. Modeling of DC machines.                                                                                                                                                                                                                                                                |                                                                                                        |   |   |    |   |
| 2. Simulation under no-load and loaded conditions for a PMDC motor                                                                                                                                                                                                                         |                                                                                                        |   |   |    |   |
| 3. Simulation of smooth starting for DC motor.                                                                                                                                                                                                                                             |                                                                                                        |   |   |    |   |
| Experiential Learning (Activity Based Learning): MATLAB/Simulink Modeling of Shunt, Series & Compound DC Motors using State-Space Equations                                                                                                                                                |                                                                                                        |   |   |    |   |
| Industrial Application : DC Motors in Automotive Systems (Wipers, Power Steering, Blowers)                                                                                                                                                                                                 |                                                                                                        |   |   |    |   |
| Content Beyond Syllabus : Nonlinear Modeling: Saturation, Friction, Brush Voltage Drop                                                                                                                                                                                                     |                                                                                                        |   |   |    |   |
| <b>UNIT 2 REFERENCE FRAME THEORY</b>                                                                                                                                                                                                                                                       |                                                                                                        |   |   | 9  |   |
| Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame.                                                                                                                                     |                                                                                                        |   |   |    |   |
| Experiential Learning (Activity Based Learning): abc → dq Transformation Demo with Real-Time Visualization in MATLAB                                                                                                                                                                       |                                                                                                        |   |   |    |   |
| Industrial Application : High-Performance Motor Drives in Electric Vehicles                                                                                                                                                                                                                |                                                                                                        |   |   |    |   |
| Content Beyond Syllabus : Field-Oriented Control (FOC) using Park and Clarke Transformations                                                                                                                                                                                               |                                                                                                        |   |   |    |   |
| <b>UNIT 3 INDUCTION MACHINES</b>                                                                                                                                                                                                                                                           |                                                                                                        |   |   | 12 |   |
| Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no-load and load conditions- Machine variable form, arbitrary reference variable form |                                                                                                        |   |   |    |   |
| <b>Lab Component :</b>                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |    |   |
| 1. Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form.                                                                                                                                         |                                                                                                        |   |   |    |   |





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Experiential Learning (Activity Based Learning): Dynamic Simulation of Induction Motor under No-Load and Load Using dq Model

Industrial Application : Industrial Pump & Conveyor Drives (Major Real World Application)

Content Beyond Syllabus : Sensorless Vector Control of Induction Motors.

**UNIT 4 SYNCHRONOUS MACHINES**

12

Three phase synchronous machine - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations).

**Lab Component :**

1. Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.

Experiential Learning (Activity Based Learning): Simulation of Synchronous Machine Using Park's Equations (d-q Model)

Industrial Application : PMSM Traction Drives in Electric Vehicles

Content Beyond Syllabus : Introduction to Permanent Magnet Synchronous Machines (PMSMs)

**UNIT 5 MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS**

9

Preliminary Remarks - Necessity of Multiphase Machines - Evolution of Multiphase Machines - Advantages of Multiphase Machines - Working Principle - Multiphase Induction Machine, Multiphase Synchronous Machine - Modeling of 'n' phase machine. Applications of Multiphase Machines

Experiential Learning (Activity Based Learning): Modeling and Simulation of a Five-Phase Machine and Its Torque Ripple Analysis

Industrial Application : Aerospace & Naval Systems Using Multiphase Drives (High Reliability)

Content Beyond Syllabus : Fault-Tolerant Control Strategies for Multiphase Motors

**TOTAL 60 Periods**

**Course Outcomes**

At the end of the course, students should be able to

|            |                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Model and evaluate brushed DC motors under no-load, load, and startup conditions                         |
| <b>CO2</b> | Apply and implement $abc \rightarrow dq$ transformations for motor control and reference frame analysis. |
| <b>CO3</b> | Investigate and assess induction motor performance in machine and arbitrary reference frames             |
| <b>CO4</b> | Develop and examine synchronous machine performance using Park's d-q equations.                          |
| <b>CO5</b> | Examine and assess multiphase machines and evaluate torque ripple and fault-tolerant strategies.         |

**TEXT BOOKS**



**Meenakshi Sundararajan Engineering College**  
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**Department: Electrical and Electronics Engineering, R2024, CBCS**

|          |                                                                                                                  |
|----------|------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7 <sup>th</sup> Edition, 2020. |
| <b>2</b> | R.Ramanujam, Modeling and Analysis of Electrical Machines, I.K. International Publishing House Pvt. Ltd, 2018.   |

**REFERENCES**

|          |                                                                                                                                                                   |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley, 2021, 1st Edition |
| <b>2</b> | Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.      |
| <b>3</b> | Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.     |
| <b>4</b> | R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2015, 1st Edition.                                          |
| <b>5</b> | Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997, 1st Edition.                                                            |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/<br>PO | PO1         | PO2        | PO3         | PO4         | PO5      | PO6         | PO7      | PO8         | PO9        | PO10     | PO11     | PSO<br>1    | PSO<br>2   | PSO<br>3    |
|-----------|-------------|------------|-------------|-------------|----------|-------------|----------|-------------|------------|----------|----------|-------------|------------|-------------|
| CO1       | 3           | 2          | 2           | 1           | 1        | 1           | -        | 2           | -          | -        | -        | 3           | 3          | 1           |
| CO2       | 3           | 3          | 2           | 1           | 1        | 1           | -        | 2           | -          | -        | -        | 2           | 3          | 1           |
| CO3       | 3           | 3          | 2           | 2           | 1        | 1           | -        | 2           | 1          | -        | -        | 3           | 3          | 2           |
| CO4       | 2           | 2          | 1           | 1           | 1        | -           | -        | 1           | -          | -        | -        | 2           | 1          | 3           |
| CO5       | 3           | 2          | 2           | 1           | 1        | -           | -        | 2           | 1          | -        | -        | 3           | 2          | 3           |
| CO6       | 3           | 3          | 2           | 2           | 1        | 1           | -        | 2           | 1          | -        | -        | 3           | 3          | 3           |
| AVG       | <b>2.83</b> | <b>2.5</b> | <b>1.83</b> | <b>1.33</b> | <b>1</b> | <b>0.67</b> | <b>-</b> | <b>1.83</b> | <b>0.5</b> | <b>-</b> | <b>-</b> | <b>2.67</b> | <b>2.5</b> | <b>2.17</b> |

**Product based outcome**

|          |                                                                                                                  |
|----------|------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Analyze and evaluate the performance of electrical machines under different operating conditions.                |
| <b>2</b> | Demonstrate real-time behavior and control of DC, induction, synchronous, and multiphase machines.               |
| <b>3</b> | Apply reference frame theory and dq transformations to study machine dynamics.                                   |
| <b>4</b> | Monitor, predict, and assess health and faults of electrical machines.                                           |
| <b>5</b> | Simulate and emulate machine operation in practical systems such as microgrids and electric vehicle powertrains. |

**Product based Projects (in team)**

|          |                                     |
|----------|-------------------------------------|
| <b>1</b> | Smart DC Motor performance analyzer |
|----------|-------------------------------------|



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|    |                                                                       |
|----|-----------------------------------------------------------------------|
| 2  | Automated DC Motor classification & fault detector                    |
| 3  | dq visualizer: Real-time dq-Transformation learning tool              |
| 4  | Smart Vector control demo kit (induction motor)                       |
| 5  | Portable induction motor condition monitoring device                  |
| 6  | Induction motor digital twin for load prediction                      |
| 7  | Synchronous Generator health analyzer                                 |
| 8  | Microgrid simulator using synchronous generator model                 |
| 9  | Multiphase motor demonstration kit (5-phase/6-phase)                  |
| 10 | Electric Vehicle powertrain emulator (DC + Induction + PMSM co-model) |



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| U24EEP22                                                                                                                                                                                                                                                                                                                                                                        | SPECIAL ELECTRICAL MACHINES                                                                                                       | L | T         | P | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|---|-----------|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                   | 2 | 0         | 2 | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                         |                                                                                                                                   |   |           |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                               | Understand the construction, operation, and control of stepper motors for precision drive applications.                           |   |           |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                               | Understand the working principles, control strategies, and sensorless operation of SRM drives                                     |   |           |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                               | Illustrate BLDC motor operation, performance characteristics, and control methods.                                                |   |           |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                               | Demonstrate PMSM operation, torque-speed behavior, and control strategies for electric vehicle applications.                      |   |           |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                               | Illustrate the principles and characteristics of other special electrical machines like hysteresis, AC series, and linear motors. |   |           |   |   |
| <b>UNIT I STEPPER MOTORS</b>                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                   |   | <b>12</b> |   |   |
| Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications.                                                                                                                                                                                            |                                                                                                                                   |   |           |   |   |
| <b>Lab Component :</b><br>1. Simulation of Stepper motor                                                                                                                                                                                                                                                                                                                        |                                                                                                                                   |   |           |   |   |
| Experiential Learning (Activity Based Learning): Simulate or experimentally plot torque-speed and torque current characteristics of a DC motor using MATLAB/Simulink<br>Industrial Application: Servo motors with closed loop control for robotic arms in assembly lines.<br>Content Beyond Syllabus: Study of regenerative braking and energy recovery in motor drive systems. |                                                                                                                                   |   |           |   |   |
| <b>UNIT II SWITCHED RELUCTANCE MOTORS</b>                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                   |   | <b>12</b> |   |   |
| Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation –applications.                |                                                                                                                                   |   |           |   |   |
| <b>Lab Component :</b><br>1. Simulation of SRM motor                                                                                                                                                                                                                                                                                                                            |                                                                                                                                   |   |           |   |   |
| Experiential Learning (Activity Based Learning): Simulate SRM torque–speed characteristics using finite element tools<br>Industrial Application : Industrial pumps and wind energy converters<br>Content Beyond Syllabus : Experiment: Advanced power converter topologies for SRM drives                                                                                       |                                                                                                                                   |   |           |   |   |
| <b>UNIT III PERMANENT MAGNET BRUSHLESS DC MOTORS</b>                                                                                                                                                                                                                                                                                                                            |                                                                                                                                   |   | <b>12</b> |   |   |
| Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.                                                                                                                                            |                                                                                                                                   |   |           |   |   |
| <b>Lab Component :</b><br>1. Simulation of BLDC motor                                                                                                                                                                                                                                                                                                                           |                                                                                                                                   |   |           |   |   |
| Experiential Learning (Activity Based Learning): Current Controller Design for PM Motor using MATLAB/Simulink.<br>Industrial Application : Automotive fuel pumps and power steering systems<br>Content Beyond Syllabus : Field-oriented control (FOC) of BLDC motors                                                                                                            |                                                                                                                                   |   |           |   |   |
| <b>Unit IV PERMANENT MAGNET SYNCHROUNOUS MOTORS</b>                                                                                                                                                                                                                                                                                                                             |                                                                                                                                   |   | <b>12</b> |   |   |



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Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics –evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor.

**Lab Component :**

1. Simulation of PMSM motor

Experiential Learning (Activity Based Learning): Design of PI based current controller for PMSM using MATLAB/Simulink

Industrial Application : Electric and hybrid vehicles (traction drive)

Content Beyond Syllabus : PMSM efficiency optimization in EV propulsion

**UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES**

**12**

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

**Lab Component :**

1. Simulation of any other special machines

Experiential Learning (Activity Based Learning): Develop an animation/simulation of linear vs. rotary motor operation.

Industrial Application : Hysteresis motor – precision instruments, timing devices

Content Beyond Syllabus : Smart motor control using embedded systems and IoT

**TOTAL 60 Periods**

**Course Outcomes**

**At the end of the course, the student will be able to**

- |            |                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Examine stepper motor construction, torque-speed characteristics, and closed-loop drive circuits.       |
| <b>CO2</b> | Design SRM controllers and evaluate torque-speed performance for industrial applications                |
| <b>CO3</b> | Optimize BLDC motor controllers for speed and current regulation and validate system performance.       |
| <b>CO4</b> | Characterize PMSM performance and assess controllers for traction applications.                         |
| <b>CO5</b> | Investigate and verify the operation, characteristics, and applications of special electrical machines. |

**TEXT BOOKS**

- |   |                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------|
| 1 | T.J.E. Miller, 'Brushless magnet and Reluctance motor drives', Clarendon press, London, second edition, 1993            |
| 2 | R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017 |

**REFERENCES**

- |   |                                                                                                                                             |
|---|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.                  |
| 2 | Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008. |
| 3 | Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009                  |
| 4 | T.Kenjo, 'Stepping motors and their microprocessor controls', Oxford University press, New Delhi, 2000 Dekker 2009                          |



| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
|                                                                                                                                                                 | PO1                                                                                                                  | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                             | 3                                                                                                                    | 3   | 2   | 2   | 1   | 2   | -   | 2   | -   | -    | -    | 3    | 3    | 2    |  |
| CO2                                                                                                                                                             | 3                                                                                                                    | 3   | 2   | 2   | 1   | 3   | -   | 2   | -   | -    | -    | 2    | 3    | 2    |  |
| CO3                                                                                                                                                             | 3                                                                                                                    | 3   | 2   | 2   | 1   | 2   | -   | 2   | -   | -    | -    | 3    | 3    | 2    |  |
| CO4                                                                                                                                                             | 2                                                                                                                    | 2   | 1   | 1   | 1   | 1   | -   | 1   | -   | -    | -    | 2    | 2    | 2    |  |
| CO5                                                                                                                                                             | 3                                                                                                                    | 3   | 2   | 2   | 1   | 2   | -   | 2   | -   | -    | -    | 3    | 3    | 3    |  |
| AVG                                                                                                                                                             | 2.8                                                                                                                  | 2.8 | 1.8 | 1.8 | 1   | 2   | -   | 1.8 | -   | -    | -    | 2.6  | 2.8  | 2.2  |  |
|                                                                                                                                                                 |                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| Product Based Outcomes                                                                                                                                          |                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                               | Model and simulate stepper, SRM, BLDC, and PMSM motors for performance evaluation.                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                               | Design and implement speed and current controllers for special machines using MATLAB/Simulink.                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                               | Analyze torque-speed and dynamic behavior of various special machines under different load conditions.               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                               | Demonstrate real-time or virtual operation of special electrical machines in practical applications.                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                               | Evaluate and optimize machine performance for industrial, automotive, and automation systems.                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                                                                 |                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| Product Based Projects ( in Team)                                                                                                                               |                                                                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                               | Stepper Motor Performance Analyzer – Simulate and analyze torque-speed characteristics and closed-loop operation.    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                               | Switched Reluctance Motor Drive Simulator – Model SRM and implement sensorless control strategies.                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                               | BLDC Motor Speed Control Demo Kit – Design and simulate a closed-loop BLDC motor speed controller.                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                               | PMSM Torque-Speed Visualization Tool – Model PMSM and simulate field-oriented control (FOC) strategies.              |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                               | Special Machine Comparative Analysis Tool – Compare stepper, SRM, BLDC, and PMSM performance in MATLAB/Simulink.     |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 6                                                                                                                                                               | Industrial Application Demo – Simulate a motor-driven industrial system (e.g., pumps or conveyor) using SRM or BLDC. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 7                                                                                                                                                               | Electric Vehicle Traction Drive Emulator – Co-model BLDC + PMSM for EV powertrain simulation.                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 8                                                                                                                                                               | Hysteresis and Linear Motor Simulation – Demonstrate operation and characteristics of other special machines.        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 9                                                                                                                                                               | Smart Controller for Special Machines – Implement current/speed control with MATLAB/Simulink for any special motor.  |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 10                                                                                                                                                              | IoT-Based Motor Monitoring Prototype – Monitor motor parameters like speed, current, and torque in real time.        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |



|                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |   |   |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
| U24EEP23                                                                                                                                                                                                                                                                                                                                                                                               | MULTILEVEL POWER CONVERTER CIRCUITS                                                                                                          | L | T | P  | C |
|                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              | 2 | 0 | 2  | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                |                                                                                                                                              |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                      | Explain and analyze multilevel inverter topologies and PWM techniques.                                                                       |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                      | Analyze and compare cascaded H-bridge multilevel inverter configurations and modulation schemes.                                             |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                      | Analyze and evaluate diode-clamped multilevel converters and voltage balancing methods.                                                      |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                      | Analyze and evaluate flying-capacitor multilevel converters with emphasis on modulation techniques and dynamic voltage-balancing mechanisms. |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                      | Assess reduced-switch-count multilevel converter topologies with focus on operating principles and structural features.                      |   |   |    |   |
| UNIT I MULTILEVEL TOPOLOGIES                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                              |   |   | 12 |   |
| Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.                                                                                                                                                                                                                       |                                                                                                                                              |   |   |    |   |
| <b>Lab Component :</b><br>1. Simulation of Fixed PWM, Sinusoidal PWM for an Multilevel inverter.                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |   |   |    |   |
| <a href="#">Experiential Learning (Activity Based Learning): Topology Selection for Real-Time Application</a><br><a href="#">Industrial Application : Grid-tied solar inverter systems</a><br><a href="#">Content Beyond Syllabus : Advanced modulation techniques for asymmetric MLI</a>                                                                                                              |                                                                                                                                              |   |   |    |   |
| UNIT II CASCADED H-BRIDGE MULTILEVEL INVERTERS                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                              |   |   | 12 |   |
| Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes- Staircase Modulation |                                                                                                                                              |   |   |    |   |
| <b>Lab Component :</b><br>1. Simulation of H bridge inverter with R load .                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |   |   |    |   |
| <a href="#">Experiential Learning (Activity Based Learning): harmonic analysis and modulation study of CHB inverter.</a><br><a href="#">Industrial Application : Medium-voltage drives, EV traction drives</a><br><a href="#">Content Beyond Syllabus : Staircase modulation, Phase/Level-shifted PWM comparison</a>                                                                                   |                                                                                                                                              |   |   |    |   |
| UNIT III DIODE CLAMPED MULTILEVEL CONVERTER                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                              |   |   | 12 |   |
| Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters –Performance results.                                                                                                                                                                                   |                                                                                                                                              |   |   |    |   |
| <b>Lab Component :</b><br>1. Simulation of three level diode clamped MLI with R load.                                                                                                                                                                                                                                                                                                                  |                                                                                                                                              |   |   |    |   |
| <a href="#">Experiential Learning (Activity Based Learning) : investigate voltage balancing and performance of diode clamped inverter.</a><br><a href="#">Industrial Application : Renewable energy systems, industrial motor drives</a><br><a href="#">Content Beyond Syllabus : Voltage balancing strategies, dynamic modeling of DCMC converters</a>                                                |                                                                                                                                              |   |   |    |   |





|                                                                                                                                           |                                                                                                                                                                           |                   |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>Unit IV FLYING CAPACITOR MULTILEVEL CONVERTER</b>                                                                                      |                                                                                                                                                                           | <b>12</b>         |
| Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltagebalance of FCMC.                               |                                                                                                                                                                           |                   |
| <b>Lab Component :</b>                                                                                                                    |                                                                                                                                                                           |                   |
| 1. Simulation of three level capacitor clamped MLI with R load                                                                            |                                                                                                                                                                           |                   |
| Experiential Learning (Activity Based Learning) analyze capacitor voltage balancing and switching strategy.                               |                                                                                                                                                                           |                   |
| Industrial Application : STATCOM, FACTS devices                                                                                           |                                                                                                                                                                           |                   |
| Content Beyond Syllabus : Advanced voltage balancing and capacitor optimization                                                           |                                                                                                                                                                           |                   |
| <b>UNIT V MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT</b>                                                                              |                                                                                                                                                                           | <b>12</b>         |
| Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.                                |                                                                                                                                                                           |                   |
| <b>Lab Component :</b>                                                                                                                    |                                                                                                                                                                           |                   |
| 1. Simulation of MLI with reduced switch configuration.                                                                                   |                                                                                                                                                                           |                   |
| Experiential Learning (Activity Based Learning): Develop switching sequence and pulse generation method for reduced switch configuration. |                                                                                                                                                                           |                   |
| Industrial Application : Low-cost renewable energy converters, EV converters                                                              |                                                                                                                                                                           |                   |
| Content Beyond Syllabus : Topology optimization, control methods for switch minimization                                                  |                                                                                                                                                                           |                   |
| <b>TOTAL</b>                                                                                                                              |                                                                                                                                                                           | <b>60 Periods</b> |
| <b>Course Outcomes</b>                                                                                                                    |                                                                                                                                                                           |                   |
| <b>At the end of the course, the student will be able to</b>                                                                              |                                                                                                                                                                           |                   |
| <b>CO1</b>                                                                                                                                | Apply and analyze fixed and sinusoidal PWM techniques for multilevel inverters.                                                                                           |                   |
| <b>CO2</b>                                                                                                                                | Design and compare cascaded H-bridge inverters using unipolar and bipolar PWM schemes.                                                                                    |                   |
| <b>CO3</b>                                                                                                                                | Evaluate diode-clamped multilevel converters for voltage balance and performance.                                                                                         |                   |
| <b>CO4</b>                                                                                                                                | Examine and develop flying capacitor multilevel converters with dynamic voltage balancing behavior.                                                                       |                   |
| <b>CO5</b>                                                                                                                                | Validate flying capacitor multilevel converters with dynamic voltage balancing performance.                                                                               |                   |
| <b>TEXT BOOKS</b>                                                                                                                         |                                                                                                                                                                           |                   |
|                                                                                                                                           |                                                                                                                                                                           |                   |
| 1                                                                                                                                         | Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4 <sup>th</sup> edition.                   |                   |
| 2                                                                                                                                         | Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,"Multilevel Convertersfor Industrial Applications", CRC Press, 22-Jul-2013, 20171 <sup>st</sup> Edition. |                   |
| 3                                                                                                                                         | BinWu, Mehdi Narimani,High Power Converters and AC drives by IEEE press 2017, 2 <sup>nd</sup> Edition.                                                                    |                   |
| <b>REFERENCES</b>                                                                                                                         |                                                                                                                                                                           |                   |
| 1                                                                                                                                         | Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1 <sup>st</sup> Edition.             |                   |
| 2                                                                                                                                         | Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1 <sup>st</sup> Edition.                                  |                   |
| 3                                                                                                                                         | Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1 <sup>st</sup> Edition.                                                            |                   |
| 4                                                                                                                                         | Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc,2021, 1 <sup>st</sup> Edition.                                               |                   |



|                                                                                                                                                                                      |                                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| 5                                                                                                                                                                                    | Iftekhhar Maswood, Dehghani Tafti, Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1 <sup>st</sup> Edition. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b><br><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b> |                                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                                                                                                                                      | PO1                                                                                                                                           | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                                                  | 3                                                                                                                                             | 3   | 2   | 2   | 1   | 1   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 2    |  |
| CO2                                                                                                                                                                                  | 3                                                                                                                                             | 3   | 2   | 2   | 1   | 2   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 2    |  |
| CO3                                                                                                                                                                                  | 3                                                                                                                                             | 2   | 2   | 2   | 1   | 2   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 2    |  |
| CO4                                                                                                                                                                                  | 3                                                                                                                                             | 3   | 2   | 2   | 1   | 2   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 2    |  |
| CO5                                                                                                                                                                                  | 3                                                                                                                                             | 3   | 2   | 2   | 1   | 2   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 2    |  |
| CO6                                                                                                                                                                                  | 3                                                                                                                                             | 3   | 2   | 2   | 1   | 3   | 0   | 2   | 0   | 0    | 0    | 3    | 3    | 3    |  |
| AVG                                                                                                                                                                                  | 3.0                                                                                                                                           | 2.8 | 2.0 | 2.0 | 1.0 | 2.0 | 0   | 2.0 | 0   | 0    | 0    | 3.0  | 3.0  | 2.2  |  |
| <b>Product Based Outcomes</b>                                                                                                                                                        |                                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                                                    | Model and simulate different multilevel inverter topologies with symmetric and asymmetric DC sources.                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                                                    | Design and implement PWM strategies for cascaded, diode-clamped, and flying-capacitor MLIs.                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                                                    | Analyze voltage balancing and switching performance of multilevel converters.                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                                                    | Evaluate reduced-switch multilevel inverter configurations for cost-effective power conversion.                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                                                    | Demonstrate the application of multilevel inverters in renewable energy and electric drive systems                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| <b>Product Based Projects ( in Team)</b>                                                                                                                                             |                                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                                                    | Three-Level Diode-Clamped Inverter Simulator                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                                                    | Three-Level Flying Capacitor Inverter Model                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                                                    | Cascaded H-Bridge Multilevel Inverter with PWM Control                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                                                    | Comparison Tool for Phase-Shifted and Level-Shifted PWM                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                                                    | Voltage Balancing Analyzer for Diode-Clamped MLI                                                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 6                                                                                                                                                                                    | Reduced Switch Count Multilevel Inverter Simulation                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 7                                                                                                                                                                                    | Grid-Connected Solar Inverter Using Multilevel Topology                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 8                                                                                                                                                                                    | EV Traction Inverter Using Cascaded H-Bridge MLI                                                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 9                                                                                                                                                                                    | THD and Harmonic Performance Analyzer for MLIs                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 10                                                                                                                                                                                   | Low-Cost Multilevel Inverter Design for Renewable Applications                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |



| U24EEP24                                                                                                                                                                                                                                                                                                                                                                                 | ELECTRICAL DRIVES                                                                          | L | T | P         | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---|---|-----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                            | 2 | 0 | 2         | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                  |                                                                                            |   |   |           |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                        | Analyze motor–load dynamics and drive characteristics for various industrial applications. |   |   |           |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                        | Analyze and evaluate converter and chopper fed DC motor drives in four-quadrant operation. |   |   |           |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                        | Analyze and design induction motor drives with V/f and voltage/current control strategies. |   |   |           |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                        | Analyze and simulate synchronous motor drives, including PMSM and V/f control.             |   |   |           |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                        | Design and evaluate current and speed controllers for closed-loop motor drives.            |   |   |           |   |
| <b>UNIT I DRIVE CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                                                                                      |                                                                                            |   |   | <b>9</b>  |   |
| Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.                                                                                                                                                                 |                                                                                            |   |   |           |   |
| <a href="#">Experiential Learning (Activity Based Learning): Analyze motor–load characteristics for fan, pump, traction and elevator loads using simulation tools.</a><br><a href="#">Industrial Application : Motor selection in elevators, conveyors, cranes, and rolling mills.</a><br><a href="#">Content Beyond Syllabus : Introduction to digital twins of motor–load systems.</a> |                                                                                            |   |   |           |   |
| <b>UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE</b>                                                                                                                                                                                                                                                                                                                                    |                                                                                            |   |   | <b>15</b> |   |
| Steady state analysis of the single and three phase converter fed separately excited DC motor drive – continuous and discontinuous conduction – Time ratio and current limit control – 4 quadrant operationof converter / chopper fed drive.                                                                                                                                             |                                                                                            |   |   |           |   |
| <b>Lab Component :</b><br><br>1. Simulation of converter and chopper fed DC drive                                                                                                                                                                                                                                                                                                        |                                                                                            |   |   |           |   |
| <a href="#">Experiential Learning (Activity Based Learning): Simulate 4-quadrant operation of chopper-fed DC drives and observe transient responses.</a><br><a href="#">Industrial Application : DC drives in electric traction, steel rolling mills, battery-powered vehicles.</a><br><a href="#">Content Beyond Syllabus : Regenerative braking and energy recovery in DC drives.</a>  |                                                                                            |   |   |           |   |
| <b>UNIT III INDUCTION MOTOR DRIVES</b>                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |   |   | <b>15</b> |   |
| Stator voltage control – energy efficient drive – v/f control – constant air gap flux – field weakening mode – voltage / current fed inverter – closed loop control.                                                                                                                                                                                                                     |                                                                                            |   |   |           |   |
| <b>Lab Component :</b><br><br>1.Simulation of closed loop operation of stator voltage control of induction motor drive<br>2. Simulation of closed loop operation of v/f control of induction motor drive                                                                                                                                                                                 |                                                                                            |   |   |           |   |
| <a href="#">Experiential Learning (Activity Based Learning) : Implement voltage source inverter and current source inverter fed motor drive.</a><br><a href="#">Industrial Application : Variable speed drives for pumps, compressors, HVAC systems. Content Beyond Syllabus : Introduction to vector control and energy-efficient drive strategies.</a>                                 |                                                                                            |   |   |           |   |
| <b>Unit IV SYNCHRONOUS MOTOR DRIVES</b>                                                                                                                                                                                                                                                                                                                                                  |                                                                                            |   |   | <b>12</b> |   |



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V/f control and self-control of synchronous motor: Margin angle control and power factor control – permanent magnet synchronous motor.

**Lab Component :**

1. Simulation of synchronous motor drive

Experiential Learning (Activity Based Learning): Simulate PMSM drive with self-control and analyze power factor variation.

Industrial Application : Electric vehicles, robotics, CNC machines, renewable energy systems.

Content Beyond Syllabus : Sensorless control techniques for PMSM drives.

|                                                |          |
|------------------------------------------------|----------|
| <b>UNIT V DESIGN OF CONTROLLERS FOR DRIVES</b> | <b>9</b> |
|------------------------------------------------|----------|

Transfer function for DC motor / load and converter – closed loop control with current and speed feedback – armature voltage control and field weakening mode – design of controllers; current controller and speed controller-converter selection and characteristics.

Experiential Learning (Activity Based Learning): Design and tune current and speed controllers for a closed-loop DC drive.

Industrial Application : Servo drives, precision motion control systems.

Content Beyond Syllabus : Intelligent controllers (PI tuning using AI/optimization techniques).

**TOTAL 60 Periods**

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                    |
|------------|----------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Analyze motor-load characteristics and select suitable motors for industrial drives.               |
| <b>CO2</b> | Simulate and evaluate converter/chopper fed DC drives under steady-state and transient conditions. |
| <b>CO3</b> | Design and simulate induction motor drives with closed-loop V/f and stator voltage control.        |
| <b>CO4</b> | Simulate and assess synchronous motor drives and PMSM performance with V/f and self-control.       |
| <b>CO5</b> | Design and tune current and speed controllers for DC and AC drives with feedback control.          |

**TEXT BOOKS**

|   |                                                                                                                  |
|---|------------------------------------------------------------------------------------------------------------------|
| 1 | Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2 <sup>nd</sup> Edition January 2010. |
| 2 | Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1 <sup>st</sup> Edition.           |

**REFERENCES**

|   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 1 | S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3 <sup>rd</sup> Edition 2012.                       |
| 2 | Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1 <sup>st</sup> Edition.             |
| 3 | Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey, 1989, 1 <sup>st</sup> Edition.        |
| 4 | R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1 <sup>st</sup> Edition. |



| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
|                                                                                                                                                                 | PO1                                                                                      | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                                                                                                             | 3                                                                                        | 2   | 1   | –   | –   | –   | –   | –   | –   | –    | –    | 2    | 1    | –    |  |
| CO2                                                                                                                                                             | 3                                                                                        | 3   | 2   | 1   | –   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |  |
| CO3                                                                                                                                                             | 3                                                                                        | 3   | 3   | 2   | 1   | –   | –   | –   | –   | –    | –    | 3    | 2    | –    |  |
| CO4                                                                                                                                                             | 2                                                                                        | 3   | 3   | 2   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | 1    |  |
| CO5                                                                                                                                                             | 2                                                                                        | 3   | 3   | 3   | 2   | –   | –   | –   | –   | –    | –    | 3    | 3    | 2    |  |
| AVG                                                                                                                                                             | 2.6                                                                                      | 2.8 | 2.4 | 1.6 | 1.0 | –   | –   | –   | –   | –    | –    | 2.6  | 2.2  | 0.6  |  |
| Product Based Outcomes                                                                                                                                          |                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                               | Ability to model and simulate DC and AC motor drive systems for industrial applications. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                               | Ability to analyze steady-state and transient performance of electrical drives.          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                               | Ability to design and tune current and speed controllers for closed-loop drives.         |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                               | Ability to select suitable motor-drive combinations for real-time load conditions.       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                               | Ability to develop simulation-based solutions for EV and automation drive systems.       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| Product Based Projects ( in Team)                                                                                                                               |                                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                                                                                                               | Smart DC Drive Performance Analyzer                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                                                                                                               | Four-Quadrant Chopper-Fed DC Drive Trainer Kit                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                                                                                                               | Energy-Efficient Induction Motor Drive using V/f Control                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                                                                                                               | Closed-Loop Speed Control of Induction Motor using PI Controller                         |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                                                                                                               | PMSM Drive Model for Electric Vehicle Applications                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 6                                                                                                                                                               | Digital Twin of DC Motor Drive System                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 7                                                                                                                                                               | Regenerative Braking System for DC Drives                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 8                                                                                                                                                               | Induction Motor Drive with Field Weakening Control                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 9                                                                                                                                                               | Controller Design Tool for Electrical Drives (GUI-based)                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 10                                                                                                                                                              | EV Traction Drive Emulator (DC + AC Drive Models)                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |



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|                                                                                                                                                                                                                                                                                                                                                    |                                                                                |   |   |           |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---|---|-----------|---|
| U24EEP25                                                                                                                                                                                                                                                                                                                                           | POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS                                 | L | T | P         | C |
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                | 2 | 0 | 2         | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                            |                                                                                |   |   |           |   |
| 1                                                                                                                                                                                                                                                                                                                                                  | Explain and assess renewable energy resources and their environmental impacts. |   |   |           |   |
| 2                                                                                                                                                                                                                                                                                                                                                  | Analyze power electronic converters used for solar and wind energy systems.    |   |   |           |   |
| 3                                                                                                                                                                                                                                                                                                                                                  | Analyze and design solar PV systems based on performance characteristics.      |   |   |           |   |
| 4                                                                                                                                                                                                                                                                                                                                                  | Evaluate wind energy conversion systems and generator configurations.          |   |   |           |   |
| 5                                                                                                                                                                                                                                                                                                                                                  | Analyze and integrate hybrid renewable energy systems with storage and MPPT.   |   |   |           |   |
| <b>UNIT 1 INTRODUCTION TO RENEWABLE ENERGY SYSTEMS</b>                                                                                                                                                                                                                                                                                             |                                                                                |   |   | <b>12</b> |   |
| Introduction- Impacts of renewable energy generation on the environment – GHG effect, Qualitative study of renewable energy resources: Ocean, Biomass, Geothermal, Hydrogen energy systems, Solar Photovoltaic (PV) system, Wind Energy system and Fuel cells-Operating Principles types, VI characteristics.                                      |                                                                                |   |   |           |   |
| <b>Lab Component :</b><br>1. Simulation on Modelling of fuel cell- V I Characteristics                                                                                                                                                                                                                                                             |                                                                                |   |   |           |   |
| Experiential Learning (Activity Based Learning): Case study on GHG Reduction Analysis<br>Industrial Application :Hydrogen used in fuel-cell vehicles<br>Content Beyond Syllabus : AI/ML for renewable forecasting                                                                                                                                  |                                                                                |   |   |           |   |
| <b>UNIT 2 POWER ELECTRONIC CONVERTERS FOR RENEWABLE ENERGY</b>                                                                                                                                                                                                                                                                                     |                                                                                |   |   | <b>12</b> |   |
| Solar: Line commutated converters (inversion mode) - Boost and buck-boost converters.<br>Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters- multi-source converter.                                                                                                |                                                                                |   |   |           |   |
| <b>Lab Component :</b><br>1. Simulation on Grid integration of RES.                                                                                                                                                                                                                                                                                |                                                                                |   |   |           |   |
| Experiential Learning (Activity Based Learning): Case Study on real converter designs from manufacturers<br>Industrial Application : Essential of Boost Converters in DC microgrids and rooftop inverters.<br>Content Beyond Syllabus : Z-source and quasi-Z-source inverters for wind and solar Energy                                            |                                                                                |   |   |           |   |
| <b>UNIT 3 SOLAR PHOTO VOLTAIC SYSTEMS</b>                                                                                                                                                                                                                                                                                                          |                                                                                |   |   | <b>12</b> |   |
| Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Standalone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing. |                                                                                |   |   |           |   |
| <b>Lab Component :</b><br>Simulation on modelling of Solar PV System- V I Characteristics<br>Experiential Learning (Activity Based Learning): PV System Sizing Project<br>Industrial Application : Smart inverters for grid support (VAR control, frequency support)<br>Content Beyond Syllabus : Advanced PV Cell Technologies                    |                                                                                |   |   |           |   |



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|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                 |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|----|
| UNIT 4 WIND ENERGY CONVERSION SYSTEMS                                                                                                                                                                                                                                                                                                                                        |                                                                                                                 | 15 |
| Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve and Operating area, Types of wind generators system based on Electrical Machines-Induction Generator and Permanent Magnet Synchronous Generator (PMSG), Grid Connected- Self-excited operation of Induction Generator and Variable Speed PMSG. |                                                                                                                 |    |
| Lab Component :                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                 |    |
| 1. Simulation of self- excited Induction Generator.<br>2. Simulation of DFIG/ PMSG based Wind turbine.                                                                                                                                                                                                                                                                       |                                                                                                                 |    |
| Experiential Learning (Activity Based Learning): Exercise on Wind Power Calculation.<br>Industrial Application : Grid Integration Practices<br>Content Beyond Syllabus : Cascaded H-Bridge for high power wind systems                                                                                                                                                       |                                                                                                                 |    |
| UNIT 5 HYBRID RENEWABLE ENERGY SYSTEMS                                                                                                                                                                                                                                                                                                                                       |                                                                                                                 | 9  |
| Energy Storage systems, Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-Diesel, Wind-PV, Maximum Power Point Tracking (MPPT) algorithms.                                                                                                                                                                                          |                                                                                                                 |    |
| Experiential Learning (Activity Based Learning): Simulation of Wind - PV hybrid System.<br>Industrial Application : Smart Grid With Battery Energy Storage Systems (BESS)<br>Content Beyond Syllabus : Fuzzy logic–based MPPT                                                                                                                                                |                                                                                                                 |    |
| TOTAL Periods                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                 | 60 |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                 |    |
| After completion the above subject, students will be able to                                                                                                                                                                                                                                                                                                                 |                                                                                                                 |    |
| CO1                                                                                                                                                                                                                                                                                                                                                                          | Investigate renewable energy systems and evaluate their environmental impacts.                                  |    |
| CO2                                                                                                                                                                                                                                                                                                                                                                          | Model and characterize power electronic converters for grid-connected RES.                                      |    |
| CO3                                                                                                                                                                                                                                                                                                                                                                          | Design and simulate solar PV systems under varying operating conditions.                                        |    |
| CO4                                                                                                                                                                                                                                                                                                                                                                          | Analyze and simulate wind energy conversion systems using different generators.                                 |    |
| CO5                                                                                                                                                                                                                                                                                                                                                                          | Simulate and validate hybrid renewable energy systems with MPPT techniques and storage.                         |    |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                 |    |
| 1                                                                                                                                                                                                                                                                                                                                                                            | Gray, L. Johnson, “Wind energy system”, prentice hall of india, 2 nd Edition, 2006.                             |    |
| 2                                                                                                                                                                                                                                                                                                                                                                            | Rai. G.D,” Solar energy utilization”, Khanna publishers, 5 th Edition, 2008.                                    |    |
| 3                                                                                                                                                                                                                                                                                                                                                                            | Rashid .M. H “Power electronics Hand book”, Academic press,2nd Edition, 2006 4 th Edition, 2017                 |    |
| REFERENCES                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                 |    |
| 1                                                                                                                                                                                                                                                                                                                                                                            | Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6 th Edition, 2017.                             |    |
| 2                                                                                                                                                                                                                                                                                                                                                                            | S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7 th impression. |    |
| 3                                                                                                                                                                                                                                                                                                                                                                            | H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Company, New Delhi, 2017, 3 rd Edition.   |    |





| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO/PO                                                                                                                                                           | PO1                                                                                                           | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 2                                                                                                             | 1   | –   | –   | –   | 2   | 3   | 2   | –   | 1    | 1    | 2    | 1    | –    |
| CO2                                                                                                                                                             | 3                                                                                                             | 3   | 2   | 2   | 3   | –   | 1   | –   | –   | 1    | –    | 3    | 2    | 2    |
| CO3                                                                                                                                                             | 3                                                                                                             | 3   | 3   | 2   | 3   | –   | 1   | –   | –   | 1    | –    | 3    | 3    | 2    |
| CO4                                                                                                                                                             | 3                                                                                                             | 2   | 2   | 2   | 2   | –   | 1   | –   | –   | 1    | –    | 3    | 2    | 2    |
| CO5                                                                                                                                                             | 3                                                                                                             | 2   | 3   | 2   | 3   | –   | 2   | –   | –   | 1    | –    | 3    | 3    | 3    |
| AVG                                                                                                                                                             | 2.8                                                                                                           | 2.2 | 2.0 | 1.6 | 2.2 | 0.4 | 1.6 | 0.4 | 0.0 | 1.0  | 0.2  | 2.8  | 2.2  | 1.8  |
| Product Based Outcomes                                                                                                                                          |                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                               | Design and develop a functional renewable energy product using appropriate power electronic converters.       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                               | Implement intelligent control and monitoring techniques to improve energy efficiency and system performance.  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                               | Integrate sensors, controllers, and communication modules for real-time energy monitoring and data analysis.  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                               | Demonstrate safe, reliable, and sustainable operation of renewable energy systems under practical conditions. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                               | Evaluate and optimize system performance based on efficiency, cost, and real-world application requirements.  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product Based Projects ( in Team)                                                                                                                               |                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                               | Smart Solar Charger with MPPT                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                               | IoT-Enabled Solar Power Monitor                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                               | Solar-Based Smart Street Lighting System                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                               | Portable Foldable Solar Power Bank                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                               | Low-Cost Portable Micro Wind Turbine                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                               | Hybrid Wind–Solar Rooftop Kit (Portable)                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                               | Smart Wind Turbine Efficiency Analyzer                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                               | Bidirectional DC–DC Converter for EV Charge/Discharge                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                                                                                                               | Smart Energy Meter for Renewable Homes                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                                                                                                              | AI-Based Solar Energy Forecasting Device                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24EEP26                                                                                                                                                                                                                                                                                                                                                                                      | CONTROL OF POWER ELECTRONIC CIRCUITS                                                                   | L | T | P         | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---|---|-----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                        | 2 | 0 | 2         | 3 |
| <b>Course Objectives</b><br>After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                       |                                                                                                        |   |   |           |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                             | Analyze and model transfer functions, pole-zero maps, and state-space systems in control applications. |   |   |           |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                             | Apply and manipulate symbolic calculations for solving control and power electronics equations.        |   |   |           |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                             | Analyze and design sliding-mode control (SMC) for DC-DC converters.                                    |   |   |           |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                             | Design and evaluate boost converter-based power factor correction (PFC) circuits.                      |   |   |           |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                             | Design and simulate advanced PFC circuits using C'uk, SEPIC, and bridgeless topologies.                |   |   |           |   |
| <b>UNIT 1 SIMULATION BASICS IN CONTROL SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                            |                                                                                                        |   |   | <b>12</b> |   |
| Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model. |                                                                                                        |   |   |           |   |
| <b>Lab Component :</b><br>1. Simulation exercises on zero, first and second order basic blocks.                                                                                                                                                                                                                                                                                               |                                                                                                        |   |   |           |   |
| Experiential Learning (Activity Based Learning): model and analyze dynamic control systems using MATLAB.                                                                                                                                                                                                                                                                                      |                                                                                                        |   |   |           |   |
| Industrial Application : Control analysis of SMPS, motor drives, and process control loops.                                                                                                                                                                                                                                                                                                   |                                                                                                        |   |   |           |   |
| Content Beyond Syllabus : Introduction to digital control and discretization of transfer functions.                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |           |   |
| <b>UNIT 2 SYMBOLIC CALCULATIONS</b>                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   | <b>12</b> |   |
| Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations                                                                                                                     |                                                                                                        |   |   |           |   |
| <b>Lab Component :</b><br>1. Simulation exercises based on symbolic calculations.                                                                                                                                                                                                                                                                                                             |                                                                                                        |   |   |           |   |
| Experiential Learning (Activity Based Learning): analytical modelling using MATLAB symbolic tools.                                                                                                                                                                                                                                                                                            |                                                                                                        |   |   |           |   |
| Industrial Application : Analytical modeling of converters and controllers in R&D                                                                                                                                                                                                                                                                                                             |                                                                                                        |   |   |           |   |
| Content Beyond Syllabus : Symbolic linearization of nonlinear power electronic systems.                                                                                                                                                                                                                                                                                                       |                                                                                                        |   |   |           |   |
| <b>UNIT 3 SLIDING MODE CONTROL BASICS</b>                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   | <b>12</b> |   |
| Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.                                                                                                                                                                                                  |                                                                                                        |   |   |           |   |
| <b>Lab Component :</b><br>1. Simulation of Sliding mode control based buck converter.                                                                                                                                                                                                                                                                                                         |                                                                                                        |   |   |           |   |



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Experiential Learning (Activity Based Learning): design robust controllers for power converters using MATLAB.

Industrial Application : Robust control of DC-DC converters in EVs, aerospace and renewable systems.

Content Beyond Syllabus : Chattering reduction techniques and higher-order sliding mode control.

**UNIT 4 POWER FACTOR CORRECTION CIRCUITS**

**12**

Introduction, Operating Principle of Single-Phase PFCs, Control of boost converter based PFCs, Designing the Inner Average-Current-Control Loop, Designing the Outer Voltage-Control Loop, Example of Single-Phase PFC Systems.

**Lab Component :**

1. Simulation of Single-Phase PFC circuit employing boost converter.

Experiential Learning (Activity Based Learning): Design of inner current loop and outer voltage loop for boost PFC converters.

Industrial Application : PFC circuits in SMPS, EV chargers, LED drivers.

Content Beyond Syllabus : Interleaved and digital PFC techniques.

**UNIT 5 CONTROLLER DESIGN FOR PFC CIRCUITS**

**12**

Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter - PFC circuits employing bridgeless topologies.

**Lab Component :**

1. Simulation of Single-Phase PFC circuit employing Cuk converters.

Experiential Learning (Activity Based Learning): Simulation of SEPIC PFC converters.

Industrial Application : High-efficiency power supplies for telecom and data centers.

Content Beyond Syllabus : Wide bandgap devices (SiC/GaN) in PFC converters.

**TOTAL 60 Periods**

**Course Outcomes**

After completion the above subject, students will be able to

|            |                                                                                                      |
|------------|------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Model and characterize transfer functions, pole-zero plots, and time/frequency responses             |
| <b>CO2</b> | Compute and solve polynomial and matrix equations for control system and power-converter design.     |
| <b>CO3</b> | Design and validate sliding-mode control strategies for buck converters under parameter variations.  |
| <b>CO4</b> | Evaluate and verify boost converter-based PFC circuits with inner current and outer voltage loops.   |
| <b>CO5</b> | Design and optimize advanced PFC circuits (Cuk, SEPIC, bridgeless) for high-efficiency applications. |

**TEXT BOOKS**

|   |                                                                                                                                                         |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1 <sup>st</sup> Edition, Cengage Learning. |
| 2 | Ned Mohan, "Power Electronics: A First Course", Johnwiley, 2013, 1 <sup>st</sup> Edition.                                                               |
| 3 | Marian K. Kazimierczuk and AgasthyaAyachit, "Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley 2016, 1 <sup>st</sup> Edition.  |



## REFERENCES

|   |                                                                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002, 1 <sup>st</sup> Edition.                                                  |
| 2 | Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.                                                                              |
|   | Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1 <sup>st</sup> Edition, CRC Press. |
| 3 | MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.                                                                                              |

| CO/PO, PSO Mapping |  |
|--------------------|--|
|--------------------|--|

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1   | 3   | 2   | –   | –   | –   | –   | 1   | –   | –   | –    | –    | 2    | 1    | –    |
| CO2   | 3   | 3   | –   | –   | –   | –   | 1   | –   | –   | –    | –    | 2    | 1    | –    |
| CO3   | 2   | 3   | –   | –   | –   | –   | 1   | –   | –   | –    | –    | 2    | 2    | –    |
| CO4   | 3   | 3   | 2   | 2   | –   | –   | 1   | –   | –   | –    | –    | 3    | 2    | 1    |
| CO5   | 3   | 3   | 2   | 2   | –   | –   | 1   | –   | –   | –    | –    | 3    | 2    | 1    |
| AVG   | 2.8 | 2.8 | 1.2 | 0.8 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0  | 0.0  | 2.4  | 1.6  | 0.4  |

| Product Based Outcomes |     |
|------------------------|-----|
| 1                      | 2   |
| 3                      | 4   |
| 5                      | 6   |
| 7                      | 8   |
| 9                      | 10  |
| 11                     | 12  |
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| 95                     | 96  |
| 97                     | 98  |
| 99                     | 100 |

|   |                                                                                                   |
|---|---------------------------------------------------------------------------------------------------|
| 1 | Ability to design and simulate controlled power electronic converters for real-time applications. |
| 2 | Ability to apply advanced control techniques for improving converter performance and robustness.  |
| 3 | Ability to analyze power quality and power factor improvement techniques.                         |
| 4 | Ability to develop simulation-based solutions for industrial power electronics problems.          |
| 5 | Ability to integrate control theory with practical power converter design.                        |

| Product Based Projects ( in Team) |                                   |
|-----------------------------------|-----------------------------------|
| 1                                 | Product Based Projects ( in Team) |

|    |                                                         |
|----|---------------------------------------------------------|
| 1  | Sliding Mode Controlled Buck Converter Simulator        |
| 2  | Power Factor Correction Analyzer for Single-Phase Loads |
| 3  | MATLAB-Based Control System Visualization Tool          |
| 4  | Boost Converter with Unity Power Factor Simulation      |
| 5  | Bridgeless PFC Converter Model                          |
| 6  | Symbolic Solver for Converter Transfer Functions        |
| 7  | Robust DC-DC Converter Control Demo                     |
| 8  | Comparative Study of PI vs SMC for Buck Converter       |
| 9  | Low-Power SMPS with PFC (Simulation Model)              |
| 10 | Educational Toolkit for Control of Power Converters     |



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**PROFESSIONAL ELECTIVE COURSES : VERTICALS**

**VERTICAL III : EMBEDDED SYSTEMS**

| SI. NO. | COURSE CODE | COURSE TITLE                                | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|---------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                             |          |     | L                | T | P |         |
| 1       | U24EEP31    | EMBEDDED SYSTEM DESIGN                      | PEC      | 4   | 2                | 0 | 2 | 3       |
| 2       | U24EEP32    | EMBEDDED C PROGRAMMING                      | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP33    | EMBEDDED PROCESSORS                         | PEC      | 4   | 2                | 0 | 2 | 3       |
| 4       | U24EEP34    | EMBEDDED CONTROL FOR ELECTRIC DRIVES        | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP35    | SMART SYSTEM AUTOMATION                     | PEC      | 4   | 2                | 0 | 2 | 3       |
| 6       | U24EEP36    | EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS | PEC      | 4   | 2                | 0 | 2 | 3       |



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| U24EEP31                                                                                                                                                                                                                                        | EMBEDDED SYSTEM DESIGN                                                             | L | T | P  | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                 |                                                                                    | 2 | 0 | 2  | 3 |
| Course Objectives                                                                                                                                                                                                                               |                                                                                    |   |   |    |   |
| To apply integrated AI tools for decision-making in modern power systems.                                                                                                                                                                       |                                                                                    |   |   |    |   |
| 1                                                                                                                                                                                                                                               | To introduce the Building Blocks of an embedded System and Software Tools          |   |   |    |   |
| 2                                                                                                                                                                                                                                               | To emphasize the role of Input/output interfacing with Bus Communication protocol. |   |   |    |   |
| 3                                                                                                                                                                                                                                               | To illustrate the ISR and scheduling for the multitasking process.                 |   |   |    |   |
| 4                                                                                                                                                                                                                                               | To explain the basics of a Real-time operating system                              |   |   |    |   |
| 5                                                                                                                                                                                                                                               | To analyze the applications based on embedded design approaches                    |   |   |    |   |
| UNIT I INTRODUCTION TO EMBEDDED SYSTEMS                                                                                                                                                                                                         |                                                                                    |   |   | 12 |   |
| Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Real Time Clock, In-circuit emulator, Target Hardware Debugging |                                                                                    |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                  |                                                                                    |   |   |    |   |
| Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:                                                                                                 |                                                                                    |   |   |    |   |
| 1. Introduction to IDE and Programming Environment.                                                                                                                                                                                             |                                                                                    |   |   |    |   |
| 2. Configure timer block for signal generation (with given frequency).                                                                                                                                                                          |                                                                                    |   |   |    |   |
| Experiential learning: Interface an RTC module (DS1307 or DS3231) with a microcontroller to understanding RTC functionality and low-power design considerations.                                                                                |                                                                                    |   |   |    |   |
| Industrial Application: In Manufacturing industry, software timers to schedule periodic quality checks or inspections and triggers a camera to capture images of products for defect detection or logs sensor data for quality analytics.       |                                                                                    |   |   |    |   |
| Content Beyond Syllabus : SAE-J Standard in Embedded System Design                                                                                                                                                                              |                                                                                    |   |   |    |   |
| UNIT II EMBEDDED NETWORKING                                                                                                                                                                                                                     |                                                                                    |   |   | 12 |   |
| Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C)                                           |                                                                                    |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                  |                                                                                    |   |   |    |   |
| 1. I <sup>2</sup> C communication with peripherals                                                                                                                                                                                              |                                                                                    |   |   |    |   |
| 2. Master-slave communication between processors using SPI.                                                                                                                                                                                     |                                                                                    |   |   |    |   |
| 3. Networking of processor using Wi-Fi.                                                                                                                                                                                                         |                                                                                    |   |   |    |   |
| Experiential learning: To Understand what embedded networking is, the role of I/O ports, and how devices communicate using switch triggering and LED blinking                                                                                   |                                                                                    |   |   |    |   |
| Industrial Application: Automotive embedded systems - A Car manufacturer(engine control units and airbags control system)                                                                                                                       |                                                                                    |   |   |    |   |
| Content beyond Syllabus: Advanced networking protocol _CAN Protocol :: Bus Arbitration & Collision Avoidance when multiple devices sharing a common communication medium                                                                        |                                                                                    |   |   |    |   |



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|                                                                                                                                                                                                                                                                                                                      |                                                                                              |                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------|
| <b>UNIT III INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER</b>                                                                                                                                                                                                                                                   |                                                                                              | <b>12</b>         |
| Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline – Introduction to Device Drivers.                                                                              |                                                                                              |                   |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                |                                                                                              |                   |
| 1. Interrupts programming example using GPIO.                                                                                                                                                                                                                                                                        |                                                                                              |                   |
| Experiential Learning: Embedded C Programming: Write a program that detects a button pressing and toggle the state of a LED accordingly                                                                                                                                                                              |                                                                                              |                   |
| Industrial Application: Automated Industrial Temperature Monitoring system                                                                                                                                                                                                                                           |                                                                                              |                   |
| Content Beyond Syllabus : Serial communication protocol.                                                                                                                                                                                                                                                             |                                                                                              |                   |
| <b>UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN</b>                                                                                                                                                                                                                                                                     |                                                                                              | <b>12</b>         |
| Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Pre-emptive and non-pre-emptive scheduling, Task communication-shared memory, message passing- Inter process Communication- Introduction to process synchronization using semaphores. |                                                                                              |                   |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                |                                                                                              |                   |
| 1. Basic RTOS concept and programming                                                                                                                                                                                                                                                                                |                                                                                              |                   |
| 2. Basic RTOS concept and programming                                                                                                                                                                                                                                                                                |                                                                                              |                   |
| Experiential Learning: Writing simple assembly programs for Arithmetic & logical operations.                                                                                                                                                                                                                         |                                                                                              |                   |
| Industrial Application: Speed Control drive in Automotive industry                                                                                                                                                                                                                                                   |                                                                                              |                   |
| Content Beyond Syllabus : PWM signal generation using ARM controller                                                                                                                                                                                                                                                 |                                                                                              |                   |
| <b>UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT</b>                                                                                                                                                                                                                                                                |                                                                                              | <b>12</b>         |
| Embedded Product Development Life Cycle- Different Computational models - Precision Agriculture-Autonomous vehicle.                                                                                                                                                                                                  |                                                                                              |                   |
| <b>Lab Component:</b>                                                                                                                                                                                                                                                                                                |                                                                                              |                   |
| 1. Embedded systems-based Mini project.                                                                                                                                                                                                                                                                              |                                                                                              |                   |
| Experiential Learning: To understand the embedded design concept behind Pacemaker                                                                                                                                                                                                                                    |                                                                                              |                   |
| Industrial Application: MODBUS communication in SCADA application.                                                                                                                                                                                                                                                   |                                                                                              |                   |
| Content Beyond Syllabus: Role of IEEE standards, regulatory guidelines in the design of Precision Agriculture.                                                                                                                                                                                                       |                                                                                              |                   |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                         |                                                                                              | <b>60 Periods</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                               |                                                                                              |                   |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                         |                                                                                              |                   |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                           | The hardware functional and software strategies required to develop various Embedded systems |                   |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                           | The basic differences between various Bus communication standards                            |                   |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                           | The incorporation of the interface as Interrupt services                                     |                   |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                           | The various scheduling algorithms through a Real-time operating system.                      |                   |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                           | The various embedded concepts for developing automation applications.                        |                   |





|          |                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------|
| <b>1</b> | Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2021 |
| <b>2</b> | Peckol, "Embedded system Design", John Wiley & Sons,2018                                        |

|          |                                                                                                                        |
|----------|------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Shibu. K.V, “Introduction to Embedded Systems”, TataMcgraw Hill, 2nd edition 2017.                                     |
| <b>2</b> | Lya B.Das,” Embedded Systems” ,Pearson Education, 1st edit 1st edition 2012                                            |
| <b>3</b> | Parag H.Dave,Himanshu B.Dave,” Embedded Systems-Concepts ,Design and Programming, Pearson Education,2015, 1st edition. |
| <b>4</b> | Elicia White, “Making Embedded systems”, O’Reilly Series ,SPD,2011, 1st edition                                        |
| <b>5</b> | Tammy Noergaard, “Embedded Systems Architecture”, Newnes, 2nd edition, 2013                                            |

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs:

[illegible]

|   |                                                                                                                                                                               |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | At the end of the course, the student will be able to                                                                                                                         |
| 2 | Develop a Basic temperature monitoring and control systems                                                                                                                    |
| 3 | Develop a display system to show the sensor data using I2C protocol                                                                                                           |
| 4 | Design a Smart Home Intrusion Detection & Alert System                                                                                                                        |
| 5 | Develop a prototype on Smart Home Automation System : Role of RTOS in Managing multiple tasks like monitoring temperature, controlling lights, handling security alerts, etc. |

|    |                                                     |
|----|-----------------------------------------------------|
| 1  | Real-Time Clock Based Smart Attendance Logger       |
| 2  | Conveyor Belt Monitoring and Scheduling System      |
| 3  | RS232-Based Sensor Data Monitoring System           |
| 4  | CAN Bus Based Multi-Node Automotive Simulation      |
| 5  | Interrupt-Based Smart Switch Controller             |
| 6  | Temperature Monitoring System with Interrupt Alerts |
| 7  | RTOS-Based Traffic Light Controller                 |
| 8  | PWM-Based Speed Control Using RTOS                  |
| 9  | Enhanced Precision Agriculture Monitoring System    |
| 10 | Robotic Arm Control System                          |



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| U24EEP32                                                                                                                                                                                                                                                                                                                                     | EMBEDDED C PROGRAMMING                                                                                                               | L | T | P  | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                      | 2 | 0 | 2  | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |   |   |    |   |
| To learn embedded programming and microcontroller concepts and apply them to develop simple real-time applications such as home automation, motor control, sensor-based systems, and basic IoT devices.                                                                                                                                      |                                                                                                                                      |   |   |    |   |
| 1                                                                                                                                                                                                                                                                                                                                            | To deliver insight into embedded C programming and its salient features for embedded systems.                                        |   |   |    |   |
| 2                                                                                                                                                                                                                                                                                                                                            | To Illustrate the software and hardware architecture for distributed computing in embedded systems                                   |   |   |    |   |
| 3                                                                                                                                                                                                                                                                                                                                            | To develop a solution for problems by using the concept learned in programming using the embedded controllers                        |   |   |    |   |
| 4                                                                                                                                                                                                                                                                                                                                            | To develop simple applications with 8051 by using its various features and interfacing with various external hardware.               |   |   |    |   |
| 5                                                                                                                                                                                                                                                                                                                                            | To enhance Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills. |   |   |    |   |
| UNIT I BASIC C PROGRAMMING                                                                                                                                                                                                                                                                                                                   |                                                                                                                                      |   |   | 12 |   |
| Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.                                                                                                                                       |                                                                                                                                      |   |   |    |   |
| Lab Component:<br>Laboratory exercise: Use 8051 microcontroller/Embedded processor/IDE/open sourceplatform to give hands-on training on Embedded C- programming.<br>1. Introduction to IDE (like code blocks, vscode ,etc)and Programming Environment (likeKeililu vision, Proteus)<br>2. Configuring an I/O port using bitwise programming. |                                                                                                                                      |   |   |    |   |
| Experiential Learning : Write programs demonstrating different data types (int, float, char, double)<br>Industrial Application : Automotive companies use C compilers and debuggers for ECU software testing.                                                                                                                                |                                                                                                                                      |   |   |    |   |
| Content Beyond Syllabus: Memory Management Concepts Dynamic memory allocation using malloc(), calloc(), realloc(), and free().                                                                                                                                                                                                               |                                                                                                                                      |   |   |    |   |
| UNIT II EMBEDDED C                                                                                                                                                                                                                                                                                                                           |                                                                                                                                      |   |   | 12 |   |
| Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.                                                                                   |                                                                                                                                      |   |   |    |   |
| Lab Component:<br>1. Configuring timer for generating hardware delay.<br>2. Flashing an LED using an interrupt                                                                                                                                                                                                                               |                                                                                                                                      |   |   |    |   |
| Experiential learning: limplementing delay routines using Empty loop and Timer-based delays.<br>Industrial Application: Used in embedded firmware development to model real-world entities like                                                                                                                                              |                                                                                                                                      |   |   |    |   |



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|                                                                                                                                                                                                                                                                                         |                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| motors, sensors, and communication modules.<br>Content beyond Syllabus: Implementing polymorphism in C using function pointers.                                                                                                                                                         |                                                                                                 |
| <b>UNIT III Programming in C</b>                                                                                                                                                                                                                                                        | <b>12</b>                                                                                       |
| Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051 Accessing code ROM space in 8051, Data serialization using 8051                                                                                                   |                                                                                                 |
| <b>Lab Component:</b><br>1. configuring timer for generating PWM signal                                                                                                                                                                                                                 |                                                                                                 |
| Experiential Learning: Embedded C Programming: Write a program that detects a button pressing and toggle the state of a LED accordingly<br>Industrial Application : Automated Industrial Temperature Monitoring system<br>Content Beyond Syllabus : Serial communication protocol       |                                                                                                 |
| <b>UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C</b>                                                                                                                                                                                                                          | <b>12</b>                                                                                       |
| Basics of serial communication, 8051 interfaces to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.                                                                                                                        |                                                                                                 |
| <b>Lab Component:</b><br>1. Serial communication using UART port of 8051<br>2. Embedded C programming based Mini project<br>3. Assignment: Introduction to Arduino IDE, Raspberry Pi 150                                                                                                |                                                                                                 |
| Experiential Learning: Writing simple assembly programs for Arithmetic & logical operations.<br>Industrial Application: Speed Control drive in Automotive industry<br>Content Beyond Syllabus: PWM signal generation using ARM controller                                               |                                                                                                 |
| <b>UNIT V 8051 INTERFACING</b>                                                                                                                                                                                                                                                          | <b>12</b>                                                                                       |
| ADC interfacing, DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing.                                                                                                                                                                                       |                                                                                                 |
| <b>Lab Component:</b><br>1. Interfacing an ADC with 8051<br>2. Interfacing an analog sensor with 8051<br>3. Interfacing 16x2 LCD with 8051<br>4. Interfacing a stepper motor with 8051                                                                                                  |                                                                                                 |
| Experiential Learning: To understand the embedded design concept behind Pacemaker<br>Industrial Application: Prototype simple robotic arm control with motor drivers.<br>Content Beyond Syllabus: Role of IEEE standards, regulatory guidelines in the design of Precision Agriculture. |                                                                                                 |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                            | <b>60 Periods</b>                                                                               |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                  |                                                                                                 |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                            |                                                                                                 |
| <b>CO1</b>                                                                                                                                                                                                                                                                              | Deliver insight into embedded C programming and its salient features for embedded systems.      |
| <b>CO2</b>                                                                                                                                                                                                                                                                              | Illustrate the software and hardware architecture for distributed computing in embedded systems |



|                                                                         |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|--|
| CO3                                                                     | Develop a solution for problems by using the concept learned in programming using the embedded controllers                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO4                                                                     | Develop simple applications with 8051 by using its various features and interfacing with various external hardware                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO5                                                                     | Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| TEXT BOOKS                                                              |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                       | Paul Deitel and Harvey Deitel, “C How to Program”, 9th Edition, Pearson Education Limited, 2022, 1st edition.                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                       | Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002. 3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006. |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                       | Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                       | Paul Deitel and Harvey Deitel, “C How to Program”, 9th Edition, Pearson Education Limited, 2022, 1st edition.                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| REFERENCES                                                              |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                       | Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015, 1st edition.                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                       | Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3rd edition.                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                       | Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2nd Edition 2007.                             |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                       | Myke Predko, “Programming and customizing the 8051 microcontrollers”,McGraww Hill 2000, 1st edition.                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| CO/PO, PSO Mapping                                                      |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
|                                                                         | PO1                                                                                                                                                                       | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |  |
| CO1                                                                     | 1                                                                                                                                                                         | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -    | -    | 1    | 2    | 2    |  |
| CO2                                                                     | 1                                                                                                                                                                         | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -    | -    | 1    | 3    | 2    |  |
| CO3                                                                     | 2                                                                                                                                                                         | 2   | 3   | 2   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |  |
| CO4                                                                     | 3                                                                                                                                                                         | 2   | 3   | 2   | 3   | -   | -   | -   | -   | -    | -    | 1    | 1    | 1    |  |
| CO5                                                                     | 3                                                                                                                                                                         | 2   | 1   | 3   | 1   | -   | -   | -   | 1   | -    | -    | 2    | 3    | 2    |  |
| AVG                                                                     | 2                                                                                                                                                                         | 1.6 | 2.2 | 2.2 | 1.8 | -   | -   | -   | 1   | -    | -    | 1.4  | 2.4  | 2    |  |
| Product based outcomes                                                  |                                                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 1                                                                       | create a mini-project such as a simple calculator, area-volume calculator, or student-information display program.                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 2                                                                       | create Motor Control System using modular structured C code                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 3                                                                       | produce hardware-interfacing applications such as LED blinking, switch monitoring, buzzer control, or 7-segment display-driving programs.                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 4                                                                       | Develop Temperature sensor with serial reporting & interrupt-based stopwatch<br>Interrupt-based digital stopwatch                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |  |
| 5                                                                       | produce a fully functional embedded system that integrates ADC, DAC, sensors, LCD display, and stepper motor actuation.                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |  |



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| Product based Projects (in Team) |                                                    |
|----------------------------------|----------------------------------------------------|
| 1                                | Automotive ECU Sensor Data Simulator               |
| 2                                | Modular Embedded Device Controller                 |
| 3                                | Student Performance Analytics System               |
| 4                                | Real-Time Motor Protection System                  |
| 5                                | Automated Industrial Temperature Monitoring System |
| 6                                | Smart Switch & Indicator System                    |
| 7                                | Automotive Speed Control Drive                     |
| 8                                | Serial Data Logger System                          |
| 9                                | Robotic Arm Control System                         |
| 10                               | Smart Medical Assist Device (Pacemaker Concept)    |



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| U24EEP33                                                                                                                                                                                                                                                 | EMBEDDED PROCESSORS                                                                | L | T | P  | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                          |                                                                                    | 2 | 0 | 2  | 3 |
| Course Objectives                                                                                                                                                                                                                                        |                                                                                    |   |   |    |   |
| To provide students with a strong foundation in ARM processor architecture and programming, memory management, and single-board embedded systems, enabling them to develop real-time embedded applications for automation, IoT, and consumer electronics |                                                                                    |   |   |    |   |
| 1                                                                                                                                                                                                                                                        | To introduce the architecture of the ARM processor.                                |   |   |    |   |
| 2                                                                                                                                                                                                                                                        | To train students in ARM programming.                                              |   |   |    |   |
| 3                                                                                                                                                                                                                                                        | To discuss memory management, append location development with an ARM processor.   |   |   |    |   |
| 4                                                                                                                                                                                                                                                        | To involve Discussions/ Practice/Exercise in revising & familiarizing the concepts |   |   |    |   |
| 5                                                                                                                                                                                                                                                        | To impart the knowledge on single board embedded processors.                       |   |   |    |   |
| UNIT I ARM ARCHITECTURE                                                                                                                                                                                                                                  |                                                                                    |   |   | 12 |   |
| Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure                                                                                                                            |                                                                                    |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                           |                                                                                    |   |   |    |   |
| 1. Programming with IDE - ARM microcontroller                                                                                                                                                                                                            |                                                                                    |   |   |    |   |
| Experiential Learning: ARM-based Raspberry Pi to implement an interrupt-driven input system using GPIO pins.                                                                                                                                             |                                                                                    |   |   |    |   |
| Industrial Application: Real-Time Industrial Image Processing System                                                                                                                                                                                     |                                                                                    |   |   |    |   |
| Content Beyond Syllabus: Advanced Processor STM 32 Architecture Concepts                                                                                                                                                                                 |                                                                                    |   |   |    |   |
| UNIT II ARM MICROCONTROLLER PROGRAMMING                                                                                                                                                                                                                  |                                                                                    |   |   | 12 |   |
| ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM- basic programming.                                                                                                                                                      |                                                                                    |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                           |                                                                                    |   |   |    |   |
| 1.Advanced Timer Features, PWM Generator.                                                                                                                                                                                                                |                                                                                    |   |   |    |   |
| Experiential learning: ARM-based Raspberry Pi / ARM Cortex microcontroller to perform basic signal processing (averaging sensor data) using both ARM and Thumb instruction sets                                                                          |                                                                                    |   |   |    |   |
| Industrial Application: Used in embedded firmware development to model real-world entities like motors, sensors, and communication modules.                                                                                                              |                                                                                    |   |   |    |   |
| Content beyond Syllabus: High-performance multimedia and AI-enabled ARM systems.                                                                                                                                                                         |                                                                                    |   |   |    |   |
| UNIT III PERIPHERALS OF ARM                                                                                                                                                                                                                              |                                                                                    |   |   | 12 |   |
| I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing-stepper motor interfacing.                                                                                                                      |                                                                                    |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                           |                                                                                    |   |   |    |   |
| 1. ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.                                                                                                                                                         |                                                                                    |   |   |    |   |
| Experiential Learning: Hands-on understanding of memory usage, peripheral interfacing, and serial communication in embedded systems.                                                                                                                     |                                                                                    |   |   |    |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Industrial Application: Automated Industrial Conveyor Belt Control System<br>Content Beyond Syllabus : Capture/Compare units for speed and position measurement                                                                                                                                                                                                                                       |                                                                                                                                        |
| <b>UNIT IV ARM COMMUNICATION</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>12</b>                                                                                                                              |
| ARM With CAN, I2C, and SPI protocols                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                        |
| <b>Lab Component:</b><br>1. ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.<br>2. Seminar:<br>a) ARM and GSM/GPS interfacing<br>b) Introduction to ARM Cortex Processor                                                                                                                                                                                 |                                                                                                                                        |
| Experiential Learning: Interfacing a temperature sensor via I <sup>2</sup> C protocol<br>Industrial Application: CAN is used for real-time communication between ECUs<br>Content Beyond Syllabus: Introduction to CAN-FD, I <sup>3</sup> C, and SPI with DMA for higher data rates, lower power consumption,                                                                                          |                                                                                                                                        |
| <b>UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR</b>                                                                                                                                                                                                                                                                                                                                         | <b>12</b>                                                                                                                              |
| Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi                                                                                                                                                                                         |                                                                                                                                        |
| <b>Lab Component:</b><br>1. Raspberry Pi based Mini project.                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                        |
| Experiential Learning: Setting up a Raspberry Pi, boot into Raspberry Pi OS, and write a Python program to Control an LED or relay through GPIO pins<br>Industrial Application: Smart Home Automation System<br>Content Beyond Syllabus: Introduction to real-time data acquisition and edge computing on Raspberry Pi, using multi-threading and asynchronous GPIO handling for improved performance |                                                                                                                                        |
| <b>TOTAL</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>60 Periods</b>                                                                                                                      |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                        |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                        |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                            | Interpret the basics and functionality of processor functional blocks.                                                                 |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                            | Observe the specialty of RISC processor Architecture                                                                                   |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                            | Incorporate the I/O hardware interface of processor with peripherals.                                                                  |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                            | Emphasis the communication features of the processor                                                                                   |
| <b>CO5</b>                                                                                                                                                                                                                                                                                                                                                                                            | Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors. |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                        |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                              | Steve Furber, 'ARM system on chip architecture', Addison Wesley, 2nd Edition, 2015.                                                    |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                              | Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer's                                                   |





|                                                                                                                                                                        |                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
|                                                                                                                                                                        | Guide Designing and Optimizing System Software', Elsevier 2004, 1st Edition.                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                                                             |                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | William Hohl, 'ARM Assembly Language' Fundamentals and Techniques, CRC Press, 2nd Edition 2014.                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | Rajkamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | ARM System Developer's Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO                                                                                                                                                                  | PO1                                                                                                                                                                        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                    | 1                                                                                                                                                                          | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -    | -    | 2    | 1    | 2    |
| CO2                                                                                                                                                                    | 1                                                                                                                                                                          | 1   | 2   | 2   | 1   | -   | -   | -   | -   | -    | -    | 1    | 2    | 2    |
| CO3                                                                                                                                                                    | 3                                                                                                                                                                          | 2   | 3   | 2   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    | 3    |
| CO4                                                                                                                                                                    | 3                                                                                                                                                                          | 2   | 3   | 2   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    | 3    |
| CO5                                                                                                                                                                    | 3                                                                                                                                                                          | 2   | 1   | 2   | 1   | -   | -   | -   | 1   | -    | -    | 1    | 2    | 2    |
| AVG                                                                                                                                                                    | 2.2                                                                                                                                                                        | 1.6 | 2.2 | 2   | 1.8 | -   | -   | -   | 1   | -    | -    | 1.8  | 2.2  | 2.4  |
| Product based outcome                                                                                                                                                  |                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | Design an ARM-Based Real-Time Interrupt Handling System                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | Design an instruction-level programming and DSP application on ARM microcontrollers, suitable for audio, communication, or control systems.                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | Design an Embedded Sensor Data Acquisition and Control System.                                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | Understand multi-protocol communication, bus arbitration, and real-time data transfer for industrial embedded networks.                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | Design a Raspberry Pi-Based IoT/Automation Prototype                                                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Product based Projects (in Team)                                                                                                                                       |                                                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | ARM-Based Sensor Data Logger                                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | ARM Thumb Instruction DSP Signal Processor                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | ARM based Stepper Motor Control System                                                                                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | CAN Bus-Based Vehicle Subsystem Simulation                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | I <sup>2</sup> C Sensor Hub                                                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                      | SPI-Based High-Speed Data Transfer System                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                      | Raspberry Pi Smart Home Automation Prototype                                                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                                      | Raspberry Pi IoT Environmental Monitoring System                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                                                                                                                      | Raspberry Pi Robotics Controller                                                                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                                                                                                                     | ARM-Based Interrupt Handling Simulator                                                                                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |



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| U24EEP34                                                                                                                                                                                                                                                                     | EMBEDDED CONTROL FOR ELECTRIC DRIVES                                                               | L | T | P  | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                              |                                                                                                    | 2 | 0 | 2  | 3 |
| Course Objectives                                                                                                                                                                                                                                                            |                                                                                                    |   |   |    |   |
| To understand and implement embedded and intelligent control techniques for electrical drives using optimization, machine learning, and high-performance computing for real-time applications such as electric vehicles, robotics, automation, and smart industrial systems. |                                                                                                    |   |   |    |   |
| 1                                                                                                                                                                                                                                                                            | To provide the control concept for electrical drives                                               |   |   |    |   |
| 2                                                                                                                                                                                                                                                                            | To emphasize the need of embedded systems for controlling the electrical drives                    |   |   |    |   |
| 3                                                                                                                                                                                                                                                                            | To provide knowledge about various embedded system-based control strategies for electrical drives  |   |   |    |   |
| 4                                                                                                                                                                                                                                                                            | To Impart the knowledge of optimization and machine learning techniques used for electrical drives |   |   |    |   |
| 5                                                                                                                                                                                                                                                                            | To familiarize the high-performance computing for electrical drives.                               |   |   |    |   |
| UNIT 1 INTRODUCTION TO ELECTRIC DRIVES                                                                                                                                                                                                                                       |                                                                                                    |   |   | 12 |   |
| Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.                                                                                                                 |                                                                                                    |   |   |    |   |
| Lab Component :                                                                                                                                                                                                                                                              |                                                                                                    |   |   |    |   |
| 1. Simulation of four quadrant operation and speed control of DC motor                                                                                                                                                                                                       |                                                                                                    |   |   |    |   |
| 2. Simulation of 3-phase inverter.                                                                                                                                                                                                                                           |                                                                                                    |   |   |    |   |
| Experiential Learning (Activity Based Learning): Simulation and analysis of four-quadrant DC motor operation using MATLAB/Simulink                                                                                                                                           |                                                                                                    |   |   |    |   |
| Industrial Application : Elevators, electric cranes, rolling mills, EV traction systems                                                                                                                                                                                      |                                                                                                    |   |   |    |   |
| Content Beyond Syllabus : Digital twin concept for electric drives                                                                                                                                                                                                           |                                                                                                    |   |   |    |   |
| UNIT 2 EMBEDDED SYSTEM FOR MOTOR CONTROL                                                                                                                                                                                                                                     |                                                                                                    |   |   | 12 |   |
| Embedded Processors choice for motor control- Sensors and interface modules for Electric drives-IoT for Electrical drives applications                                                                                                                                       |                                                                                                    |   |   |    |   |
| Lab Component :                                                                                                                                                                                                                                                              |                                                                                                    |   |   |    |   |
| 1. Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.                                                                                                                                                                                              |                                                                                                    |   |   |    |   |
| 2. Mini project: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)                                                                                                                                                                         |                                                                                                    |   |   |    |   |
| Experiential Learning (Activity Based Learning): IoT-based motor health monitoring using ESP32/Arduino                                                                                                                                                                       |                                                                                                    |   |   |    |   |
| Industrial Application : Smart manufacturing systems, Industry 4.0 motor monitoring                                                                                                                                                                                          |                                                                                                    |   |   |    |   |
| Content Beyond Syllabus : Cybersecurity in IoT-enabled drive systems                                                                                                                                                                                                         |                                                                                                    |   |   |    |   |
| UNIT 3 INDUCTION MOTOR CONTROL                                                                                                                                                                                                                                               |                                                                                                    |   |   | 12 |   |
| Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.                                                              |                                                                                                    |   |   |    |   |
| Lab Component :                                                                                                                                                                                                                                                              |                                                                                                    |   |   |    |   |
| 1. Simulation of Speed control of Induction motor using any suitable software package.                                                                                                                                                                                       |                                                                                                    |   |   |    |   |



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Experiential Learning (Activity Based Learning): Design of fuzzy logic controller for IM speed control  
Industrial Application : Pumps, compressors, conveyor belts, HVAC systems  
Content Beyond Syllabus : AI-based efficiency optimization

|                                                                                                                  |                                                                                                                                                                   |                   |
|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <b>UNIT 4 BLDC MOTOR CONTROL</b>                                                                                 |                                                                                                                                                                   | <b>12</b>         |
| Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor basedBDLC motor speed control. |                                                                                                                                                                   |                   |
| <b>Lab Component :</b>                                                                                           |                                                                                                                                                                   |                   |
| 1. Simulation of Speed control of BLDC motor using any suitable software package.                                |                                                                                                                                                                   |                   |
| Experiential Learning (Activity Based Learning): Embedded BLDC speed controller using Hall sensors               |                                                                                                                                                                   |                   |
| Industrial Application : Electric vehicles, drones, robotics, medical devices                                    |                                                                                                                                                                   |                   |
| Content Beyond Syllabus : Field-Oriented Control (FOC) of BLDC motors                                            |                                                                                                                                                                   |                   |
| <b>UNIT 5 SRM MOTOR CONTROL</b>                                                                                  |                                                                                                                                                                   | <b>12</b>         |
| Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.  |                                                                                                                                                                   |                   |
| <b>Lab Component :</b>                                                                                           |                                                                                                                                                                   |                   |
| 1. Simulation of Speed control of SRM using any suitable software package                                        |                                                                                                                                                                   |                   |
| Experiential Learning (Activity Based Learning): Torque ripple analysis and reduction                            |                                                                                                                                                                   |                   |
| Industrial Application : Aerospace actuators, high-speed industrial drives                                       |                                                                                                                                                                   |                   |
| Content Beyond Syllabus : ML-based rotor position estimation                                                     |                                                                                                                                                                   |                   |
| <b>TOTAL</b>                                                                                                     |                                                                                                                                                                   | <b>60 Periods</b> |
| <b>Course Outcomes</b>                                                                                           |                                                                                                                                                                   |                   |
| After completion the above subject, students will be able to                                                     |                                                                                                                                                                   |                   |
| <b>CO1</b>                                                                                                       | Interpret the significance of embedded control of electrical drives                                                                                               |                   |
| <b>CO2</b>                                                                                                       | Deliver insight into various control strategies for electrical drives                                                                                             |                   |
| <b>CO3</b>                                                                                                       | Developing knowledge of Machine learning and optimization techniques for motor control.                                                                           |                   |
| <b>CO4</b>                                                                                                       | Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.                                                                   |                   |
| <b>CO5</b>                                                                                                       | Improved Employability and entrepreneurship capacity due to knowledge up gradation onrecent trends in embedded system skills required for motor control strategy. |                   |
| <b>TEXT BOOKS</b>                                                                                                |                                                                                                                                                                   |                   |
| 1                                                                                                                | R.Krishnan, “Electric Motor Drives – Modeling, Analysis and Control”,Prentice-Hall of India Pvt.Ltd., New Delhi,2010, 1 <sup>st</sup> Edition.                    |                   |
| 2                                                                                                                | Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1 <sup>st</sup> Edition                                         |                   |
| <b>REFERENCES</b>                                                                                                |                                                                                                                                                                   |                   |
| 1                                                                                                                | VedamSubramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2 <sup>nd</sup> Edition.             |                   |
| 2                                                                                                                | K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1 <sup>st</sup> Edition.                                                                 |                   |
| 3                                                                                                                | Steve Furber. ‘ARM system on chip architecture’. Addison Wesley, 2 <sup>nd</sup> Edition 2015.                                                                    |                   |



|                                                                                                                                                                        |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 4                                                                                                                                                                      | Ron Sass and AnderewG.Schmidt, “ Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010, 1 <sup>st</sup> Edition. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | Tim Wescott , Applied Control Theory for Embedded Systems , Elsevier, 2006, 1 <sup>st</sup> Edition.                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO                                                                                                                                                                  | PO1                                                                                                                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                    | 3                                                                                                                                                | 2   | 2   | 2   | 1   | –   | 1   | 2   | –   | 1    | –    | 3    | 2    | 1    |
| CO2                                                                                                                                                                    | 3                                                                                                                                                | 3   | 2   | 2   | 2   | –   | 1   | 2   | –   | 1    | –    | 3    | 3    | 2    |
| CO3                                                                                                                                                                    | 3                                                                                                                                                | 3   | 3   | 2   | 3   | –   | 2   | 2   | –   | 1    | –    | 3    | 3    | 3    |
| CO4                                                                                                                                                                    | 3                                                                                                                                                | 2   | 3   | 3   | 3   | –   | 2   | 2   | –   | 1    | –    | 3    | 3    | 3    |
| CO5                                                                                                                                                                    | 2                                                                                                                                                | 2   | 2   | 2   | 3   | –   | 2   | 3   | –   | 2    | –    | 3    | 3    | 3    |
| AVG                                                                                                                                                                    | 2.8                                                                                                                                              | 2.4 | 2.4 | 2.2 | 2.4 | –   | 1.6 | 2.2 | –   | 1.2  | –    | 3.0  | 2.8  | 2.4  |
| <b>Product Based Outcomes</b>                                                                                                                                          |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | Design and implement an embedded motor control system for real-time speed regulation.                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | Develop an IoT-enabled electric drive for monitoring and diagnostics.                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | Apply AI/ML techniques to improve drive efficiency and dynamic performance.                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | Build cost-effective embedded solutions for EV and automation applications.                                                                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | Demonstrate industry-ready skills in embedded motor control and intelligent drives.                                                              |     |     |     |     |     |     |     |     |      |      |      |      |      |
| <b>Product Based Projects ( in Team)</b>                                                                                                                               |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                      | Embedded DC Motor Speed Controller using PID                                                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                      | IoT-Based Motor Speed & Temperature Monitoring System                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                      | Smart BLDC Motor Controller for E-Bike Application                                                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                      | Fuzzy Logic Controlled Induction Motor Drive                                                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                      | Embedded SRM Speed Controller with Torque Ripple Reduction                                                                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 6                                                                                                                                                                      | EV Traction Motor Control Prototype (BLDC/PMSM)                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 7                                                                                                                                                                      | Predictive Maintenance System for Motors using ML                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 8                                                                                                                                                                      | Solar-Powered Embedded Motor Drive System                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 9                                                                                                                                                                      | UAV Propulsion Motor Control Unit                                                                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 10                                                                                                                                                                     | Digital Twin of Electric Drive using Embedded Data Acquisition                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                   |   |   |   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---|---|---|----|
| U24EEP35                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | SMART SYSTEM AUTOMATION                                                           | L | T | P | C  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                   | 2 | 0 | 2 | 3  |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                   |   |   |   |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To introduce the smart system technologies and its role in real time applications |   |   |   |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To teach the architecture and requirements of Home Automation.                    |   |   |   |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To provide an insight into smart appliances and energy management concepts.       |   |   |   |    |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To familiarize the design and needs of smart wearable devices                     |   |   |   |    |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To teach the basics of robotics and its role for automation                       |   |   |   |    |
| UNIT 1 INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                   |   |   |   | 12 |
| Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                   |   |   |   |    |
| <b>Lab Component:</b><br>Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to give hands on training to understand concepts related to smart automation.<br>1. Hands on experiments based on Ubidots & Thing speak / Open-source AnalyticsPlatform<br><br>Experiential Learning (Activity Based Learning): Hands-on setup of a Smart Node using ESP32 (Sensor + Actuator + MQTT communication) Students build a mini smart system prototype with real sensors and cloud connectivity.<br>Industrial Application : Industry-grade communication protocols (Modbus, CAN, RS485) in building automation Real protocol choices used in factories, energy plants, and building management systems.<br>Content Beyond Syllabus : Digital Twins for Smart Systems Using virtual replicas of hardware to simulate performance and predict failures. |                                                                                   |   |   |   |    |
| UNIT 2 HOME AUTOMATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                   |   |   |   | 12 |
| Home Automation – System Architecture - Essential Components - Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                   |   |   |   |    |
| <b>Lab Component:</b><br>1. Design and implementation of a smart home system<br><br>Experiential Learning (Activity Based Learning): Design and Deployment of a Secure Home Automation Network using Node-RED / Blynk Students automate a room: lights, fan, sensors, and smartphone control with dashboards.<br>Industrial Application : Smart Home Security and Access Control Systems (Biometric + IoT Integration) Focus on real industry solutions like smart locks, alarms, and cloud monitoring.<br>Content Beyond Syllabus : Matter Protocol (Future of Smart Home Interoperability) Latest standard used by Google, Apple, Amazon, Samsung.                                                                                                                                                                                                            |                                                                                   |   |   |   |    |
| UNIT 3 SMART APPLIANCES AND ENERGY MANAGEMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                   |   |   |   | 12 |
| Significance of smart appliances for energy management -Smart Meters: Significance, Architecture& Energy Measurement Technique – Security Considerations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                   |   |   |   |    |
| <b>Lab Component:</b><br>1. Bluetooth Based Home Automation Project using Android Phone                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                   |   |   |   |    |



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Experiential Learning (Activity Based Learning): Real-time Energy Monitoring using Smart Meter Prototype (CT Sensor + ESP32) Students measure and analyze energy consumption of appliances. Industrial Application : Demand Response Energy Management in Smart Grids How industries reduce load during peak hours using smart appliances.  
 Content Beyond Syllabus : AI-based Energy Prediction and Load Forecasting Machine learning to predict energy usage patterns.

|                                      |           |
|--------------------------------------|-----------|
| <b>UNIT 4 SMART WEARABLE DEVICES</b> | <b>12</b> |
|--------------------------------------|-----------|

Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.

**Lab Component:**

1. GSM Based Home Devices Control
2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India

Experiential Learning (Activity Based Learning): Development of a Wearable Health Monitor (Heart rate, SpO<sub>2</sub>, Step Count) Students prototype a wearable health-tracking band with BLE. Industrial Application : Medical Wearables in Remote Patient Monitoring Industry use of continuous vitals monitoring, fall detection, elderly care.  
 Content Beyond Syllabus : Edge AI for Wearables (Fall detection, Activity classification on-device) Running ML inference directly on small wearable processors.

|                                             |           |
|---------------------------------------------|-----------|
| <b>UNIT 5 EMBEDDED SYSTEMS AND ROBOTICS</b> | <b>12</b> |
|---------------------------------------------|-----------|

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

**Lab Component:**

1. Pick and place robots using Arduino/ any suitable Embedded processor
2. Mini project: Design of a Smart Automation system ( for any application of students choice)

Experiential Learning (Activity Based Learning): Building a Line-following or Obstacle-avoiding Mobile Robot using Embedded Controller Students design, program, and test a full robot hardware system. Industrial Application : Robotics in Warehouse Automation (AGVs, AMRs) Use of smart mobile robots in logistics, Amazon-like warehouses.  
 Content Beyond Syllabus : Swarm Robotics & Cooperative Robot Behaviors

|              |                   |
|--------------|-------------------|
| <b>TOTAL</b> | <b>60 Periods</b> |
|--------------|-------------------|

|                        |
|------------------------|
| <b>Course Outcomes</b> |
|------------------------|

**At the end of the course, the student will be able to**

- |            |                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Understand the concepts of smart system design and its present developments                                                 |
| <b>CO2</b> | Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications. |
| <b>CO3</b> | Acquire knowledge on different platforms and Infrastructure for Smart system design.                                        |
| <b>CO4</b> | Infer about smart appliances and energy management concepts                                                                 |
| <b>CO5</b> | Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.           |

|                   |
|-------------------|
| <b>TEXT BOOKS</b> |
|-------------------|





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|   |                                                                                                                                                      |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Grimm, Christoph, Neumann, Peter, Mahlkech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013.                   |
| 2 | KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1 st Edition. |
| 3 | NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1 st Edition.                                 |

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|   |                                                                                       |
|---|---------------------------------------------------------------------------------------|
| 1 | Thomas Bräunl, Embedded Robotics, Springer, 2003.                                     |
| 2 | Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw-Hill, 2008 |
| 3 | Karim Yaghmour, Embedded Android, O'Reilly, 2013.                                     |
| 4 | Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013      |
| 5 | C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.                   |
| 6 | Anna Ha'c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003               |
| 7 | J. J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Education      |
| 8 | Y. Koren, "Robotics for Engineers", McGraw-Hill.                                      |
| 9 | Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011                               |

**LIST OF OPEN SOURCE SOFTWARE/LEARNING WEBSITE**

|   |                                                                                                                                                                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <a href="https://microcontrollerslab.com/home-automation-projects-ideas/">https://microcontrollerslab.com/home-automation-projects-ideas/</a>                                                                                                                                                     |
| 2 | <a href="https://www.learnrobotics.org/blog/simple-robot/">https://www.learnrobotics.org/blog/simple-robot/</a>                                                                                                                                                                                   |
| 3 | <a href="https://robolabor.ee/homelab/en/iot">https://robolabor.ee/homelab/en/iot</a>                                                                                                                                                                                                             |
| 4 | <a href="https://electrovolt.ir/wp-content/uploads/2018/03/ExploringRaspberryPiMolloyDerekElectroVolt.ir.pdf">https://electrovolt.ir/wp-content/uploads/2018/03/ExploringRaspberryPiMolloyDerekElectroVolt.ir.pdf</a>                                                                             |
| 5 | <a href="http://www.robot.bmstu.ru/files/books/(Ebook%20%20English)%20McgrawHil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf">http://www.robot.bmstu.ru/files/books/(Ebook%20%20English)%20McgrawHil,%20Pic%20Robotics%20--%20A%20Beginner'S%20Guide%20To%20Robotic.pdf</a> |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1        | PO2        | PO3        | PO4        | PO5        | PO6 | PO7 | PO8 | PO9        | PO10 | PO11 | PSO1       | PSO2       | PSO3       |
|-----|------------|------------|------------|------------|------------|-----|-----|-----|------------|------|------|------------|------------|------------|
| CO1 | 2          | 1          | 3          | 1          | 3          | –   | –   | –   | –          | –    | –    | 1          | 2          | 2          |
| CO2 | 3          | 1          | 2          | 2          | 3          | –   | –   | –   | –          | –    | –    | 1          | 1          | 3          |
| CO3 | 2          | 2          | 3          | 2          | 3          | –   | –   | –   | –          | –    | –    | 2          | 2          | 2          |
| CO4 | 2          | 2          | 2          | 1          | 3          | –   | –   | –   | –          | –    | –    | 1          | 2          | 2          |
| CO5 | 3          | 2          | 2          | 2          | 3          | –   | –   | –   | 1          | –    | –    | 2          | 2          | 3          |
| AVG | <b>2.4</b> | <b>1.6</b> | <b>2.4</b> | <b>1.6</b> | <b>3.0</b> | –   | –   | –   | <b>0.2</b> | –    | –    | <b>1.4</b> | <b>1.8</b> | <b>2.4</b> |

**Product based outcome**

|   |                                                                                                                                                   |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Design and prototype a smart sensor–actuator node with appropriate hardware, firmware, and communication protocol (Wi- Fi/BLE/MQTT).              |
| 2 | Create a working home automation product, integrating sensing, control units, secure communication, and user interfaces.                          |
| 3 | Build a functional smart meter or energy monitoring system that measures power consumption and provides analytics through an app/cloud dashboard. |
| 4 | Develop a wearable health monitoring prototype that measures body parameters and                                                                  |





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|                                         |                                                                                                                                       |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
|                                         | sends data to a smartphone or cloud.                                                                                                  |
| 5                                       | Design and demonstrate a mobile robot / embedded system automation product integrating sensors, navigation logic, and remote control. |
| <b>Product based Projects (in team)</b> |                                                                                                                                       |
| 1                                       | Smart Home Node (single room automation kit)                                                                                          |
| 2                                       | Intelligent Energy Monitoring smart plug                                                                                              |
| 3                                       | Home security & access control system                                                                                                 |
| 4                                       | Smart Wearable for vitals monitoring                                                                                                  |
| 5                                       | Indoor position tracking robot (IoT Robot)                                                                                            |
| 6                                       | Solar-powered smart metering system                                                                                                   |
| 7                                       | Universal smart remote for home appliances                                                                                            |
| 8                                       | Smart kitchen safety system                                                                                                           |
| 9                                       | IoT based patient health monitoring system                                                                                            |
| 10                                      | Autonomous pick and place mini robot                                                                                                  |



# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

|                                                                                                                                                                                                        |                                                                                               |   |   |   |    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|---|---|---|----|
| U24EEP36                                                                                                                                                                                               | EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS                                                   | L | T | P | C  |
|                                                                                                                                                                                                        |                                                                                               | 2 | 0 | 2 | 3  |
| Course Objectives                                                                                                                                                                                      |                                                                                               |   |   |   |    |
| To provide students with fundamental and application-oriented knowledge of electronic engine control, vehicle sensors, automation, communication, and infotainment systems used in modern automobiles. |                                                                                               |   |   |   |    |
| 1                                                                                                                                                                                                      | To expose the students to the fundamentals and building of Electronic Engine Control systems. |   |   |   |    |
| 2                                                                                                                                                                                                      | To teach on sensor functional components for vehicles.                                        |   |   |   |    |
| 3                                                                                                                                                                                                      | To discuss on programmable controllers for vehicles management systems                        |   |   |   |    |
| 4                                                                                                                                                                                                      | To teach logics of automation & communication techniques for vehicle communication.           |   |   |   |    |
| 5                                                                                                                                                                                                      | To introduce the infotainment system development.                                             |   |   |   |    |
| UNIT 1 INTRODUCTION TO AUTOMOTIVE SYSTEMS                                                                                                                                                              |                                                                                               |   |   |   | 12 |
| Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.                                                       |                                                                                               |   |   |   |    |
| Lab Component:<br>Laboratory exercise: Use MATLAB SIMULINK /equivalent simulation /open source tools<br>1.Simulation study of automotive sensors and actuators components                              |                                                                                               |   |   |   |    |
| Experiential Learning (Activity Based Learning): Modeling Air–Fuel Ratio Control Using Arduino/ESP32 (Closed-Loop Simulation) Students simulate oxygen sensor feedback and adjust PWM fuel injection.  |                                                                                               |   |   |   |    |
| Industrial Application : Open-Source ECU (Speeduino/Megasquirt) Calibration Workflow. How automotive tuners adjust ignition maps, AFR maps, and throttle response                                      |                                                                                               |   |   |   |    |
| Content Beyond Syllabus : Introduction to Functional Safety (ISO 26262) for Automotive Electronics                                                                                                     |                                                                                               |   |   |   |    |
| UNIT 2 SENSORS AND ACTUATORS FOR AUTOMOTIVES                                                                                                                                                           |                                                                                               |   |   |   | 12 |
| Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.                                                                                    |                                                                                               |   |   |   |    |
| Lab Component:<br>1.Interfacing a sensor used in car with microcontroller.                                                                                                                             |                                                                                               |   |   |   |    |
| Experiential Learning (Activity Based Learning): Building a Mini ECU Sensor Hub Interface MAP sensor, throttle position sensor, temperature sensor, and actuators with microcontroller.                |                                                                                               |   |   |   |    |
| Industrial Application : Hall-Effect Based Crankshaft Position Sensing in Real Engines                                                                                                                 |                                                                                               |   |   |   |    |
| Content Beyond Syllabus : Sensor Fusion Techniques for Automotive Perception (Kalman/Complementary Filters)                                                                                            |                                                                                               |   |   |   |    |
| UNIT 3 VEHICLE MANAGEMENT SYSTEMS                                                                                                                                                                      |                                                                                               |   |   |   | 12 |
| Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.                                                                                      |                                                                                               |   |   |   |    |
| Lab Component:<br>1. Adaptive cruise control, Anti-Lock Braking System                                                                                                                                 |                                                                                               |   |   |   |    |



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Experiential Learning (Activity Based Learning): Implementation of a simplified adaptive cruise control (ACC) using ultrasonic sensors. Students develop PID-based following distance control. Industrial Application : Electronic stability control (ESC) architecture used in modern cars. Content Beyond Syllabus : Introduction to automotive embedded AI - Object detection for driver assist.

## UNIT 4 ONBOARD DIAGNOSTICS AND COMMUNICATION

12

OBD , Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY, ETHERNET and MOST.

### Lab Component:

1. CAN Connectivity in an Automotive Application using vehicle network toolbox

Experiential Learning (Activity Based Learning): Hands-on OBD-II data retrieval using ELM317 & Python/Android App. Students read RPM, speed, fuel trims, trouble codes. Industrial Application : In-vehicle network security - attacks on CAN bus and real countermeasures.

Content Beyond Syllabus : Automotive ethernet (100BASE-T1) and its role in next-gen vehicles.

## UNIT 5 RECENT TRENDS

12

Navigation- Autonomous car- Role of IoT in Automotive systems.

### Lab Component:

1. Establishing connection between Bluetooth module and microcontroller.
2. Assignment: AUTOSAR
3. Mini project : Battery Management system for EV batteries

Experiential Learning (Activity Based Learning): Mini Autonomous Vehicle Prototype Using ESP32 + Camera (Line/Path Following)

Industrial Application : V2X Communication (Vehicle-to-Vehicle and Vehicle-to-Infrastructure)

Content Beyond Syllabus : Digital Twin for Automotive Systems (Virtual Vehicle Models)

**TOTAL 60 periods**

## Course Outcomes

At the end of this course, the students will have the ability in

|     |                                                                                                                                                                          |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Insight into the significance of the role of embedded system for automotive applications.                                                                                |
| CO2 | Illustrate the need, selection of sensors and actuators and interfacing with ECU                                                                                         |
| CO3 | Develop the Embedded concepts for vehicle management and control systems                                                                                                 |
| CO4 | Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs                                                   |
| CO5 | Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems |

## TEXTBOOKS

|   |                                                                                                                            |
|---|----------------------------------------------------------------------------------------------------------------------------|
| 1 | William B. Ribbens , "Understanding Automotive Electronics", Elsevier, 8 <sup>th</sup> Edition, 2017.                      |
| 2 | L.Vlasic, M.Parent, F.Harshima, "Intelligent Vehicle Technologies", SAE International, 2001, 1 <sup>st</sup> Edition, 2017 |



| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2 Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                               |      |      |      |     |     |     |     |     |      |      |       |       |       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|-----|-----|-----|-----|-----|------|------|-------|-------|-------|
| CO/PO                                                                                                                                                                  | PO 1                                                                                                                                          | PO 2 | PO 3 | PO 4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 | PSO 3 |
| CO1                                                                                                                                                                    | 1                                                                                                                                             | 3    | 2    | 2    | 1   | -   | -   | -   | -   | -    | -    | 2     | 1     | 3     |
| CO2                                                                                                                                                                    | 2                                                                                                                                             | 3    | 3    | 2    | 2   | -   | -   | -   | -   | -    | -    | 2     | 2     | 2     |
| CO3                                                                                                                                                                    | 3                                                                                                                                             | 3    | 3    | 3    | 3   | -   | -   | -   | -   | -    | -    | 2     | 1     | 3     |
| CO4                                                                                                                                                                    | 3                                                                                                                                             | 3    | 3    | 3    | 3   | -   | -   | -   | -   | -    | -    | 1     | 3     | 2     |
| CO5                                                                                                                                                                    | 3                                                                                                                                             | 3    | 1    | 2    | 1   | -   | -   | -   | 1   | -    | -    | 2     | 2     | 3     |
| AVG                                                                                                                                                                    | 2.4                                                                                                                                           | 3    | 2.4  | 2.4  | 2   | -   | -   | -   | 1   | -    | -    | 1.8   | 1.8   | 2.6   |
| <b>Product based outcomes</b>                                                                                                                                          |                                                                                                                                               |      |      |      |     |     |     |     |     |      |      |       |       |       |
| 1                                                                                                                                                                      | Miniature Electronic Control Unit (ECU) Prototype - A working ECU capable of acquiring sensor data, processing it, and controlling actuators. |      |      |      |     |     |     |     |     |      |      |       |       |       |
| 2                                                                                                                                                                      | On-Board Vehicle Diagnostics (OBD) Scanner - A functional OBD-II reader that fetches live vehicle parameters and trouble codes.               |      |      |      |     |     |     |     |     |      |      |       |       |       |



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|                                         |                                                                                                                                                                        |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3                                       | Adaptive Cruise Control (ACC) Demo System - A small-scale model car that adjusts its speed based on distance measurement.                                              |
| 4                                       | Smart Automotive Sensor Hub - Integrated module that reads MAP, TPS, temperature, and speed sensors and transmits data (Bluetooth/CAN).                                |
| 5                                       | Autonomous Navigation Robot (Automotive Concept Demonstrator) - A scaled self-driving vehicle demonstrating lane following, collision avoidance, and IoT connectivity. |
| <b>Product based Projects (in team)</b> |                                                                                                                                                                        |
| 1                                       | Open-Source ECU for Small Engines - Based on ESP32/STM32/Arduino - Controls fuel injection, ignition timing, and throttle                                              |
| 2                                       | Smart OBD-II Diagnostic Tool - Reads DTC codes, live engine parameters - Mobile app dashboard via Bluetooth                                                            |
| 3                                       | Mini Autonomous Car with Lane Detection - Uses camera or IR sensors - Performs lane following + collision avoidance                                                    |
| 4                                       | Adaptive Cruise Control Model Car - Ultrasonic/LiDAR sensors - PID speed adjustment based on leading vehicle                                                           |
| 5                                       | Vehicle Energy Management System - Real-time monitoring of battery, alternator, load distribution - Predictive alerts and optimization                                 |
| 6                                       | CAN Bus-Based Vehicle Communication Demo - Multiple ECUs (speed controller, brake module, sensor module) communicating using CAN/LIN                                   |
| 7                                       | Smart Parking Assist System - Ultrasonic/LiDAR + motor for steering - Automatic parallel/angled parking demo                                                           |
| 8                                       | In-Vehicle Infotainment Prototype - MOST/CAN-based communication - Integrates audio, navigation, and vehicle diagnostics                                               |
| 9                                       | Automotive Safety and Collision Avoidance System - Detects front/rear obstacles - Automatic emergency braking (AEB) prototype                                          |
| 10                                      | IoT-Enabled Vehicle Monitoring System - Sends GPS, speed, fuel level, and harsh-driving alerts to cloud - Mobile dashboard for remote monitoring                       |



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**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY**

| SI. NO. | COURSE CODE | COURSE TITLE                                             | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|----------------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                          |          |     | L                | T | P |         |
| 1       | U24EEP41    | Electric Vehicle Architecture                            | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP42    | Electric Vehicle Design, Mechanics and Control           | PEC      | 4   | 2                | 0 | 2 | 3       |
| 3       | U24EEP43    | Design Of Electric Vehicle Charging System               | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP44    | Testing Of Electric Vehicle                              | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP45    | Grid Integration of Electric Vehicles                    | PEC      | 3   | 3                | 0 | 0 | 3       |
| 6       | U24EEP46    | Design Of Motor & Power Converters for Electric Vehicles | PEC      | 4   | 2                | 0 | 2 | 3       |
| 7       | U24EEP47    | Electric & Hybrid Vehicles                               | PEC      | 3   | 3                | 0 | 0 | 3       |



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| U24EEP41                                                                                                                                                                                                                                  | ELECTRIC VEHICLE ARCHITECTURE                                                                                                       | L | T | P        | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|---|---|----------|---|
|                                                                                                                                                                                                                                           |                                                                                                                                     | 3 | 0 | 0        | 3 |
| <b>COURSE OBJECTIVES</b>                                                                                                                                                                                                                  |                                                                                                                                     |   |   |          |   |
| After completing this course, the students will be able to:                                                                                                                                                                               |                                                                                                                                     |   |   |          |   |
| 1                                                                                                                                                                                                                                         | Explain the evolution, architecture, and sizing of electric vehicles for two-wheelers, passenger cars, and heavy-duty applications. |   |   |          |   |
| 2                                                                                                                                                                                                                                         | Apply principles of vehicle mechanics and dynamics to analyze motion, forces, and propulsion requirements of electric vehicles.     |   |   |          |   |
| 3                                                                                                                                                                                                                                         | Analyze and design EV and HEV powertrain components including transmission and braking systems based on performance requirements.   |   |   |          |   |
| 4                                                                                                                                                                                                                                         | Design hybrid vehicle supervisory and mode-selection control strategies for efficient energy management.                            |   |   |          |   |
| 5                                                                                                                                                                                                                                         | Evaluate plug-in hybrid electric vehicle architectures, charging mechanisms, and operational advantages for long-range mobility.    |   |   |          |   |
| <b>UNIT 1 VEHICLE ARCHITECTURE and SIZING</b>                                                                                                                                                                                             |                                                                                                                                     |   |   | <b>9</b> |   |
| Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications. |                                                                                                                                     |   |   |          |   |
| Experiential Learning (Activity Based Learning): Build a functional EV model (mini car/bike) using DC motors and batteries to understand architecture and power flow.                                                                     |                                                                                                                                     |   |   |          |   |
| Industrial Application: Design and development of powertrains in Tata Motors, Mahindra Electric, and Ather Energy.                                                                                                                        |                                                                                                                                     |   |   |          |   |
| Content Beyond Syllabus: AI-based vehicle sizing for efficiency and cost trade-offs.                                                                                                                                                      |                                                                                                                                     |   |   |          |   |
| <b>UNIT 2 VEHICLE MECHANICS</b>                                                                                                                                                                                                           |                                                                                                                                     |   |   | <b>9</b> |   |
| Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.                                       |                                                                                                                                     |   |   |          |   |
| Experiential Learning (Activity Based Learning): Perform rolling resistance and aerodynamic drag calculations for a given EV.                                                                                                             |                                                                                                                                     |   |   |          |   |
| Industrial Application: Design of suspension and propulsion systems in electric two- and four-wheelers.                                                                                                                                   |                                                                                                                                     |   |   |          |   |
| Content Beyond Syllabus: Integration of AI in vehicle dynamics control (autonomous stability systems).                                                                                                                                    |                                                                                                                                     |   |   |          |   |
| <b>UNIT 3 POWER COMPONENTS AND BRAKES</b>                                                                                                                                                                                                 |                                                                                                                                     |   |   | <b>9</b> |   |





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Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.

Experiential Learning (Activity Based Learning): MATLAB/Excel-based HEV powertrain sizing with sample calculation of energy flow.

Industrial Application: Powertrain design and testing in OEMs like Hyundai, Ashok Leyland EV Division, Ola Electric.

Content Beyond Syllabus: Optimization of powertrain component life using AI-based predictive maintenance.

## UNIT 4 HYBRID VEHICLE CONTROL STRATEGY

9

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

Experiential Learning (Activity Based Learning): Design a mode selection control algorithm for a hybrid vehicle prototype.

Industrial Application: Energy management in fleet hybrid buses and trucks.

Content Beyond Syllabus: AI and neural network-based hybrid energy management systems.

## UNIT 5 PLUG-IN HYBRID ELECTRIC VEHICLE

9

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs.

Experiential Learning (Activity Based Learning): Simulate charging and discharging cycles using MATLAB or Proteus.

Industrial Application: Applications in long-range commercial fleets and smart grid integration.

Content Beyond Syllabus: Bidirectional charging and vehicle-to-grid (V2G) technology.

## TOTAL PERIODS

45



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## COURSE OUTCOMES

At the end of the course, the student will be able to

|     |                                                                                                                                             |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Explain and classify different EV, HEV, and PHEV architectures and analyze basic sizing parameters for various electric vehicle categories. |
| CO2 | Analyze vehicle dynamics and estimate propulsion power, velocity, and acceleration requirements for electric vehicles.                      |
| CO3 | Select and size powertrain components and braking systems for EV and HEV applications based on vehicle requirements.                        |
| CO4 | Describe and apply hybrid vehicle supervisory control and mode selection strategies for different driving conditions.                       |
| CO5 | Explain and compare plug-in hybrid electric vehicles with EVs and HEVs and illustrate their charging mechanisms and advantages.             |

## TEXT BOOKS

|   |                                                                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004. |
| 2 | Build Your Own Electric Vehicle, Seth Leitman, Bob Brant, McGraw Hill, Third Edition 2013.                                                                          |

## REFERENCES

|   |                                                                                                                                                                                     |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.                                                                                                         |
| 2 | The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011. |
| 3 | Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021                      |
| 4 | Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020                                        |

**CO/PO, PSO Mapping**  
**(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak**  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | –   | –   | –   | –   | –   | –   | 1   | –   | 1    | 1    | 3    | 2    | 1    |
| CO2 | 3   | –   | 3   | 3   | –   | –   | 2   | 1   | –   | 2    | 3    | 3    | 3    | 3    |
| CO3 | 3   | –   | –   | –   | –   | –   | –   | 1   | –   | 1    | 1    | 3    | 3    | 3    |
| CO4 | 3   | –   | 3   | 3   | –   | –   | –   | 1   | –   | 3    | 3    | 3    | 3    | 3    |



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|     |   |   |   |   |   |   |     |   |   |     |     |   |     |     |
|-----|---|---|---|---|---|---|-----|---|---|-----|-----|---|-----|-----|
| CO5 | 3 | – | 3 | 3 | – | – | 3   | 1 | – | 3   | 3   | 3 | 3   | 3   |
| AVG | 3 | – | 3 | 3 | – | – | 2.5 | 1 | – | 2.2 | 2.3 | 3 | 2.8 | 2.6 |

## PRODUCT BASED OUTCOME

|   |                                                                                                     |
|---|-----------------------------------------------------------------------------------------------------|
| 1 | Build a functional low-cost EV or HEV working model demonstrating power flow from battery to motor. |
| 2 | Develop a MATLAB/Excel-based EV performance analysis product validated using a hardware model.      |
| 3 | Design a low-cost EV drivetrain and braking demonstration system.                                   |
| 4 | Implement a basic hybrid mode selection logic using switches / logic control.                       |
| 5 | Simulate and demonstrate EV charging, SOC variation, and regenerative braking concepts.             |

## PRODUCT-BASED TEAM PROJECTS

|    |                                                         |
|----|---------------------------------------------------------|
| 1  | Mini Electric Car Using DC Motor                        |
| 2  | EV Powertrain Sizing Calculator + Validation Model      |
| 3  | EV Road Load & Performance Analyzer                     |
| 4  | Series–Parallel Hybrid Architecture Demonstration Model |
| 5  | Regenerative Braking Demonstration Model                |
| 6  | PHEV Charging & SOC Simulation Tool                     |
| 7  | EV Gear Ratio Effect Demonstrator                       |
| 8  | Rule-Based Hybrid Mode Selector                         |
| 9  | Electric Bicycle Power Requirement Estimator            |
| 10 | V2G Concept Demonstration Model                         |



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|                                                                                                                                                                        |                                                                                                                                                             |   |   |   |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|----|
| U24EEP42                                                                                                                                                               | ELECTRIC VEHICLE DESIGN, MECHANICS AND<br>CONTROL                                                                                                           | L | T | P | C  |
|                                                                                                                                                                        |                                                                                                                                                             | 2 | 0 | 2 | 3  |
| COURSE OBJECTIVES                                                                                                                                                      |                                                                                                                                                             |   |   |   |    |
| After completion of this course, the students will be able to:                                                                                                         |                                                                                                                                                             |   |   |   |    |
| 1                                                                                                                                                                      | Explain the working principles, performance parameters, fuel economy, and emission control techniques of internal combustion engines and alternative fuels. |   |   |   |    |
| 2                                                                                                                                                                      | Compare electric, hybrid, and internal combustion engine vehicles and apply basic vehicle mechanics to analyze propulsion systems.                          |   |   |   |    |
| 3                                                                                                                                                                      | Describe battery types and parameters and analyze battery modeling, management, and charging methods for electric and hybrid vehicles.                      |   |   |   |    |
| 4                                                                                                                                                                      | Apply control system fundamentals to analyze stability, transient response, and frequency-domain characteristics of power electronic systems.               |   |   |   |    |
| 5                                                                                                                                                                      | Explain AC machine modeling and apply advanced control strategies such as vector control and direct torque control for electric drive applications.         |   |   |   |    |
| UNIT I INTERNAL COMBUSTION ENGINES                                                                                                                                     |                                                                                                                                                             |   |   |   | 9  |
| IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.                                                      |                                                                                                                                                             |   |   |   |    |
| Experiential Learning (Activity Based Learning): Assembly of a IC Engine                                                                                               |                                                                                                                                                             |   |   |   |    |
| Industrial Application: Automotive design and R&D to meet government regulations (e.g., CAFE norms, Bharat Stage standards in India).                                  |                                                                                                                                                             |   |   |   |    |
| Content Beyond Syllabus: Alternative fuels: CNG, LNG, Hydrogen, Bio-diesel, and Synthetic fuels (e-fuels).                                                             |                                                                                                                                                             |   |   |   |    |
| UNIT II ELECTRIC VEHICLES AND VEHICLE MECHANICS                                                                                                                        |                                                                                                                                                             |   |   |   | 9  |
| Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics. |                                                                                                                                                             |   |   |   |    |
| Experiential Learning (Activity Based Learning): Simulation of EV Power Train Industrial                                                                               |                                                                                                                                                             |   |   |   |    |
| Application: Fleet Decision-Making                                                                                                                                     |                                                                                                                                                             |   |   |   |    |
| Content Beyond Syllabus: EV Charging Infrastructure                                                                                                                    |                                                                                                                                                             |   |   |   |    |
| UNIT III BATTERY MODELING, TYPES AND CHARGING                                                                                                                          |                                                                                                                                                             |   |   |   | 18 |



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Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Li-ion battery, Sodium ion-Nickel Manganese Cobalt Battery- Li-Iron Phosphate Battery - Li-Polymer Battery and Solid state Battery , Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

Experiential Learning (Activity Based Learning): Types of charges in EV

Industrial Application: Battery recycling and second-life applications.

Content Beyond Syllabus : Cell balancing

Lab Component:

1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.

## UNIT IV CONTROL PRELIMINARIES

12

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

Experiential Learning (Activity Based Learning): Line following Robot.

Industrial Application: Simulate EV regenerative braking transient current spikes.

Content Beyond Syllabus: Study of oscillations in real EV charging circuits.

Lab Component:

1. Simulation of boost converter and calculating gain and phase margin from the transfer function.

## UNIT 5 CONTROL OF AC MACHINES

12

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames-Vector control- Direct torque control

Experiential Learning (Activity Based Learning): V/F control of Machines

Industrial Application: Marine Propulsion: Electric ships using PMSM drives with FOC for efficiency.

Content Beyond Syllabus: Park & Clarke transformations applied to BLDC and PMSM motors in EVs.

Lab Component:

- 1.Simulation of vector control of induction motor.

TOTAL PERIODS

60

## COURSE OUTCOMES

At the end of the course, the student will be able to

CO1

Analyze IC engine performance using BMEP, BSFC, and fuel economy metrics and evaluate emission control and exhaust treatment systems.



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|            |                                                                                                                                                      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO2</b> | Compare EV, HEV, and ICE vehicles and apply vehicle mechanics principles to simulate and assess electric powertrain performance.                     |
| <b>CO3</b> | Model different battery chemistries using equivalent circuit models and evaluate charging, balancing, and management strategies for EV applications. |
| <b>CO4</b> | Analyze control systems using transfer functions, Bode plots, and stability margins and assess transient behavior in EV power electronic systems.    |
| <b>CO5</b> | Apply reference frame theory to model AC machines and implement vector control and direct torque control strategies for electric drive systems.      |

## TEXT BOOKS

|   |                                                                                                                      |
|---|----------------------------------------------------------------------------------------------------------------------|
| 1 | Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021                      |
| 2 | Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition |

## REFERENCES

|   |                                                                                                                                                                           |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Power Electronic Converters, Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH. |
| 2 | C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.                                                                |
| 3 | Ali Emadi, Mehrdad Ehsani, John M. Miller, "Vehicular Electric Power Systems", Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition                               |
| 4 | Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall, 1997, 1st Edition                                                                     |
| 5 | Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimi Reddy Prathap Reddy, Wiley, 2021, 1st Edition.      |

**CO/PO, PSO Mapping**  
(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | -   | -   | -   | -   | -   | -   | 1   | 2   | -    | 2    | 3    | -    | -    |
| <b>CO2</b> | 3   | 3   | 3   | 3   | 3   |     | -   | 1   | 3   | -    | 2    | 3    | -    | 3    |
| <b>CO3</b> | 3   | -   | 1   | 3   | 3   | 3   | -   | 1   | 2   | -    | 2    | 3    | -    | 3    |
| <b>CO4</b> | 3   | -   | -   | -   | 3   | 3   | -   | 1   | 2   | -    | 2    | 3    | -    | 3    |
| <b>CO5</b> | 3   | -   | 3   | -   | -   | 3   | -   | 1   | 2   | -    | 2    | 3    | 2    | 3    |



|                                    |                                                                                                                       |   |     |   |   |   |   |   |     |   |   |   |   |   |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---|-----|---|---|---|---|---|-----|---|---|---|---|---|
| <b>AVG</b>                         | 3                                                                                                                     | 3 | 2.3 | 3 | 3 | 3 | - | 1 | 2.2 | - | 2 | 3 | 2 | 3 |
| <b>PRODUCT BASED OUTCOME</b>       |                                                                                                                       |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 1                                  | Develop emission reduction strategies for diesel engines using suitable after-treatment systems (DOC, DPF, SCR, EGR). |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 2                                  | Design basic architectures of EV and HEV Power trains.                                                                |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 3                                  | Design battery management system (BMS) concepts such as SOC, SOH estimation and thermal management.                   |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 4                                  | Design control strategies for boost converters used in EV power electronics.                                          |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 5                                  | Design vector control and direct torque control (DTC) schemes for AC motors used in EV propulsion.                    |   |     |   |   |   |   |   |     |   |   |   |   |   |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                                                                       |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 1                                  | IOT Based Crash Detection System                                                                                      |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 2                                  | Smart Helmet Safety System for Electric Two wheelers                                                                  |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 3                                  | Speed Control System for Electric Vehicles Using PID Controller                                                       |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 4                                  | Mobile Use Detection While Driving                                                                                    |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 5                                  | Smart Headlight Control System                                                                                        |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 6                                  | Virtual EV Design using MATLAB                                                                                        |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 7                                  | Child in Car forgotten Alert System                                                                                   |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 8                                  | Wireless Charging in EV                                                                                               |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 9                                  | Solar-powered EV charging system with MPPT (maximum power point tracking)                                             |   |     |   |   |   |   |   |     |   |   |   |   |   |
| 10                                 | Smart Traffic Management System                                                                                       |   |     |   |   |   |   |   |     |   |   |   |   |   |





# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EEP43                                                                                                                                                                                                                                                                                                                                        | DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM                                                                                               | L | T | P | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                          | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                               |                                                                                                                                          |   |   |   |   |
| After completion of this course, the students will be able to:                                                                                                                                                                                                                                                                                  |                                                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                               | Explain EV evolution, architectures, and vehicle classifications and identify charging-related implications for different EV categories. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                               | Analyze power electronic converter topologies used in AC–DC and DC–DC EV charging systems.                                               |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                               | Apply renewable energy integration principles to analyze EV charging systems with solar PV and energy storage.                           |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                               | Explain wireless power transfer principles and compare EV wireless charging standards and operation modes.                               |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                               | Apply power factor correction principles to design boost PFC circuits for EV charging systems.                                           |   |   |   |   |
| UNIT I CHARGING STATIONS AND STANDARDS                                                                                                                                                                                                                                                                                                          |                                                                                                                                          |   |   | 9 |   |
| Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.                                                                                                       |                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Build a functional EV model (mini car/bike) using DC motors and batteries to understand architecture and power flow.</a>                                                                                                                                                           |                                                                                                                                          |   |   |   |   |
| <a href="#">Industrial Application: Design and development of powertrains in Tata Motors, Mahindra Electric, and Ather Energy.</a>                                                                                                                                                                                                              |                                                                                                                                          |   |   |   |   |
| <a href="#">Content Beyond Syllabus: AI-based vehicle sizing for efficiency and cost trade-offs.</a>                                                                                                                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| UNIT 2 POWER ELECTRONICS FOR EV CHARGING                                                                                                                                                                                                                                                                                                        |                                                                                                                                          |   |   | 9 |   |
| Layouts of EV Battery Charging Systems - AC charging-DC charging systems - Power Electronic Converters for EV Battery Charging - AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters - Non-isolated DC–DC bidirectional converter topologies - Half-bridge bidirectional converter. |                                                                                                                                          |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Students design and analyze single-phase boost PFC converter using MATLAB/Simulink.</a>                                                                                                                                                                                            |                                                                                                                                          |   |   |   |   |
| <a href="#">Industrial Application: Bidirectional converters enable Vehicle-to-Grid (V2G) energy transfer.</a>                                                                                                                                                                                                                                  |                                                                                                                                          |   |   |   |   |
| <a href="#">Content Beyond Syllabus: Digital control of converters using DSP/FPGA.</a>                                                                                                                                                                                                                                                          |                                                                                                                                          |   |   |   |   |
| UNIT 3 EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS                                                                                                                                                                                                                                                                                          |                                                                                                                                          |   |   | 9 |   |



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Introduction - EV charger topologies, EV charging/discharging strategies - Integration of EV charging - home solar PV system, Operation modes of EVC-HSP system, Control strategy of EVCHSP system - fast-charging infrastructure with solar PV and energy storage.

Experiential Learning (Activity Based Learning): Simulate power flow control between PV, grid, and EV using MATLAB or PSIM.

Industrial Application: BPCL & IOCL deploying hybrid solar-powered EV charging stations at fuel outlets.

Content Beyond Syllabus: AI-based optimal scheduling of solar EV charging loads.

## UNIT 4 HYBRID VEHICLE CONTROL STRATEGY

9

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs - Charging Modes in EVs - Benefits of WPT - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

Experiential Learning (Activity Based Learning): Design a small 12 V wireless charger using coils and measure transfer efficiency.

Industrial Application: WiTricity and Qualcomm Halo systems for wireless EV charging.

Content Beyond Syllabus: Standardization roadmap for megawatt-level WPT for buses/trucks.

## UNIT 5 POWER FACTOR CORRECTION IN CHARGING SYSTEM

9

Need for power factor correction - Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses.

Experiential Learning (Activity Based Learning): Students calculate and simulate boost inductor sizing and efficiency under different loads.

Industrial Application: Onboard chargers in EVs (e.g., BYD, Hyundai Kona) use boost PFC circuits.

Content Beyond Syllabus: Bridgeless PFC topologies for high efficiency.

## TOTAL PERIODS

45

## COURSE OUTCOMES

At the end of the course, the student will be able to

|     |                                                                                                                             |
|-----|-----------------------------------------------------------------------------------------------------------------------------|
| CO1 | Differentiate EV architectures and vehicle types and relate them to charging requirements and power flow configurations.    |
| CO2 | Design and analyze AC–DC and bidirectional DC–DC converter topologies for EV battery charging and V2G applications.         |
| CO3 | Analyze and simulate power flow and control strategies for EV charging systems integrated with solar PV and energy storage. |



|   |                                                                                                                                      |
|---|--------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Develop a comparative EV charging station and standards analysis product covering conductive, inductive, and bidirectional charging. |
|---|--------------------------------------------------------------------------------------------------------------------------------------|



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Department: Electrical and Electronics Engineering, R2024, CBCS

|   |                                                                                                                            |
|---|----------------------------------------------------------------------------------------------------------------------------|
| 2 | Build a functional AC–DC / DC–DC converter model for EV charging applications with performance evaluation.                 |
| 3 | Create a renewable-integrated EV charging system model incorporating PV, storage, and grid interaction.                    |
| 4 | Implement a wireless power transfer charging prototype or simulation compliant with EV charging standards.                 |
| 5 | Design a boost converter-based power factor correction system and validate its performance through simulation or hardware. |

## PRODUCT-BASED TEAM PROJECTS

|    |                                              |
|----|----------------------------------------------|
| 1  | EV Charging Standards Comparison Dashboard   |
| 2  | 12V Wireless EV Charger Prototype            |
| 3  | Smart EV Charging Billing Prototype          |
| 4  | Single-Phase Boost PFC AC–DC Charger         |
| 5  | Bridgeless PFC Converter Prototype           |
| 6  | Bidirectional DC–DC Converter for V2G        |
| 7  | Converter Loss & Thermal Estimation Tool     |
| 8  | Solar PV Based EV Charging Station Model     |
| 9  | Electric Bicycle Power Requirement Estimator |
| 10 | EV–Home–Solar Power Flow Controller          |



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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EEP44                                                                                                                                                                                                                                                                                                                                            | TESTING OF ELECTRIC VEHICLES                                                                                                         | L | T | P | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                      | 2 | 0 | 2 | 3 |
| <b>COURSE OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |   |   |   |   |
| After completion of this course, the students will be able to:                                                                                                                                                                                                                                                                                      |                                                                                                                                      |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                   | Explain the need for EV standardization and identify national and international standards applicable to electric vehicle components. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                   | Apply standardized testing procedures to analyze the performance of electric motors and controllers used in EV and HEV applications. |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                   | Explain functional safety principles and analyze reliability and risk assessment methods used in electric and autonomous vehicles.   |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                   | Analyze electromagnetic compatibility (EMC) issues in electric vehicles and apply mitigation requirements to EV subsystems.          |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                   | Analyze electromagnetic interference (EMI) mechanisms in motor drives and DC–DC converters and design suitable mitigation models.    |   |   |   |   |
| UNIT I EV STANDARDIZATION                                                                                                                                                                                                                                                                                                                           |                                                                                                                                      |   |   | 9 |   |
| Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.                                             |                                                                                                                                      |   |   |   |   |
| Experiential Learning (Activity Based Learning): Identify the standards applicable to 5 EV components (battery, charger, motor, connector, BMS).                                                                                                                                                                                                    |                                                                                                                                      |   |   |   |   |
| Industrial Application: Vehicle homologation, export/import compliance & safety certification. Used by companies like Tata Motors, Toyota, Tesla.                                                                                                                                                                                                   |                                                                                                                                      |   |   |   |   |
| Content Beyond Syllabus: Cyber security in EVs                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |   |   |   |   |
| UNIT II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES                                                                                                                                                                                                                                                        |                                                                                                                                      |   |   | 9 |   |
| Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer |                                                                                                                                      |   |   |   |   |
| Experiential Learning (Activity Based Learning): MATLAB/Simulink motor testing simulation.                                                                                                                                                                                                                                                          |                                                                                                                                      |   |   |   |   |
| Industrial Application: Used in component qualification, R&D labs (BOSCH, Mahindra Electric).                                                                                                                                                                                                                                                       |                                                                                                                                      |   |   |   |   |
| Content Beyond Syllabus: CHAdeMO & ISO 15118 protocols for bidirectional charging.                                                                                                                                                                                                                                                                  |                                                                                                                                      |   |   |   |   |
| UNIT III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC                                                                                                                                                                                                                                                                                                  |                                                                                                                                      |   |   | 9 |   |



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Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality – Standards Functional safety of autonomous vehicles.

Experiential Learning (Activity Based Learning): Build a redundant control logic demo using Arduino.  
Industrial Application: Adopted in ADAS, autonomous EVs, battery safety systems, drive controls, followed by Ather, Mercedes EQ, BMW i-Series.

Content Beyond Syllabus: WLTC & WHTC Power Devices in Motor Drives

## UNIT IV EMC IN ELECTRIC VEHICLES

9

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements

Experiential Learning (Activity Based Learning): PCB layout comparison for low-EMC design (poor vs optimized).

Industrial Application: charging stations, BMS, V2G communication, wireless charging infrastructure, developed by Siemens, ABB, Qualcomm Halo.

Content Beyond Syllabus: Functional safety challenge: sensor fusion errors.

## UNIT V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM

9

Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path.

Experiential Learning (Activity Based Learning): Functional safety challenge: sensor fusion errors.

Industrial Application: EMI in IGBT/SiC based inverters, DC-DC converters, onboard chargers, used by Delta Electronics, Hitachi, BYD.

Content Beyond Syllabus: Digital twin for controller and power train testing.

## LAB COMPONENT: 15 PERIODS

1. Design and simulate motor controllers for hybrid electric vehicle applications.
2. Simulation of EMC analysis for Wireless power transfer EV charging.
3. Design and simulation of EMI filter.

## TOTAL PERIODS

60

## COURSE OUTCOMES



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|                                                                                                                                                                 |                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, the student will be able to                                                                                                           |                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                                                                                                                             | Identify, classify, and interpret EV standards related to batteries, chargers, motors, connectors, and BMS for homologation and safety compliance. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                                                                                                             | Execute and analyze motor and controller testing procedures using M–G sets and dynamometers and interpret type-test results.                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                                                                                                             | Perform hazard analysis, fault tree analysis, and reliability modeling to evaluate functional safety compliance of EV systems.                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                                                                                                             | Analyze EMC problems in EV subsystems and propose design practices to meet vehicle EMC requirements.                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                                                                                                             | Model EMI sources and coupling paths in motor drives and DC–DC converters and design EMI mitigation and filtering strategies.                      |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                                                                                                                      |                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                               | Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                               | Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                                                      |                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                               | EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                               | EMI/EMC Computational Modeling Handbook, Druce Archambeault, Colin Branch, Omar M.Ramachi, Springer 2012, 2nd Edition.                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                               | Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.                                                                                         |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                               | Electric Vehicle Systems Architecture and Standardization Needs, Reports Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |                                                                                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                 | PO1                                                                                                                                                | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                             | 3                                                                                                                                                  | 1   | 1   | -   | -   | -   | 2   | -   | -   | -    | -    | 3    | -    | 2    |
| CO2                                                                                                                                                             | 3                                                                                                                                                  | 1   | 1   | -   | -   | -   | 1   | -   | -   | -    | -    | 3    | -    | 2    |
| CO3                                                                                                                                                             | 3                                                                                                                                                  | 1   | 1   | -   | -   | -   | 2   | -   | -   | -    | -    | 3    | -    | 2    |
| CO4                                                                                                                                                             | 3                                                                                                                                                  | 1   | 1   | -   | -   | -   | 1   | -   | -   | -    | -    | 3    | -    | 2    |
| CO5                                                                                                                                                             | 3                                                                                                                                                  | 1   | 1   | -   | -   | -   | 2   | -   | -   | -    | -    | 3    | -    | 3    |





|                             |                                                                                         |   |   |   |   |   |     |   |   |   |   |   |   |   |
|-----------------------------|-----------------------------------------------------------------------------------------|---|---|---|---|---|-----|---|---|---|---|---|---|---|
| AVG                         | 3                                                                                       | 1 | 1 | - | - | - | 1.8 | - | - | - | 2 | 3 | 2 | 3 |
| PRODUCT BASED OUTCOME       |                                                                                         |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 1                           | To design and document standardization-compliant EV components and subsystems.          |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 2                           | To simulate, perform, or create testing frameworks for EV motors and controllers.       |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 3                           | To produce safety engineering deliverables used in industry.                            |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 4                           | To design and analyze solutions for EMC issues in EV systems.                           |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 5                           | To identify, model, and mitigate EMI in power electronic systems.                       |   |   |   |   |   |     |   |   |   |   |   |   |   |
| PRODUCT-BASED TEAM PROJECTS |                                                                                         |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 1                           | Design of a universal EV charging connector mock-up based on IEC and CHAdeMO standards. |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 2                           | BLDC motor digital twin for performance prediction.                                     |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 3                           | Safety-compliant design of an EV thermal runaway detection module.                      |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 4                           | Digital Twin of an Electric Vehicle Power train with Safety & EMC Layers                |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 5                           | Motor vibration pattern analyzer using MEMS sensors.                                    |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 6                           | LC filter design for a DC supply and measure ripple reduction                           |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 7                           | EMC/EMI Optimized DC-DC Converter for EV Applications                                   |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 8                           | Wireless Charging System with EMI/EMC Analysis                                          |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 9                           | Design a watchdog timer circuit for EV microcontrollers.                                |   |   |   |   |   |     |   |   |   |   |   |   |   |
| 10                          | Smart BMS with State of Health (SOH) Prediction                                         |   |   |   |   |   |     |   |   |   |   |   |   |   |



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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EEP45                                                                                                                                                                                                                                                                                                                               | GRID INTEGRATION OF ELECTRIC VEHICLES                                                                                                              | L | T | P | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                    | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                    |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                      | Explain the concept, evolution, and applications of Vehicle-to-Grid (V2G) systems and their role in electricity markets and renewable integration. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                      | Analyze the technical, economic, and environmental benefits of V2G for EV owners, utilities, and society.                                          |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                      | Evaluate the technical, economic, and regulatory challenges associated with large-scale implementation of V2G systems.                             |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                      | Analyze the impact of EV and V2G penetration on smart grids and renewable energy systems using communication and interoperability standards.       |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                      | Apply machine-to-machine (M2M) communication and data management principles for scalable grid integration and management of EVs.                   |   |   |   |   |
| UNIT I DEFINITION AND STATUS OF V2G                                                                                                                                                                                                                                                                                                    |                                                                                                                                                    |   |   | 9 |   |
| Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice, V2G - Power Markets and Applications. Electricity Markets and V2G Suitability, Long-Term Storage, Renewable Energy, and Other Grid Applications, Beyond the Grid: Other Concepts Related to V2G. |                                                                                                                                                    |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Study EV tariffs from local electricity boards</a><br><a href="#">Industrial Application: V2G-enabled community microgrids for backup power</a><br><a href="#">Content Beyond Syllabus: V2G for disaster relief microgrids</a>                                            |                                                                                                                                                    |   |   |   |   |
| UNIT II BENEFITS AND CHALLENGES OF V2G                                                                                                                                                                                                                                                                                                 |                                                                                                                                                    |   |   | 9 |   |
| Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.                                                                                                         |                                                                                                                                                    |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Calculate revenue from V2G for fleet owners</a><br><a href="#">Industrial Application: “Energy Arbitrage” using EV fleet charging</a><br><a href="#">Content Beyond Syllabus: Smart city integration using V2G-enabled street lighting</a>                                |                                                                                                                                                    |   |   |   |   |
| UNIT III CHALLENGES TO V2G                                                                                                                                                                                                                                                                                                             |                                                                                                                                                    |   |   | 9 |   |



# Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Department: Electrical and Electronics Engineering, R2024, CBCS

Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. Evaluating V2G Costs and Revenues, EV Costs and Benefits, V2G and Regulatory Frameworks, Market Design Challenges. Other V2G Regulatory and Legal Challenges.

Experiential Learning (Activity Based Learning): V2G laws in Japan, Europe, USA, India

Industrial Application: Regulatory frameworks for grid-balancing contracts

Content Beyond Syllabus: Second-life EV batteries for stationary storage

## UNIT IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS

9

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

Experiential Learning (Activity Based Learning): EV impact on distribution transformer using ETAP/DlgSILENT

Industrial Application: V2G-ready residential smart meters

Content Beyond Syllabus: Digital Twins for EV-grid interaction

## UNIT V GRID INTEGRATION AND MANAGEMENT OF EVS

9

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling

Experiential Learning (Activity Based Learning): Collect EV charging data using Arduino/ESP32

Industrial Application: Smart charging in IT campuses/tech parks

Content Beyond Syllabus: Vehicle-to-cloud (V2C) predictive energy systems

**TOTAL PERIODS**

**45**

## COURSE OUTCOMES

**At the end of the course, the student will be able to**

|            |                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Define, classify, and interpret V2G concepts and relate them to power markets, renewable integration, and grid support applications.   |
| <b>CO2</b> | Analyze and quantify technical, economic, and environmental benefits of V2G systems through revenue and efficiency calculations.       |
| <b>CO3</b> | Evaluate battery degradation, charger efficiency, aggregation, and regulatory constraints to assess the feasibility of V2G deployment. |
| <b>CO4</b> | Analyze the impact of EV and V2G penetration on distribution networks and apply IEC 61850-                                             |



| PRODUCT BASED OUTCOME |                                                                                                                           |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------|
| 1                     | To Develop a conceptual V2G system architecture diagram showing EV, bidirectional charger, grid, and communication links. |
| 2                     | To Design a sustainability impact assessment report highlighting emissions reduction and health benefits.                 |
| 3                     | To Develop a battery degradation assessment model under different V2G operating scenarios                                 |
| 4                     | To Design a smart grid interaction model integrating EVs and renewable energy sources.                                    |



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Department: Electrical and Electronics Engineering, R2024, CBCS

|                                    |                                                                          |
|------------------------------------|--------------------------------------------------------------------------|
| 5                                  | To Design an M2M-based EV energy management system architecture.         |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                          |
| 1                                  | Develop a metering model to track bidirectional energy flow and billing. |
| 2                                  | Design aggregator-based communication for large-scale EV participation.  |
| 3                                  | Integrate solar/wind with EV storage for grid balancing.                 |
| 4                                  | AI-Based V2G Energy Management System.                                   |
| 5                                  | Design a V2G-enabled microgrid to support rural or remote areas.         |
| 6                                  | Develop Data Logging and Monitoring Platform.                            |
| 7                                  | Digital Twin of a V2G-Enabled Smart Grid.                                |
| 8                                  | Develop a DC fast charging station supporting bidirectional power flow.  |
| 9                                  | Develop M2M-based communication between EVs and grid controllers.        |
| 10                                 | Design a V2G system for a campus or residential microgrid.               |



# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

| U24EEP46                                                                                                                                                                                                                                                                                                                                           | DESIGN OF MOTOR AND POWER CONVERTERS<br>FOR ELECTRIC VEHICLES                                                                                    | L | T | P         | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---|---|-----------|---|
|                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                  | 2 | 0 | 2         | 3 |
| <b>COURSE OBJECTIVES</b><br>At the end of the course, students will be able to:                                                                                                                                                                                                                                                                    |                                                                                                                                                  |   |   |           |   |
| 1                                                                                                                                                                                                                                                                                                                                                  | Explain the dynamics of electric vehicles and analyze tractive force, speed, torque, power, and energy requirements under standard drive cycles. |   |   |           |   |
| 2                                                                                                                                                                                                                                                                                                                                                  | Compare different electric motors and analyze their speed–torque characteristics to select suitable machines for EV propulsion.                  |   |   |           |   |
| 3                                                                                                                                                                                                                                                                                                                                                  | Apply control system fundamentals to model and analyze EV-related systems using transfer function and state-space representations.               |   |   |           |   |
| 4                                                                                                                                                                                                                                                                                                                                                  | Model and analyze DC–DC converters using averaged and small-signal techniques for EV power electronic applications.                              |   |   |           |   |
| 5                                                                                                                                                                                                                                                                                                                                                  | Analyze power-stage transfer functions of DC–DC converters to evaluate system response and thermal performance in EV applications.               |   |   |           |   |
| <b>UNIT I ELECTRIC VEHICLE DYNAMICS</b>                                                                                                                                                                                                                                                                                                            |                                                                                                                                                  |   |   | <b>9</b>  |   |
| Standard drive cycles-Dynamics of Electric Vehicles - Tractive force - Maximum speed, torque, power, energy requirements of EVs.                                                                                                                                                                                                                   |                                                                                                                                                  |   |   |           |   |
| Experiential Learning (Activity Based Learning): Demonstration of efficiency variation with load using a motor test bench or virtual lab.                                                                                                                                                                                                          |                                                                                                                                                  |   |   |           |   |
| Industrial Application: Efficiency mapping used in EV powertrain design by companies like Tata Motors, Mahindra Electric, and Ather Energy.                                                                                                                                                                                                        |                                                                                                                                                  |   |   |           |   |
| Content Beyond Syllabus: Hub motors for light EVs.                                                                                                                                                                                                                                                                                                 |                                                                                                                                                  |   |   |           |   |
| <b>UNIT II MOTORS FOR ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                        |                                                                                                                                                  |   |   | <b>9</b>  |   |
| Introduction – Speed and Torque control of above and below rated speed - Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs. |                                                                                                                                                  |   |   |           |   |
| Experiential Learning (Activity Based Learning): Compare motor materials (copper vs aluminium winding, permanent magnets).                                                                                                                                                                                                                         |                                                                                                                                                  |   |   |           |   |
| Industrial Application: Directly applicable in EV design companies and research labs for propulsion analysis.                                                                                                                                                                                                                                      |                                                                                                                                                  |   |   |           |   |
| Content Beyond Syllabus: AI-based predictive modelling for motor efficiency improvement.                                                                                                                                                                                                                                                           |                                                                                                                                                  |   |   |           |   |
| <b>UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS</b>                                                                                                                                                                                                                                                                                            |                                                                                                                                                  |   |   | <b>15</b> |   |



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Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

Experiential Learning (Activity Based Learning): Design a PWM inverter model to drive a three-phase induction motor.

Industrial Application: Key technology for manufacturers like Delta Electronics, Bosch, and Siemens.

Content Beyond Syllabus: SiC (Silicon Carbide) and GaN (Gallium Nitride) based converters for high efficiency.

## Lab Component :

1. Simple simulation exercises of basic control systems
2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.

## UNIT IV MODELING OF DC-DC CONVERTERS

15

Overview of PWM Converter Modelling - Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter.

Experiential Learning (Activity Based Learning): Develop a closed-loop control of motor speed using a PID controller in MATLAB.

Industrial Application: Implementation of fault detection and protection in EV drive systems.

Content Beyond Syllabus: Functional safety (ISO 26262) in EV motor drive systems.

## Lab Component :

1. Design of buck converter
2. Design of boost converter

## UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS

12





# Meenakshi Sundararajan Engineering College

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Department: Electrical and Electronics Engineering, R2024, CBCS

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

Experiential Learning (Activity Based Learning): Build a MATLAB thermal model for a motor and converter system.

Industrial Application: Used in EV motor cooling design and battery thermal management systems.

Content Beyond Syllabus: Use of phase-change materials (PCMs) in EV cooling.

## Lab Component :

1. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

**TOTAL PERIODS**

**60**

## COURSE OUTCOMES

At the end of the course, the student will be able to

|     |                                                                                                                                         |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------|
| CO1 | Calculate tractive force, maximum speed, torque, power, and energy requirements of an electric vehicle for given standard drive cycles. |
| CO2 | Compare and select appropriate electric motors by analyzing speed-torque and efficiency characteristics for EV propulsion systems.      |
| CO3 | Develop transfer function and state-space models and analyze time and frequency responses of EV drive and inverter systems.             |
| CO4 | Derive averaged and small-signal models of DC-DC converters and design closed-loop control strategies for EV motor drive applications.  |
| CO5 | Derive and evaluate power-stage transfer functions of buck-boost converters in CCM and assess thermal implications in EV systems.       |

## TEXT BOOKS

|   |                                                                                                                                          |
|---|------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.                                              |
| 2 | Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications                                  |
| 3 | Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning. |

## REFERENCES

|   |                                                                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.                                                         |
| 2 | Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition. |



|                                                                                                                                                                                                                                                  |                                                                                                                                                                                            |            |            |            |            |            |            |            |            |             |             |             |             |             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| 3                                                                                                                                                                                                                                                | Emerging Power Converters for Renewable Energy and Electric Vehicles Modelling, Design and Control, Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition. |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <p align="center"><b>CO/PO, PSO Mapping</b></p> <p align="center"><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b></p> <p align="center"><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b></p> |                                                                                                                                                                                            |            |            |            |            |            |            |            |            |             |             |             |             |             |
|                                                                                                                                                                                                                                                  | <b>PO1</b>                                                                                                                                                                                 | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
| <b>CO1</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 2          | 2          | 1          | 1          | 1          | 1          | 1          | 1          | 1           | 2           | 3           | 2           | 2           |
| <b>CO2</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 3          | 2          | 3          | 2          | 1          | 1          | 1          | 1          | 1           | 2           | 3           | 3           | 2           |
| <b>CO3</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 3          | 3          | 3          | 3          | 2          | 1          | 2          | 2          | 2           | 3           | 3           | 3           | 3           |
| <b>CO4</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 3          | 3          | 3          | 3          | 2          | 2          | 2          | 2          | 2           | 3           | 3           | 3           | 3           |
| <b>CO5</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 2          | 3          | 3          | 3          | 3          | 2          | 2          | 2          | 2           | 3           | 3           | 3           | 3           |
| <b>AVG</b>                                                                                                                                                                                                                                       | 3                                                                                                                                                                                          | 2.6        | 2.6        | 2.6        | 2.6        | 1.8        | 1.4        | 1.8        | 1.6        | 1.6         | 2.6         | 3           | 2.8         | 2.6         |
| <b>PRODUCT BASED OUTCOME</b>                                                                                                                                                                                                                     |                                                                                                                                                                                            |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 1                                                                                                                                                                                                                                                | Develop a drive-cycle-based EV performance analysis model to estimate tractive force, power, and energy requirements.                                                                      |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 2                                                                                                                                                                                                                                                | Build a comparative motor selection and performance evaluation tool for EV propulsion applications.                                                                                        |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                                                | Design a functional DC–DC / DC–AC power converter prototype or simulation model for EV applications.                                                                                       |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 4                                                                                                                                                                                                                                                | Implement a closed-loop motor control system using PWM / vector control / FOC through simulation or hardware-in-loop.                                                                      |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 5                                                                                                                                                                                                                                                | Create an integrated motor–converter thermal and protection analysis model to enhance efficiency and reliability.                                                                          |            |            |            |            |            |            |            |            |             |             |             |             |             |
| <b>PRODUCT-BASED TEAM PROJECTS</b>                                                                                                                                                                                                               |                                                                                                                                                                                            |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 1                                                                                                                                                                                                                                                | PCM-Based Cooling Demonstration Model                                                                                                                                                      |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 2                                                                                                                                                                                                                                                | Low-Cost Converter Heat Sink Design                                                                                                                                                        |            |            |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                                                | Thermal Model of Motor–Converter System                                                                                                                                                    |            |            |            |            |            |            |            |            |             |             |             |             |             |



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|    |                                             |
|----|---------------------------------------------|
| 4  | Hub Motor Performance Estimation Model      |
| 5  | BLDC Motor Speed Control using PWM          |
| 6  | Low-Cost PID Speed Control Demo             |
| 7  | Buck Converter for EV Auxiliary Loads       |
| 8  | Boost Converter for Battery Voltage Step-Up |
| 9  | Open-Loop Buck–Boost Converter              |
| 10 | Converter Efficiency Measurement System     |



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| U24EEP47                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ELECTRIC AND HYBRID VEHICLES                                                                                                   | L | T | P        | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|---|---|----------|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                | 3 | 0 | 0        | 3 |
| <b>COURSE OBJECTIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                |   |   |          |   |
| At the end of the course, students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                |   |   |          |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Explain the design considerations, performance requirements, and resistance forces involved in electric vehicle design.        |   |   |          |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Describe and analyze different energy sources used in electric vehicles including batteries, fuel cells, and ultra-capacitors. |   |   |          |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Explain the operating principles and characteristics of electric motors used in electric vehicle propulsion systems.           |   |   |          |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Explain the role of power electronic converters and controllers in electric vehicle motor drive systems.                       |   |   |          |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Explain the configurations, control strategies, and operational modes of hybrid and electric vehicles.                         |   |   |          |   |
| <b>UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                |   |   | <b>9</b> |   |
| <p>Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems.</p> <p>Experiential Learning (Activity Based Learning): Hands-on design and testing of an EV chassis for optimal weight and aerodynamics.</p> <p>Industrial Application: Use of advanced lightweight materials and CAD tools in EV body design at automotive firms.</p> <p>Content Beyond Syllabus: Experiment: Study of emerging wireless charging technologies and their integration into EV infrastructure.</p> |                                                                                                                                |   |   |          |   |
| <b>UNIT II ENERGY SOURCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                |   |   | <b>9</b> |   |
| <p>Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.</p> <p>Experiential Learning (Activity Based Learning): Battery pack assembly and real-time monitoring</p> <p>Industrial Application: Implementation of fast-charging protocols and thermal management in commercial EV batteries.</p> <p>Content Beyond Syllabus: Experiment: Exploration of solid-state battery technology and its potential</p>                                                                                                                                                |                                                                                                                                |   |   |          |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| impact on EV range and safety.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |
| <b>UNIT III MOTORS AND DRIVES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>9</b>  |
| Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, switched reluctance motors working principle, construction and characteristics.<br><br>Experiential Learning (Activity Based Learning): Testing motor characteristics and efficiency using motor drive kits in a lab environment.<br>Industrial Application: Application of BLDC motors in electric two-wheelers and PMSM in electric cars by manufacturers. Content Beyond Syllabus: Study of sensor less motor control techniques for improved reliability and cost reduction.                                                                                                                                                                                                  |           |
| <b>UNIT IV POWER CONVERTERS AND CONTROLLERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>9</b>  |
| Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes<br><br>Experiential Learning (Activity Based Learning): Simulation and hardware implementation of inverter and rectifier circuits controlling motors.<br>Industrial Application: Use of IGBT-based converters in commercial EV powertrain systems for efficiency optimization.<br>Content Beyond Syllabus: Investigation of wide-bandgap semiconductor devices like SiC and GaN in power electronics.                                                              |           |
| <b>UNIT V HYBRID AND ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>9</b>  |
| Main components and working principles of hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.<br><br>Experiential Learning (Activity Based Learning): Modeling and simulation of hybrid vehicle power split and control strategies using software tools.<br>Industrial Application: Development and testing of hybrid drive systems and regenerative braking in automotive industries. Content Beyond Syllabus: Study of Vehicle-to-Grid (V2G) technologies and their role in energy management with hybrid EVs. |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>45</b> |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |           |



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|            |                                                                                                |
|------------|------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Analyze the operation and architecture of electric and hybrid vehicles computational software. |
| <b>CO2</b> | Identify various energy source options like battery and fuel cell                              |
| <b>CO3</b> | Select suitable electric motor for applications in hybrid and electric vehicles.               |
| <b>CO4</b> | Design the controllers for hybrid and electric vehicles.                                       |
| <b>CO5</b> | Analyze the energy and design requirement for hybrid and electric vehicles.                    |

## TEXT BOOKS

|   |                                                                                           |
|---|-------------------------------------------------------------------------------------------|
| 1 | Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003          |
| 2 | Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005. |

## REFERENCES

|   |                                                                                                         |
|---|---------------------------------------------------------------------------------------------------------|
| 1 | James Larminie and John Lowry, "Electric Vehicle Technology Explained "John Wiley & Sons,2003           |
| 2 | Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005                                   |
| 3 | Ron HodKin son, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005. |

## CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak

Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |
| <b>CO2</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |
| <b>CO3</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |
| <b>CO4</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |
| <b>CO5</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |
| <b>AVG</b> | 1   | 1   | 2   | 1   | -   | 3   | 2   | -   | -   | -    | 2    | -    | 1    | 3    |

## PRODUCT BASED OUTCOME

|   |                                         |
|---|-----------------------------------------|
| 1 | EV Power train Modeling Toolkit         |
| 2 | Battery Pack Monitoring & Safety System |
| 3 | Motor Performance Analyzer              |



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|                                    |                                                           |
|------------------------------------|-----------------------------------------------------------|
| 4                                  | EV Power Converter & Motor Drive Controller Module        |
| 5                                  | Hybrid Vehicle Power-Split & Energy Management Simulator  |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                           |
| 1                                  | EV Range & Power Estimation Engine                        |
| 2                                  | Smart Lithium-Ion Battery Pack with BMS                   |
| 3                                  | EV Traction Motor Test Bench                              |
| 4                                  | DC–DC Converter + Inverter Drive Unit for EV Applications |
| 5                                  | Hybrid Vehicle Power-Split Simulation Platform            |
| 6                                  | Fast-Charging Station Prototype                           |
| 7                                  | Regenerative Braking Demonstration Kit                    |
| 8                                  | Vehicle-to-Grid (V2G) Demonstration System                |
| 9                                  | Intelligent EV Dashboard & Telemetry Unit                 |
| 10                                 | Autonomous Battery Health Prediction Tool                 |



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**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL V: ADVANCED CONTROL & INDUSTRIAL AUTOMATION**

| Sl. NO. | COURSE CODE | COURSE TITLE                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|--------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                |          |     | L                | T | P |         |
| 1       | U24EEP51    | Process Modelling & Simulation | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP52    | Computer Control of Processes  | PEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EEP53    | System Identification          | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP54    | Model Based Control            | PEC      | 3   | 3                | 0 | 0 | 3       |
| 5       | U24EEP55    | PLC Programming                | PEC      | 3   | 3                | 0 | 3 | 3       |
| 6       | U24EEP56    | Adaptive Control               | PEC      | 3   | 3                | 0 | 0 | 3       |
| 7       | U24EEP57    | Robotics & Automation          | PEC      | 3   | 3                | 0 | 0 | 3       |





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| U24EEP51                                                                                                                                                                                                                                                                                                                                                                                                                                      | PROCESS MODELLING & SIMULATION                                                         | L | T | P | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                        | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                        |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                        |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | introduce fundamental concepts and numerical methods of mathematical process modeling. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | Formulate distributed parameter models for industrial process systems.                 |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                             | Analyze process systems using degree of freedom and information flow concepts..        |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                             | Apply mathematical modeling techniques to steady-state industrial processes.           |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                             | Implement and compare simulation approaches for process modeling.                      |   |   |   |   |
| UNIT I INTRODUCTION GENERAL PRINCIPLES OF MODELLING                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                        |   |   | 9 |   |
| Introduction to mathematical modeling; Advantages and limitations of models and applications of process models of stand-alone unit operations and unit processes; Classification of models: Linear vs Nonlinear, Lumped parameter vs. Distributed parameter; Static vs. Dynamic, Continuous vs. Discrete; Numerical Methods: Iterative convergence methods, Numerical integration of ODE- IVP and ODEBVP.                                     |                                                                                        |   |   |   |   |
| <a href="#">Experiential learning: Simulation of Dynamic Process Systems using MATLAB</a><br><a href="#">Industrial Application: Mathematical Modelling in Chemical Reactor Design</a><br><a href="#">Content beyond syllabus: Machine Learning-Based Process Modelling</a>                                                                                                                                                                   |                                                                                        |   |   |   |   |
| UNIT II MODELLING OF DISTRIBUTED PROCESSES                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                        |   |   | 9 |   |
| Steady state models giving rise to differential algebraic equation (DAE) systems; Rate basedApproaches for staged processes; Modeling of differential contactors – distributed parameter models of packed beds; Packed bed reactors; Modeling of reactive separation processes; Review of solution strategies for Differential Algebraic Equations (DAEs), Partial Differential Equations (PDEs), and available numerical software libraries. |                                                                                        |   |   |   |   |
| <a href="#">Experiential learning: Temperature Distribution Modelling in a Metal Rod using MATLAB</a><br><a href="#">Industrial Application: Modeling of Packed Bed Catalytic Reactors in Petrochemical Industry</a><br><a href="#">Content beyond Syllabus: Computational Fluid Dynamics (CFD) Modelling for Distributed Systems</a>                                                                                                         |                                                                                        |   |   |   |   |
| UNIT III INTRODUCTION TO PROCESS MODELLING                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                        |   |   | 9 |   |



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Concept of degree of freedom analysis: System and its subsystem, System interaction, Degree of freedom in a system e.g. Heat exchanger, Equilibrium still, Reversal of information flow, Design variable selection algorithm, Information flow through subsystems, Structural effects of design variable selection, Persistent Recycle.

Experiential learning: Determination of Degree of Freedom for a Mixing Process Using MATLAB

Industrial Application: Degree of Freedom Analysis in Heat Exchanger Network Design

Content beyond Syllabus: Digital Twin Technology in Process Modelling

|                                                                                                                                                                                                                                                                                                                             |                                                                                 |           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------|
| <b>UNIT IV MODELLING OF INDUSTRIAL PROCESSES</b>                                                                                                                                                                                                                                                                            |                                                                                 | <b>9</b>  |
| Simple examples of process models; Models giving rise to nonlinear algebraic equation (NAE) systems, -steady state models of flash vessels, equilibrium staged processes distillation columns, absorbers, strippers, CSTR, heat exchangers, etc.; Review of solution procedures and available numerical software libraries. |                                                                                 |           |
| Experiential learning: Process Simulation Software Project: Developing and Solving a Flash Vessel Model                                                                                                                                                                                                                     |                                                                                 |           |
| Industrial Application: Real-Time Optimization (RTO) of a Distillation Column using Steady-State Models                                                                                                                                                                                                                     |                                                                                 |           |
| Content beyond Syllabus: Dynamic Modeling and Simulation of Distributed Parameter Systems (DPS)                                                                                                                                                                                                                             |                                                                                 |           |
| <b>UNIT V SIMULATION OF MATHEMATICAL MODELLING</b>                                                                                                                                                                                                                                                                          |                                                                                 | <b>9</b>  |
| Simulation and their approaches, Modular, Sequential, Simultaneous and Equation solving approach, Simulation software's and their applications, Review of solution techniques and available numerical software libraries - Case Studies.                                                                                    |                                                                                 |           |
| Experiential learning: Comparative Simulation Project: Modular vs. Equation-Solving Approach                                                                                                                                                                                                                                |                                                                                 |           |
| Industrial Application: Dynamic Process Simulation for Operator Training Systems (OTS)                                                                                                                                                                                                                                      |                                                                                 |           |
| Content beyond Syllabus: Introduction to Computational Fluid Dynamics (CFD) Simulation                                                                                                                                                                                                                                      |                                                                                 |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                        |                                                                                 | <b>45</b> |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                      |                                                                                 |           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                |                                                                                 |           |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                  | Classify and apply appropriate mathematical models to chemical process systems. |           |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                  | Formulate and analyze distributed parameter models of industrial processes.     |           |



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|            |                                                                    |
|------------|--------------------------------------------------------------------|
| <b>CO3</b> | Determine and evaluate the degree of freedom of process systems.   |
| <b>CO4</b> | Develop and solve steady-state models of industrial process units. |
| <b>CO5</b> | Simulate and compare process models using modern simulation tools. |

**TEXT BOOKS**

|   |                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Denn M. M., "Process Modeling", Longman, 1986, 1st Edition.                                                                        |
| 2 | Aris R., "Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999, Volume 1. |

**REFERENCES**

|   |                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Denn M. M., "Process Modeling", Longman, 1986, 1st Edition.                                                                        |
| 2 | Aris R., "Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999, Volume 1. |
| 3 | Denn M. M., "Process Modeling", Longman, 1986, 1st Edition.                                                                        |
| 4 | Aris R., "Mathematical Modeling, A Chemical Engineering Perspective (Process System Engineering)", Academic Press, 1999, Volume 1. |
| 5 | C.D. Holland, "Fundamentals of Modelling Separation Processes", Prentice Hall, , 1st Edition, 1975.                                |
| 6 | Hussain Asghar, "Chemical Process Simulation", Wiley Eastern Ltd., New Delhi, , 1st Edition, 1986.                                 |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak

**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 1   | 0   | 0   | 2   | 1   | 0   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |
| <b>CO2</b> | 3   | 1   | 2   | 0   | 0   | 1   | 0   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |
| <b>CO3</b> | 1   | 0   | 2   | 3   | 0   | 1   | 0   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |
| <b>CO4</b> | 1   | 0   | 3   | 0   | 0   | 1   | 0   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |
| <b>CO5</b> | 1   | 2   | 0   | 3   | 0   | 1   | 2   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |
| <b>AVG</b> | 3   | 1   | 0   | 0   | 2   | 1   | 0   | 1   | 1   | 1    | 1    | 1    | 2    | 2    |



| PRODUCT BASED OUTCOME       |                                                                                                  |
|-----------------------------|--------------------------------------------------------------------------------------------------|
| 1                           | Develop a numerical modeling tool to simulate linear and nonlinear process systems.              |
| 2                           | Design DAE-based models for packed bed and reactive separation operations.                       |
| 3                           | Create a software module to compute degree of freedom for interconnected process units.          |
| 4                           | Build steady-state models for flash, CSTR, heat exchanger, distillation, and absorption systems. |
| 5                           | Implement a full-plant simulation using modular and sequential simulation approaches.            |
| PRODUCT-BASED TEAM PROJECTS |                                                                                                  |
| 1                           | Classify linear, nonlinear, lumped and distributed process models.                               |
| 2                           | Simulate IVP and BVP using ODE integration platform.                                             |
| 3                           | Model packed-bed reactor performance using DAE simulator.                                        |
| 4                           | Develop reactive distillation model with rate-based calculations.                                |
| 5                           | Build PDE diffusion–reaction packed-bed simulation tool.                                         |
| 6                           | Automate degree-of-freedom calculation for process systems.                                      |
| 7                           | Create steady-state models for flash and CSTRs.                                                  |
| 8                           | Validate process models using real industrial data.                                              |
| 9                           | Compare modular, sequential, equation-oriented simulation approaches.                            |
| 10                          | Simulate full process plant integrating major units.                                             |



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| U24EEP52                                                                                                                                                                                                                                                                                                                                                      | COMPUTER CONTROL OF PROCESSES                                                                             | L | T | P | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                               |                                                                                                           | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                             |                                                                                                           |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                   |                                                                                                           |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                             | Introduce discrete state-variable modeling and system identification techniques for input–output systems. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                             | Analyze and identify linear and nonlinear systems under various loading and supply conditions.            |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                             | Design and implement digital controllers for discrete-time control systems.                               |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                             | Develop multi-loop regulatory control strategies for interacting process systems.                         |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                             | Apply multivariable control techniques to complex industrial processes.                                   |   |   |   |   |
| UNIT I DISCRETE STATE-VARIABLE TECHNIQUE                                                                                                                                                                                                                                                                                                                      |                                                                                                           |   |   | 9 |   |
| Identification of Non-Parametric Input-Output Models: -Transient analysis–Frequency analysis–Correlation analysis– Spectral analysis – Identification of Parametric Input-Output Models: - Least Squares Method – Recursive Least Square Method.                                                                                                              |                                                                                                           |   |   |   |   |
| Experiential learning: State-Space Modeling and Controllability Analysis of a Sampled DC Motor System using MATLAB                                                                                                                                                                                                                                            |                                                                                                           |   |   |   |   |
| Industrial Application: Digital Servo Motor Control                                                                                                                                                                                                                                                                                                           |                                                                                                           |   |   |   |   |
| Content beyond syllabus: Discrete-Time Optimal Control (LQR) Design                                                                                                                                                                                                                                                                                           |                                                                                                           |   |   |   |   |
| UNIT II SYSTEM IDENTIFICATION                                                                                                                                                                                                                                                                                                                                 |                                                                                                           |   |   | 9 |   |
| Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system. |                                                                                                           |   |   |   |   |
| Experiential learning: Real-Time Parameter Estimation using Recursive Least Squares (RLS) using MATLAB                                                                                                                                                                                                                                                        |                                                                                                           |   |   |   |   |
| Industrial Application: Adaptive Control in Process Industries                                                                                                                                                                                                                                                                                                |                                                                                                           |   |   |   |   |
| Content beyond Syllabus: Non-linear System Identification using Neural Networks                                                                                                                                                                                                                                                                               |                                                                                                           |   |   |   |   |
| UNIT III DIGITAL CONTROLLER DESIGN                                                                                                                                                                                                                                                                                                                            |                                                                                                           |   |   | 9 |   |



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Review of z-transform – Modified of z-transform – Pulse transfer function – Digital PID controller – Dead-beat controller and Dahlin's controller – Kalman's algorithm, Pole Placement Controller

Experiential learning: Implementing and Comparing Digital PID, Dead-Beat, and Dahlin's Controllers on a Real-Time System

Industrial Application: State Estimation and Filtering in Autonomous Systems

Content beyond Syllabus: Model Predictive Control (MPC)

|                                                                                                                                                                                                                                          |                                                                                                 |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------|
| <b>UNIT IV MULTI-LOOP REGULATORY CONTROL</b>                                                                                                                                                                                             |                                                                                                 | <b>9</b>  |
| Multi-loop Control - Introduction – Process Interaction – Pairing of Inputs and Outputs -The Relative Gain Array (RGA) – Properties and Application of RGA - Multi-loop PID Controller – Biggest Log Modulus Tuning Method – De-coupler. |                                                                                                 |           |
| Experiential learning: Analysing and Decoupling a Two- Input, Two- Output (TITO) System using Python                                                                                                                                     |                                                                                                 |           |
| Industrial Application: Distillation Column Control                                                                                                                                                                                      |                                                                                                 |           |
| Content beyond Syllabus: Decentralized Model Predictive Control (D-MPC)                                                                                                                                                                  |                                                                                                 |           |
| <b>UNIT V MULTIVARIABLE REGULATORY CONTROL</b>                                                                                                                                                                                           |                                                                                                 | <b>9</b>  |
| Introduction to Multivariable control –Multivariable PID Controller – Multivariable Dynamic Matrix Controller – Case Studies: - Distillation Column, CSTR and Four-tank system.                                                          |                                                                                                 |           |
| Experiential learning: Implementing and Tuning the Dynamic Matrix Controller (DMC) on the Four – Tank System using python                                                                                                                |                                                                                                 |           |
| Industrial Application: Aircraft/Flight Control Systems                                                                                                                                                                                  |                                                                                                 |           |
| Content beyond Syllabus: Anti-Windup for PID Controllers                                                                                                                                                                                 |                                                                                                 |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                     |                                                                                                 | <b>45</b> |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                   |                                                                                                 |           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                             |                                                                                                 |           |
| <b>CO1</b>                                                                                                                                                                                                                               | Classify and apply discrete-time input–output modeling and parameter estimation methods.        |           |
| <b>CO2</b>                                                                                                                                                                                                                               | Analyze and identify system parameters for linear and nonlinear electrical and process systems. |           |
| <b>CO3</b>                                                                                                                                                                                                                               | Design different digital controllers to satisfy the required criterion.                         |           |
| <b>CO4</b>                                                                                                                                                                                                                               | Analyze and implement multi-loop control using RGA-based pairing and decoupling methods.        |           |

[illegible]



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|                                    |                                                                                      |
|------------------------------------|--------------------------------------------------------------------------------------|
| 2                                  | Prototype tool for system identification using nonparametric and LS/RLS techniques.  |
| 3                                  | Controller software implementing digital PID and pole-placement algorithms.          |
| 4                                  | Software for multiloop control design using RGA-based robust decouplers controllers. |
| 5                                  | Tool for multivariable PID, DMC design validating distillation and CSTR.             |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                                      |
| 1                                  | Real-Time System Identification Toolkit                                              |
| 2                                  | Digital Controller Design Suite                                                      |
| 3                                  | Multiloop Control Configuration Dashboard                                            |
| 4                                  | Adaptive Parameter Estimation Box                                                    |
| 5                                  | Kalman Filtering and Prediction Engine                                               |
| 6                                  | Multivariable PID Controller Tuning Assistant                                        |
| 7                                  | Dynamic Matrix Control (DMC) Plant Manager                                           |
| 8                                  | Industrial Digital Control Simulation Lab                                            |
| 9                                  | Smart Process Decoupler Module                                                       |
| 10                                 | Multivariable Process Benchmark Platform                                             |





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| U24EEP53                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | SYSTEM IDENTIFICATION                                                                                 | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                       | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                       |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                       |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Introduce non-parametric methods for system identification using time- and frequency-domain analysis. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Develop parametric models and estimation techniques for linear dynamic systems.                       |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Implement recursive identification methods for real-time and closed-loop systems.                     |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Analyze and apply closed-loop identification techniques for controlled processes.                     |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Model nonlinear systems using data-driven and intelligent identification methods.                     |   |   |   |   |
| UNIT I NON-PARAMETRIC METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                       |   |   |   | 9 |
| Nonparametric methods: Transient analysis - frequency analysis - Correlation analysis - Spectral analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                       |   |   |   |   |
| Experiential learning: System Identification via Frequency Response (Bode Plot) Analysis using python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                       |   |   |   |   |
| Industrial Application: Vibration–Based Fault Diagnosis and Predictive Maintenance of Rotating Machinery in Smart Manufacturing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                       |   |   |   |   |
| Content beyond syllabus: Higher-Order Spectral (HOS) Analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                       |   |   |   |   |
| UNIT II PARAMETRIC METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                       |   |   |   | 9 |
| Parametric model structures: ARX, ARMAX, OE, BJ models - The Least square estimate - Best linear unbiased estimation under linear constraints - Updating the Parameter estimates for linear regression models - Prediction error methods: Description of Prediction error methods - Optimal Prediction – Relationships between prediction error methods and other identification methods - theoretical analysis. Instrumental variable methods: Description of Instrumental variable methods - Theoretical analysis - covariance matrix of IV estimates - Comparison of optimal IV and prediction error methods. |                                                                                                       |   |   |   |   |
| Experiential learning: Comparing Parametric Model Structures (ARX vs. ARMAX) using python                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                       |   |   |   |   |
| Industrial Application: Self-Tuning Control in Cement Kilns or Power Plants                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                       |   |   |   |   |
| Content beyond Syllabus: Subspace Identification Methods (N4SID or MOESP)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                       |   |   |   |   |
| UNIT III RECURSIVE IDENTIFICATION METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                       |   |   |   | 9 |



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The recursive least squares method - Recursive Instrumental variable method-the recursive prediction error method-model validation and model structure determination. Identification of systems operating in closed loop: Identifiability considerations - Direct identification - Indirect identification - Joint input – Output identification.

Experiential learning: Real-Time Closed-Loop Identification of a PID-Controlled System using python  
 Industrial Application: Adaptive Flight Control for Damaged Aircraft  
 Content beyond Syllabus: Extended Kalman Filter (EKF) for Joint State and Parameter Estimation

|                                            |          |
|--------------------------------------------|----------|
| <b>UNIT IV CLOSED- LOOP IDENTIFICATION</b> | <b>9</b> |
|--------------------------------------------|----------|

Identification of systems operating in closed loop: direct identification and indirect identification – Subspace Identification methods: classical and innovation forms – Relay feedback identification of stable processes.

Experiential learning: Closed-Loop Identification using Relay Feedback and Model Comparison using python  
 Industrial Application: Automatic Tuners in Distributed Control Systems (DCS)  
 Content beyond Syllabus: Closed-Loop Subspace Identification for Large-Scale MIMO Systems

|                                                                |          |
|----------------------------------------------------------------|----------|
| <b>UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS</b> | <b>9</b> |
|----------------------------------------------------------------|----------|

Modeling of nonlinear systems using ANN- NARX & NARMAX - Training Feed-forward and Recurrent Neural Networks – TSK model – Adaptive Neuro-Fuzzy Inference System (ANFIS) - Introduction to Support Vector Regression.

Experiential learning: Non-linear System Identification using an ANN-NARX Model using python  
 Industrial Application: Soft Sensors in Chemical Processing  
 Content beyond Syllabus: Deep Reinforcement Learning (DRL) for Optimal Control of Unknown Nonlinear Systems

|                      |           |
|----------------------|-----------|
| <b>TOTAL PERIODS</b> | <b>45</b> |
|----------------------|-----------|

## COURSE OUTCOMES

**At the end of the course, the student will be able to**

|            |                                                                                                              |
|------------|--------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Apply non-parametric identification techniques such as correlation and spectral analysis to dynamic systems. |
| <b>CO2</b> | Develop and compare parametric models using least squares and prediction error methods.                      |



| TEXT BOOKS |                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------|
| 1          | Lennart Ljung, “System Identification: Theory for the user”, 2nd Edition, Prentice Hall, 1999.                 |
| 2          | Dan Simon, “Optimal State Estimation Kalman, H-infinity and Non-linear Approaches”, John Wiley and Sons, 2006. |
| 3          | Tangirala, A.K., “Principles of System Identification: Theory and Practice”, CRC Press, 2014, 1st Edition.     |

|   |                                                                                                                                                                                                                  |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Cortes, C., and Vapnik, V., "Support-Vector Networks, Machine Learning", 1995, 1st Edition.                                                                                                                      |
| 2 | Miller, W.T., Sutton, R.S., and Webrose, P.J., "Neural Networks for Control", MIT Press, 1996, 1st Edition.                                                                                                      |
| 3 | Van der Heijden, F., Duin, R.P.W., De Ridder, D., and Tax, D.M.J., "Classification, Parameter Estimation and State Estimation", An Engineering Approach Using MATLAB, John Wiley & Sons Ltd., 2017, 2nd Edition. |
| 4 | Karel J. Keesman, "System Identification an Introduction", Springer, 2011, 1st Edition.                                                                                                                          |
| 5 | Tao Liu and Furong Gao, "Industrial Process Identification and control design, Step-test and relay-experiment-based methods", Springer- Verlag London Ltd., 2012, 1st Edition                                    |

**(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak**  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

[illegible]



|                             |                                                                           |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----------------------------|---------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AVG                         | 3                                                                         | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| PRODUCT BASED OUTCOME       |                                                                           |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                           | Develop transient and spectral analysis tool for systems.                 |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2                           | Build ARX–BJ model estimator with prediction optimization.                |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3                           | Design recursive estimation module for model validation.                  |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4                           | Implement closed-loop system identification using subspace methods.       |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5                           | Create ANN–ANFIS nonlinear system predictive modeling platform.           |   |   |   |   |   |   |   |   |   |   |   |   |   |
| PRODUCT-BASED TEAM PROJECTS |                                                                           |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                           | Transient and frequency analyzer for nonparametric system identification. |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2                           | ARX–ARMAX model estimator with prediction accuracy optimization.          |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3                           | BJ–OE parametric modeling tool with least-squares estimator.              |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4                           | Prediction error minimization platform for parametric identification.     |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5                           | Instrumental variable identification tool comparing estimation accuracy.  |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6                           | Recursive least-squares system tracker with adaptive updating.            |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7                           | Closed-loop identification framework using direct–indirect methods.       |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8                           | Subspace identification software including relay feedback experiments.    |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 9                           | Nonlinear NARX–NARMAX neural modeling and validation system.              |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 10                          | ANFIS–SVR hybrid nonlinear prediction and system identification platform. |   |   |   |   |   |   |   |   |   |   |   |   |   |



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| U24EEP54                                                                                                                                                                                                                                       | MODEL BASED CONTROL                                                                                      | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                |                                                                                                          | 3 | 0 | 3 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                              |                                                                                                          |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                    |                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                              | Introduce fundamentals of MIMO systems and multivariable control strategies with practical case studies. |   |   |   |   |
| 2                                                                                                                                                                                                                                              | Explain the principles and applications of model predictive control schemes for multivariable systems.   |   |   |   |   |
| 3                                                                                                                                                                                                                                              | Develop state-space based model predictive control using observers and state estimation techniques.      |   |   |   |   |
| 4                                                                                                                                                                                                                                              | Analyze constrained model predictive control schemes considering system and input limitations.           |   |   |   |   |
| 5                                                                                                                                                                                                                                              | Introduce adaptive control strategies for improving performance of dynamic systems.                      |   |   |   |   |
| UNIT I ARTIFICIAL NEURAL NETWORKS                                                                                                                                                                                                              |                                                                                                          |   |   | 9 |   |
| Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPID Case studies                                                                                                                                     |                                                                                                          |   |   |   |   |
| Experiential learning: Analyse case studies of multivariable control systems in real-world applications like robotics or aerospace.                                                                                                            |                                                                                                          |   |   |   |   |
| Industrial Application: Useful in multi-input multi-output communication systems and automation industries.                                                                                                                                    |                                                                                                          |   |   |   |   |
| Content beyond syllabus: Explore advanced multivariable control techniques like decentralized and robust MIMO control.                                                                                                                         |                                                                                                          |   |   |   |   |
| UNIT II MODEL PREDICTIVE CONTROL SCHEMES                                                                                                                                                                                                       |                                                                                                          |   |   | 9 |   |
| Introduction to Model Predictive Control - Model Predictive Control Elements – Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme Case Studies |                                                                                                          |   |   |   |   |
| Experiential learning: Simulate basic MPC algorithms for multivariable systems using MATLAB toolboxes.                                                                                                                                         |                                                                                                          |   |   |   |   |
| Industrial Application: Widely used in chemical process control, automotive control systems, and energy management.                                                                                                                            |                                                                                                          |   |   |   |   |
| Content beyond Syllabus: Explore MPC applications in autonomous vehicles and smart grids.                                                                                                                                                      |                                                                                                          |   |   |   |   |
| UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME                                                                                                                                                                                     |                                                                                                          |   |   | 9 |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies<br><br>Experiential learning: Conduct case studies on observer-based predictive control implementations.<br>Industrial Application: Applied in aerospace, automotive, and manufacturing systems for precise control.<br>Content beyond Syllabus: Study advanced observer design techniques beyond Kalman filters.                  |                                                                                           |
| <b>UNIT IV    CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>9</b>                                                                                  |
| Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.<br><br>Experiential learning: Perform simulations demonstrating constraint handling and optimization strategies<br>Industrial Application: Useful for safe and efficient operation in automotive and aerospace control.<br>Content Beyond Syllabus: Study real-time optimization techniques and computational efficiency improvements. |                                                                                           |
| <b>UNIT V    ADAPTIVE CONTROL SCHEME</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>9</b>                                                                                  |
| Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme –Case Studies<br><br>Experiential learning: Implement self-tuning regulators and adaptive control algorithms on simulation platforms.<br>Industrial Application: Enables continuous performance improvement and fault tolerance in industrial controllers.<br>Content Beyond Syllabus: Explore neural network and fuzzy logic-based adaptive control methods.                 |                                                                                           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>45</b>                                                                                 |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                           |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analyze multivariable and multiloop control systems using IMC and IMC-PID approaches.     |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Design and simulate multivariable model predictive control schemes for dynamic processes. |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply state-space and observer-based predictive control techniques to real-world systems. |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Implement constrained MPC schemes handling amplitude and rate constraints effectively.    |





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|                                    |                                                                                                                       |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| 2                                  | To Build and validate Model Predictive Control (MPC) systems for process and manufacturing industries.                |
| 3                                  | To Create constrained control solutions for safety-critical engineering systems.                                      |
| 4                                  | To Design and implement adaptive controllers that can self-tune for changing operating conditions.                    |
| 5                                  | To Deploy integrated hardware–software control products using microcontrollers, PLCs, and real-time simulation tools. |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                                                                       |
| 1                                  | Two-Tank Interactive Level Control System                                                                             |
| 2                                  | Temperature & Pressure Control of a Small Lab-Scale Reactor                                                           |
| 3                                  | DC Motor Speed & Load Control                                                                                         |
| 4                                  | Robotic Arm Joint Angle Control (2-DOF)                                                                               |
| 5                                  | MPC for Battery Charge Control in Small Battery Pack                                                                  |
| 6                                  | MPC for Water Distribution System                                                                                     |
| 7                                  | MPC for Solar PV Maximum Power Point Tracking                                                                         |
| 8                                  | MPC for Smart Grid Load Demand Forecasting and Control                                                                |
| 9                                  | Microcontroller-based MPC for Motor Drive Control                                                                     |
| 10                                 | Smart Water-Pump Controller with Constrained Control for Irrigation System                                            |





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| U24EEP55                                                                                                                                                                                                                                                                                                                                                                            | PLC PROGRAMMING                                                                                 | L | T | P | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 | 3 | 0 | 3 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                 |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                         |                                                                                                 |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                   | Introduce PLC fundamentals, programming standards, networking, and process safety applications. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                   | Explain IEC 61131-3 programming languages and instruction sets for PLC-based automation.        |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                   | Introduce industrial communication protocols such as HART and Fieldbus for process automation.  |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                   | Develop practical PLC programs for real-time industrial automation applications.                |   |   |   |   |
| UNIT I INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                 |   |   | 9 |   |
| Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC - Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control. |                                                                                                 |   |   |   |   |
| Experiential Learning (Activity Based Learning): Students connect input/output modules (push buttons, limit switches, solenoid valves).                                                                                                                                                                                                                                             |                                                                                                 |   |   |   |   |
| Industrial Application: Safety PLCs used in ESD (Emergency Shutdown System), Fire & Gas System.                                                                                                                                                                                                                                                                                     |                                                                                                 |   |   |   |   |
| Content Beyond Syllabus: Industrial Communication Protocols (Advanced)                                                                                                                                                                                                                                                                                                              |                                                                                                 |   |   |   |   |
| UNIT II IEC 61131-3                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                 |   |   | 9 |   |
| Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions - Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.                                                                                                               |                                                                                                 |   |   |   |   |
| Experiential Learning (Activity Based Learning): Create ON-delay, OFF-delay, TON, TOF, CTU, CTD programs.                                                                                                                                                                                                                                                                           |                                                                                                 |   |   |   |   |
| Industrial Application: Ladder Logic and Function Block synonymous with Automotive assembly robots                                                                                                                                                                                                                                                                                  |                                                                                                 |   |   |   |   |
| Content Beyond Syllabus: Introduction to DCS (Distributed Control Systems)                                                                                                                                                                                                                                                                                                          |                                                                                                 |   |   |   |   |
| UNIT III SCADA                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                 |   |   | 9 |   |



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Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control- Analog control, Master Terminal Unit- Operator interface.

Experiential Learning (Activity Based Learning): Using open-source software (e.g., Ignition Trial, Advanced HMI, FactoryTalk View ME Demo).

Industrial Application: SCADA used extensively in Power transmission & distribution

Content Beyond Syllabus: Industry 4.0 Smart Automation Concepts

|                                                                                                                                                                                                                                                                                |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <b>UNIT IV HART and Field Bus</b>                                                                                                                                                                                                                                              | <b>9</b>  |
| Introduction- Evolution of signal standards- HART communication protocol- communication modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture - Basic requirements of field Bus standard- Field bus Topology- Interoperability- Interchangeability. |           |
| Experiential Learning (Activity Based Learning): Using HART communicator simulation (ProComSol or freeware).                                                                                                                                                                   |           |
| Industrial Application: Foundation Fieldbus used in Refinery DCS.                                                                                                                                                                                                              |           |
| Content Beyond Syllabus: Introduction to DCS (Distributed Control Systems)                                                                                                                                                                                                     |           |
| <b>UNIT V PLC PROGRAMMING</b>                                                                                                                                                                                                                                                  | <b>9</b>  |
| Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Four way – Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System, Code Converters- DC motor Control- Alarm Circuit.                                      |           |
| Experiential Learning (Activity Based Learning): Water level control programming.                                                                                                                                                                                              |           |
| Industrial Application: Real-time applications Traffic management.                                                                                                                                                                                                             |           |
| Content Beyond Syllabus: Advanced PLC Programming Techniques                                                                                                                                                                                                                   |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                           | <b>45</b> |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                         |           |
| At the end of the course, the student will be able to                                                                                                                                                                                                                          |           |



|                   |                                                                                                                                                    |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS</b> |                                                                                                                                                    |
| 1                 | Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2019.                                                  |
| 2                 | Stuart Boyer A, "SCADA: Supervisory control and data Acquisition", Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society, 2010 |

|   |                                                                                                                |
|---|----------------------------------------------------------------------------------------------------------------|
| 1 | Develop a basic industrial automation system using PLC hardware or simulation with field input-output devices. |
| 2 | Create PLC logic programs using IEC 61131-3 languages (Ladder, FBD, ST) for real-time industrial processes.    |



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|                                    |                                                                                                             |
|------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 3                                  | Implement safety, alarm, and interlock logic for automated process control systems.                         |
| 4                                  | Build a PLC–SCADA integrated monitoring and supervisory control product for industrial applications.        |
| 5                                  | Design a complete PLC-based automation solution including communication, visualization, and fault handling. |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                                                             |
| 1                                  | PLC-Based Start–Stop Motor Control System                                                                   |
| 2                                  | Alarm & Interlock System for Industrial Process                                                             |
| 3                                  | Traffic Light Control System (Two-Way / Four-Way)                                                           |
| 4                                  | Automatic Bottle Filling System                                                                             |
| 5                                  | Conveyor-Based Material Sorting System                                                                      |
| 6                                  | PLC–SCADA Tank Level Monitoring System                                                                      |
| 7                                  | Power Substation Monitoring Using SCADA                                                                     |
| 8                                  | PLC-Based Distributed Control System Model                                                                  |
| 9                                  | Automatic Pump Control with Alarm System                                                                    |
| 10                                 | Fully Automated Water Treatment Plant Model                                                                 |



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| U24EEP56                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ADAPTIVE CONTROL                                                                             | L | T | P | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                              | 3 | 0 | 3 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                              |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                              |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Introduce adaptive control concepts and parameter estimation techniques for dynamic systems. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Explain gain scheduling principles and auto-tuning methods for nonlinear systems.            |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Develop deterministic self-tuning regulators using pole placement techniques.                |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Analyze stochastic and predictive self-tuning regulator designs for uncertain systems.       |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Design model reference adaptive control systems using stability-based approaches.            |   |   |   |   |
| UNIT I INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                              |   |   |   | 9 |
| Introduction - Adaptive Schemes - The adaptive Control Problem – Applications-Parameter estimation: - LS, RLS: and ERLS<br><br>Experiential learning: To implement Adaptive Control of an RC Circuit and Recursive Least Squares (RLS) parameter estimation for an unknown system.<br><br>Industrial Application: Adaptive Speed Control in Electric Drives (Electric vehicle motor control, CNC spindle control).<br><br>Content beyond syllabus: Real-Time System Identification on Embedded Hardware. |                                                                                              |   |   |   |   |
| UNIT II GAIN SCHEDULING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                              |   |   |   | 9 |
| Introduction- The principle - Design of gain scheduling controllers- Nonlinear transformations -application of gain scheduling - Auto-tuning techniques: Methods based on Relay feedback.<br><br>Experiential learning: Implement gain scheduling on a mass-spring-damper system with variable mass.<br><br>Industrial Application: Gain-Scheduled Controller for a Jet Engine’s Fuel Flow System.<br><br>Content beyond Syllabus: Model Predictive Gain Scheduling.                                     |                                                                                              |   |   |   |   |
| UNIT III DETERMINISTIC SELF-TUNING REGULATORS                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                              |   |   |   | 9 |
| Introduction- Pole Placement design - Indirect Self-tuning regulators - direct self-tuning regulators – Disturbances with known characteristics<br><br>Experiential learning: To design pole placement controllers for uncertain systems using simulation tools.<br><br>Industrial Application: Identification of LTI Systems Modelling and control of turbines and renewable                                                                                                                            |                                                                                              |   |   |   |   |



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energy converters.

Content beyond Syllabus: Modern Adaptive Control Strategies.

|                                                                 |          |
|-----------------------------------------------------------------|----------|
| <b>UNIT IV STOCHASTIC AND PREDICTIVE SELF-TUNING REGULATORS</b> | <b>9</b> |
|-----------------------------------------------------------------|----------|

Introduction – Design of minimum variance controller - Design of moving average controller - stochastic self-tuning regulators.

Experiential learning: Implement MA controller using Discrete FIR Filter block or MATLAB Function block.

Industrial Application: “Stochastic Self-Tuning Speed Control of Wind Turbine Generator”.

Content Beyond Syllabus: Adaptive Minimum Variance and Generalized Predictive Control (GPC).

|                                                 |          |
|-------------------------------------------------|----------|
| <b>UNIT V MODEL – REFERENCE ADAPTIVE SYSTEM</b> | <b>9</b> |
|-------------------------------------------------|----------|

Introduction- MIT rule – Determination of adaptation gain - Lyapunov theory –Design of MRAS using Lyapunov theory – Relations between MRAS and STR.

Experiential learning: Design and Simulation of a Model Reference Adaptive System (MRAS)

Industrial Application: “Implementation of MRAS Speed Estimator for Induction Motor using MIT Rule”.

Content Beyond Syllabus: Fuzzy MRAS Controllers.

|                      |           |
|----------------------|-----------|
| <b>TOTAL PERIODS</b> | <b>45</b> |
|----------------------|-----------|

**COURSE OUTCOMES**

**At the end of the course, the student will be able to**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Explain the fundamental concepts of adaptive control, including adaptive schemes, parameter estimation, and the adaptive control problem. |
| <b>CO2</b> | Design and Implement Gain Scheduling Controllers.                                                                                         |
| <b>CO3</b> | Implement deterministic self-tuning regulators and to analyse the unknown disturbances.                                                   |
| <b>CO4</b> | Design stochastic and predictive self-tuning regulators                                                                                   |
| <b>CO5</b> | Understand and design model-reference adaptive systems using the MIT rule and Lyapunov theory.                                            |



### TEXT BOOKS

1

K.J. Astrom and B. J. Wittenmark, "Adaptive Control", Second Edition, Pearson Education Inc., second Edition 2013.

### REFERENCES

1

T. Soderstorm and Petre Stoica, "System Identification", Prentice Hall International(UK) Ltd., 1989, 1st Edition. Douglas V. Hall, "Micro-processors & Interfacing". Tata McGraw Hill 2nd edition, 2009

2

Lennart Ljung, "System Identification: Theory for the User", Second Edition, Prentice Hall, 1999.

### List of Open Source Software/ Learning website:

1. <https://archive.nptel.ac.in/courses/108/102/108102113/>
2. <https://in.mathworks.com/help/slcontrol/adaptive-control-design.html>
3. [https://in.mathworks.com/videos/nonlinear-model-based-adaptive-robust\[1\]controller-in-an-oil-and-gas-wireline-operation-1637577967956.html](https://in.mathworks.com/videos/nonlinear-model-based-adaptive-robust[1]controller-in-an-oil-and-gas-wireline-operation-1637577967956.html)
4. <https://www.dynalog-us.com/adaptive-robot-control.htm>
5. <https://www.vlab.co.in>

### CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 2   | 2   | 2   | 1   | 1   | 3   | 1   | 1   | 1    | 1    | 2    | 2    | 2    |
| CO2 | 3   | 2   | 2   | 2   | 1   | 1   | 3   | 1   | 1   | 1    | 1    | 2    | 2    | 2    |
| CO3 | 3   | 3   | 3   | 3   | 1   | 1   | 3   | 1   | 3   | 1    | 1    | 2    | 2    | 2    |
| CO4 | 3   | 3   | 3   | 3   | 1   | 1   | 3   | 1   | 3   | 1    | 1    | 2    | 2    | 2    |
| CO5 | 3   | 2   | 2   | 2   | 1   | 1   | 3   | 1   | 1   | 1    | 1    | 2    | 2    | 2    |
| AVG | 3   | 2   | 2   | 2   | 1   | 1   | 3   | 1   | 1   | 1    | 1    | 2    | 2    | 2    |

### PRODUCT BASED OUTCOME

1

To create mathematical representations of systems with unknown parameters

2

To identify parametric uncertainties in linear time-invariant systems



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|                                    |                                                                                         |
|------------------------------------|-----------------------------------------------------------------------------------------|
| 3                                  | To derive adaptation laws using Lyapunov stability theory                               |
| 4                                  | To analyze closed-loop performance of STR systems                                       |
| 5                                  | To implement pole-placement based adaptive controllers                                  |
| 6                                  | To prepare comparative studies between fixed and self-tuning controllers                |
| 7                                  | To implement online parameter estimation algorithms using Recursive Least Squares (RLS) |
| 8                                  | To validate stability and convergence through analytical and simulation results         |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                                         |
| 1                                  | To compare parameter estimation methods using convergence and error metrics             |
| 2                                  | To develop a parameter estimation toolbox using MATLAB/Python                           |
| 3                                  | To design a model reference adaptive control scheme for an uncertain system             |
| 4                                  | To develop an embedded adaptive control system using Arduino/STM32                      |
| 5                                  | To develop an adaptive cruise control system for automotive applications                |
| 6                                  | To implement adaptive control in process industries (temperature/flow/level)            |
| 7                                  | To create an adaptive control software library for academic or industrial use           |
| 8                                  | To design adaptive control for robotic manipulator joints                               |





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| U24EEP57                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ROBOTICS AND AUTOMATION                                                                                                       | L | T | P | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                               | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                               |   |   |   |   |
| After completing this course, the students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                               |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Explain the fundamentals, components, generations, and embedded-system role in robotics and automation systems.               |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Analyze sensors and drive systems and determine motor power, torque, and gearing requirements for robotic applications.       |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Explain manipulator structures and analyze gripper design considerations for force, motion, and application suitability.      |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Apply kinematic principles and analyze path planning techniques for robotic motion and navigation.                            |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Evaluate real-world robotic systems through case studies across manufacturing, healthcare, and emerging robotic applications. |   |   |   |   |
| UNIT I INTRODUCTION TO ROBOTICS & AUTOMATION                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                               |   |   | 9 |   |
| Overview of Robotics & Automation – Principles and Strategies of Automation System –Hardware and software for Automation- Embedded Processors for Automation-Different Types of Robots – Various Generations of Robots - Asimov's Laws of Robotics – Key components of a robot - Design Criteria for Selection of a Robot –Role of embedded system in Robotics and Automation - Recent trends.                                                                |                                                                                                                               |   |   |   |   |
| Experiential Learning (Activity Based Learning): Hands-on teardown and analysis of a consumer robot (Vacuum robot / Toy robot / Line follower)                                                                                                                                                                                                                                                                                                                |                                                                                                                               |   |   |   |   |
| Students open, study, and document real robot components (motors, sensors, controllers, battery, PCB).                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                               |   |   |   |   |
| Industrial Application: Automation in Automotive Assembly Lines. Explains how embedded processors, robots, PLCs, and AGVs streamline manufacturing in automobile plants.                                                                                                                                                                                                                                                                                      |                                                                                                                               |   |   |   |   |
| Content Beyond Syllabus: Ethics of Autonomous Decision-Making & Asimov's Laws in Modern AI Robotics Covers safe AI,                                                                                                                                                                                                                                                                                                                                           |                                                                                                                               |   |   |   |   |
| UNIT II SENSORS AND DRIVE SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                               |   |   | 9 |   |
| Hydraulic, Pneumatic and Electric Drive Systems – Understanding how motor power, current torque, friction co-efficient affect the design of a Robot - Determination of Motor HP and Gearing Ratio – Variable Speed Arrangements. Sensors – Classification based on sensing type (including Optical, Acoustic, Magnetic) -Proximity Sensors – Ranging Sensors – Speed & Displacement Sensing - Tactile Sensors – Vision Sensing -Smart Sensors - MEMS sensors. |                                                                                                                               |   |   |   |   |
| Experiential Learning (Activity Based Learning): Calibration experiment for multiple sensors (proximity, ultrasonic, IMU, tactile) Students measure errors, drift, noise, and perform calibration.                                                                                                                                                                                                                                                            |                                                                                                                               |   |   |   |   |



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Industrial Application: Industrial Robotic Arms Using Servo Drives and Closed-Loop Encoders  
Shows how ABB/KUKA/Yaskawa use sensor feedback for precision tasks.

**UNIT III MANIPULATORS AND GRIPPERS**

**9**

Introduction to Manipulators - Joints and Degrees of Freedom - Construction of Manipulators – Manipulator Dynamics and Force Control – Electronic and Pneumatic Manipulator Control Circuits – End Effectors – Various Types of Grippers – Design Considerations.

Experiential Learning (Activity Based Learning): Design and 3D-printing of a custom gripper for a specific object Students model in CAD, 3D-print, and test gripping force, torque & compliance.

Industrial Application: Robotic Grippers in Food, Pharma, and E-Commerce Packaging Soft grippers, vacuum grippers, high-speed pick-and-place.

Content Beyond Syllabus: Soft Robotics and Bio-Inspired Grippers Covers soft actuators, pneumatic artificial muscles, and deformable manipulators.

**UNIT IV KINEMATICS AND PATH PLANNING**

**9**

Kinematic Equations – Forward and Inverse Kinematics - Solution Of Inverse Kinematics Problem – Jacobian based Velocity Kinematics– Various Path Planning Algorithms – Hill Climbing Techniques - Robot Operating System - Simulation and modeling of a simple Path Planning application.

Experiential Learning (Activity Based Learning): Simulation of robot kinematics & basic path planning using ROS + Gazebo/Webots Students create a simple robot model and perform FK, IK, and path tracking.

Industrial Application: Autonomous Mobile Robots (AMRs) in Warehouses AMR navigation using SLAM, LiDAR mapping, ROS navigation stack.

Content Beyond Syllabus: Introduction to SLAM (Simultaneous Localization and Mapping)

Explains LiDAR/camera-based mapping, particle filters, graph optimization.

**UNIT V CASE STUDIES**

**9**

Robot Cell Design - Humanoid Robot - Robots in healthcare applications – Robot Machine Interface – Robots in Manufacturing and Non-Manufacturing Applications - Self balancing robots - Micro/nano robots

Experiential Learning (Activity Based Learning): Building a simple self-balancing robot using IMU + PID Students design, tune PID, integrate sensors, control stability.

Industrial Application: Robots in Healthcare: Surgery, Rehabilitation & Telepresence Robotics Covers DaVinci surgical robot, rehab exoskeletons, nursing robots.

Content Beyond Syllabus: Micro & Nano Robotics for Drug Delivery and Biomedical Applications Explores magnetic micro-swimmers, capsule robots, nanomanipulation.

**TOTAL PERIODS**

**45**



| COURSE OUTCOMES                                                         |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, the student will be able to                   |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                                     | Classify, and explain robotic system components, automation strategies, and ethical considerations in modern robotics.                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                     | Select, and analyse suitable sensors, actuators, motor ratings, and drive mechanisms for specific robotic tasks.                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                     | Design and evaluate manipulators and grippers based on degrees of freedom, force requirements, and application constraints.                                       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                     | Solve forward and inverse kinematics problems and implement basic path planning algorithms using simulation tools such as ROS.                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                     | Analyse and evaluate robotic case studies including humanoid, healthcare, self-balancing, and micro/nano robots to assess system performance and societal impact. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                              |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | John J. Craig,” Introduction to Robotics: Mechanics and Control” Pearson, 2017                                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Mark W. Spong, Seth Hutchinson, M. Vidyasagar, “Robot Modeling and Control” Wiley, 2020.                                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                              |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., “Industrial Robotics”, Mc Graw-Hill Singapore, 1996.                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Fu K.S. Gonzaleaz R.C. And Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence” McGraw Hill International Editions, 1987                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                       | Robert J. Schilling, “Fundamentals of Robotics: Analysis and Control” Prentice Hall India Learning Private Limited, 1996                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping                                                      |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                         | PO1                                                                                                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 2                                                                                                                                                                 | 2   | 1   | –   | –   | 2   | 2   | –   | –   | –    | 1    | 2    | 1    | 1    |
| CO2                                                                     | 3                                                                                                                                                                 | 3   | 2   | –   | 2   | –   | –   | –   | –   | –    | 1    | 3    | 3    | 1    |
| CO3                                                                     | 3                                                                                                                                                                 | 2   | 3   | 1   | 2   | –   | –   | –   | –   | –    | 1    | 3    | 2    | 2    |
| CO4                                                                     | 3                                                                                                                                                                 | 3   | 2   | 2   | 3   | –   | –   | –   | –   | –    | 1    | 3    | 3    | 2    |
| CO5                                                                     | 2                                                                                                                                                                 | 2   | 2   | 1   | 1   | 3   | 2   | –   | –   | –    | 2    | 2    | 1    | 3    |



## PRODUCT BASED OUTCOME

## PRODUCT-BASED TEAM PROJECTS

|    |                                                                                                                                                                               |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | Autonomous Path-Following Robot Using ROS - Implements forward & inverse kinematics<br>- Uses LiDAR/ultrasonic sensors - Includes simulation + real hardware prototype        |
| 2  | Robotic Manipulator with 3/4 DOF + Gripper - Calculates torque, gearing ratio - Uses servo/stepper motors - Object pick & place demo                                          |
| 3  | Smart Vision-Based Sorting Robot - Uses camera module + OpenCV - Classifies objects by color/shape<br>- Robotic arm sorts items (automation)                                  |
| 4  | Self-Balancing Two-Wheel Robot - Uses MPU6050 or BNO055 - Implements PID for balance -<br>Demonstrates automation + control theory                                            |
| 5  | RFID-Based Warehouse Automation Robot - Navigation inside a defined grid - Picks & places objects at RFID-tagged locations - Implements path planning + embedded control      |
| 6  | Pneumatically Controlled Robotic Gripper - Pneumatic circuits + embedded valves - Pressure-based gripping force control - Real-world industrial automation application        |
| 7  | Voice-Controlled Home/Factory Assistant Robot - Voice recognition (Google Assistant / offline STT) -<br>Executes tasks: movement, object pick-up, switching appliances        |
| 8  | Autonomous Healthcare Robotic Assistant - Delivers medicine trays - Obstacle avoidance + navigation -<br>Uses ultrasonic & IR sensors                                         |
| 9  | Multi-Sensor Fusion Robot (Proximity + Vision + Tactile) - Simple SLAM or sensor fusion - Path planning based on sensor inputs - Demonstrates real robotics perception system |
| 10 | Humanoid Robot Head With Facial Tracking - Pan-tilt head - Tracks human face using OpenCV -<br>Demonstrates robotics + automation + vision sensing                            |



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**PROFESSIONAL ELECTIVE COURSES: VERTICALS**

**VERTICAL VI: ENERGY ENGINEERING**

| SI. NO. | COURSE CODE | COURSE TITLE                                   | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                                |          |     | L                | T | P |         |
| 1       | U24EEP61    | Energy Storage Systems                         | PEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EEP62    | Hybrid Energy Technology                       | PEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EEP63    | Design & Modelling of Renewable Energy Systems | PEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EEP64    | Grid integrating Techniques & Challenges       | PEC      | 4   | 2                | 0 | 2 | 3       |
| 5       | U24EEP65    | Battery Management System                      | PEC      | 3   | 3                | 0 | 0 | 3       |
| 6       | U24EEP66    | Energy Management & Auditing                   | PEC      | 3   | 3                | 0 | 0 | 3       |



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| U24EEP61                                                                                                                                                                                                                                                                                | ENERGY STORAGE SYSTEMS                                                                                    | L | T | P | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                         |                                                                                                           | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                       |                                                                                                           |   |   |   |   |
| After completing the course, the students will be able to                                                                                                                                                                                                                               |                                                                                                           |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                       | Understand the necessity, classification, and applications of various energy storage systems.             |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                       | Explain the operating principles of thermal, electrical, and electrochemical energy storage technologies. |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                       | Analyze the performance characteristics and limitations of batteries and fuel cells.                      |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                       | Develop mathematical models for selected energy storage systems.                                          |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                       | Evaluate alternative and hybrid energy storage technologies for practical applications.                   |   |   |   |   |
| UNIT I INTRODUCTION                                                                                                                                                                                                                                                                     |                                                                                                           |   |   | 9 |   |
| Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications.                                                                                                                                                                       |                                                                                                           |   |   |   |   |
| Experiential Learning (Activity Based Learning): Demonstrate different energy storage types (mechanical, electrical, thermal, chemical) through mini models or simulations.                                                                                                             |                                                                                                           |   |   |   |   |
| Industrial Application: large-scale storage for grid stability and load balancing.                                                                                                                                                                                                      |                                                                                                           |   |   |   |   |
| Content Beyond Syllabus: Case study on India’s largest battery energy storage project and its grid impact.                                                                                                                                                                              |                                                                                                           |   |   |   |   |
| UNIT II THERMAL STORAGE SYSTEM                                                                                                                                                                                                                                                          |                                                                                                           |   |   | 9 |   |
| Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS. |                                                                                                           |   |   |   |   |
| Experiential Learning (Activity Based Learning): Perform an experiment showing heat retention in water and rock materials over time.                                                                                                                                                    |                                                                                                           |   |   |   |   |
| Industrial Application: Used in solar thermal power plants, HVAC systems, industrial furnaces, and waste heat recovery units.                                                                                                                                                           |                                                                                                           |   |   |   |   |
| Content Beyond Syllabus: Study of Phase Change Materials (PCM) in building cooling systems.                                                                                                                                                                                             |                                                                                                           |   |   |   |   |
| UNIT III ELECTRICAL ENERGY STORAGE                                                                                                                                                                                                                                                      |                                                                                                           |   |   | 9 |   |



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Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

Experiential Learning (Activity Based Learning): Construct a battery charging–discharging test setup using Arduino for voltage and current monitoring.

Industrial Application: Widely used in electric vehicles (EVs), solar PV backup systems, portable electronics, and microgrids.

Content Beyond Syllabus: Explore Battery Management Systems (BMS) and State of Charge (SOC) estimation algorithms.

**UNIT IV FUEL CELL**

**9**

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

Experiential Learning (Activity Based Learning): Build a simple hydrogen–oxygen fuel cell demo using a PEM fuel cell kit.

Industrial Application: Used in fuel cell vehicles, backup power, and space missions.

Content Beyond Syllabus: Study of biofuel cells and microbial fuel cells for waste-to-energy applications.

**UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES**

**9**

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

Experiential Learning (Activity Based Learning): Demonstrate pumped hydro model using small tanks and water pumps to represent energy potential.

Industrial Application: Pumped hydro storage used in large-scale renewable energy balancing.

Content Beyond Syllabus: Study of Compressed Air Energy Storage (CAES) in hybrid systems.

**TOTAL PERIODS**

**45**

**COURSE OUTCOMES**

**At the end of the course, the student will be able to**

**CO1** Identify and classify the necessity, types, and applications of energy storage systems.



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|            |                                                                                                                |
|------------|----------------------------------------------------------------------------------------------------------------|
| <b>CO2</b> | Analyze and model thermal energy storage systems using sensible heat, latent heat, and simulation tools.       |
| <b>CO3</b> | Evaluate and model battery-based electrical energy storage systems based on performance and safety parameters. |
| <b>CO4</b> | Explain and analyze the principles, types, and performance characteristics of fuel cell systems.               |
| <b>CO5</b> | Compare and select alternate and hybrid energy storage technologies for practical energy applications.         |

**TEXT BOOKS**

|   |                                                                                                                                                                                                                                                |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications', John Wiley & Sons, 3rd Edition, 2021.                                                                                                                     |
| 2 | R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Ru-shi Liu, Lei Zhang and Xueliang sun, 'Electrochemical technologies for energy storage and conversion', Wiley publications, 2nd Volume set, 2012. |
| 3 | James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.                                                                                                                                         |

**REFERENCES**

|   |                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------|
| 1 | Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.                                          |
| 2 | Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration', Hemisphere Publishing Corporation, 1981, 1st Edition. |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | -   | -   | -   | 2   | 3   | -   | -   | -    | -    | 2    | -    | 3    |
| <b>CO2</b> | 3   | 3   | 2   | 2   | 3   | -   | 2   | -   | -   | -    | -    | 2    | -    | 3    |
| <b>CO3</b> | 3   | 3   | 2   | 2   | 2   | -   | 2   | -   | -   | -    | -    | 2    | -    | 3    |
| <b>CO4</b> | 3   | 2   | 2   | 2   | -   | -   | 3   | -   | -   | -    | -    | 2    | -    | 3    |
| <b>CO5</b> | 3   | 2   | 3   | 2   | 2   | -   | 3   | -   | -   | -    | -    | 2    | -    | 3    |





| AVG                         | 3                                                                                                                                | 2 |  |  |  | 2 |  | 1 |  |  |  | 2 |  | 3 |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------|---|--|--|--|---|--|---|--|--|--|---|--|---|
| PRODUCT BASED OUTCOME       |                                                                                                                                  |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 1                           | Prototype tool demonstrating comparison and selection of energy storage technologies for EV applications.                        |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 2                           | Thermal storage analyzer software for PCM, rock-bed, and water-based EV thermal management.                                      |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 3                           | Battery performance evaluation platform for charge–discharge behavior, SOC/SOH estimation, and modeling.                         |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 4                           | Fuel cell analysis toolkit for studying hydrogen-based power generation in EVs.                                                  |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 5                           | Hybrid storage system simulation tool integrating flywheel, supercapacitor, CAES, and batteries for EV performance optimization. |   |  |  |  |   |  |   |  |  |  |   |  |   |
| PRODUCT-BASED TEAM PROJECTS |                                                                                                                                  |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 1                           | Energy Storage Technology Selection Dashboard                                                                                    |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 2                           | Electric Vehicle Thermal Management System Analyzer                                                                              |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 3                           | Smart Battery Testing & Monitoring Kit for EVs                                                                                   |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 4                           | Fuel Cell Power Unit Diagnostic Tool                                                                                             |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 5                           | Hybrid Energy Storage (Battery + Supercapacitor) Control Module                                                                  |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 6                           | Battery SOC–SOH Estimator for Electric Vehicles                                                                                  |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 7                           | PCM-Based Thermal Storage Demonstration Unit                                                                                     |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 8                           | Supercapacitor-Based Regenerative Braking Energy Capture Prototype                                                               |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 9                           | Flywheel Energy Storage Mini System for EV Power Support                                                                         |   |  |  |  |   |  |   |  |  |  |   |  |   |
| 10                          | Compressed Air Energy Storage (CAES) Simulation Platform for EVs                                                                 |   |  |  |  |   |  |   |  |  |  |   |  |   |



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| U24EEP62                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | HYBRID ENERGY TECHNOLOGY                                                                               | L | T | P | C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                        | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |   |   |
| At the end of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                        |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To understand the need, classification, and environmental impact of hybrid energy systems.             |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To analyze the operation and performance of SCIG, DFIG, and PMSG for wind energy conversion.           |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To design and evaluate solar PV systems including converters, inverters, and energy storage sizing.    |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To explain and compare various power converters for hybrid and grid-interactive energy systems.        |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | To analyze and optimize hybrid renewable energy systems through case studies for performance and cost. |   |   |   |   |
| UNIT I INTRODUCTION TO HYBRID ENERGY SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                        |   |   | 9 |   |
| Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind-Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems – Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy - Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics. |                                                                                                        |   |   |   |   |
| Experiential learning: Techno-Economic Analysis and Sizing of a Stand-Alone Hybrid System using python.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                        |   |   |   |   |
| Industrial Application: Hydrogen Production and Fueling Stations (P2H: Power-to-Hydrogen).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |   |   |   |   |
| Content beyond syllabus: Integrated Energy System (IES) Modelling and Optimization.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                        |   |   |   |   |
| UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                        |   |   | 9 |   |
| Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                        |   |   |   |   |
| Experiential learning: Simulation and Modeling of DFIG or PMSG Control in MATLAB.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |   |   |   |   |
| Industrial Application: Grid Code Requirements and Wind Farm Integration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                        |   |   |   |   |
| Content beyond Syllabus: Variable Speed Synchronous Generator (VSSG) or High-Temperature Superconducting (HTS) Generators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                        |   |   |   |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                |           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-----------|
| <b>UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                | <b>9</b>  |
| Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems.<br><br>Experiential learning: Realization of a DC-DC Converter (Boost/Buck-Boost) for PV Simulation using MATLAB or python.<br>Industrial Application: Grid-Tied/Grid-Connected PV Systems with Advanced Inverter Functionality (Smart Inverters).<br>Content beyond Syllabus: Maximum Power Point Tracking (MPPT) Algorithms. |                                                                                                |           |
| <b>UNIT IV ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                | <b>9</b>  |
| Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.<br><br>Experiential learning: Design and Simulation of a Bi-Directional DC-DC Converter for Energy Storage Management using MATLAB or python.<br>Industrial Application: Power Quality Standards and Harmonic Mitigation Techniques.<br>Content beyond Syllabus: Multi-Level Inverters.                                                                                                        |                                                                                                |           |
| <b>UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                | <b>9</b>  |
| Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis - Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.<br><br>Experiential learning: Hybrid System Design and Optimization using MATLAB.<br>Industrial Application: Hybrid System Project Development and Financial Feasibility Study.<br>Content beyond Syllabus: Advanced Optimal Sizing and Energy Management System (EMS) using AI/Machine Learning.                                                                                                                                 |                                                                                                |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                | <b>45</b> |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                |           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                |           |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Explain and classify the principles, types, and environmental impact of hybrid energy systems. |           |



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|------------|-------------------------------------------------------------------------------------------------------------|
| <b>CO2</b> | Analyze the performance and operational characteristics of SCIG, DFIG, and PMSG for wind energy conversion. |
| <b>CO3</b> | Design and evaluate solar PV systems with appropriate converters, inverters, and battery/array sizing.      |
| <b>CO4</b> | Compare and select power converters for hybrid and grid-interactive renewable energy systems.               |
| <b>CO5</b> | Conduct performance, cost and feasibility analysis of hybrid renewable energy systems through case studies. |

**TEXT BOOKS**

|   |                                                                                                                                                                 |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Bahman Zohuri, "Hybrid Energy Systems", Springer, First Edition, 2018.                                                                                          |
| 2 | S.M. Mueen, "Wind Energy Conversion Systems", Springer First Edition, 2012                                                                                      |
| 3 | Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters for Renewable Energy and Electric Vehicles", CRC Press, First Edition, 2021 |

**REFERENCES**

|   |                                                                                                                |
|---|----------------------------------------------------------------------------------------------------------------|
| 1 | Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3rd Edition.                                           |
| 2 | S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 7th Impression, 2005. |
| 3 | Rashid.M. H "Power electronics Hand book", Academic press, 4th Edition, 2018.                                  |
| 4 | Rai. G.D, "Non-conventional energy sources", Khanna publishers, 6th Edition, 2017.                             |
| 5 | Rai. G.D, "Solar energy utilization", Khanna publishers, 3rd Edition, 1987.                                    |
| 6 | Gray, L. Johnson, "Wind energy system", Prentice Hall of India, 2nd Edition, 2006.                             |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 3   | 3   | 2   | 0   | 0   | 0   | 0   | 0   | 3    | 0    | 3    | 3    | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 2   | 3   | 0   | 0   | 0   | 0   | 3    | 0    | 3    | 3    | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 2   | 3   | 0   | 0   | 0   | 0   | 3    | 0    | 3    | 3    | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 2   | 0   | 0   | 0   | 0   | 0   | 3    | 0    | 3    | 3    | 3    |
| <b>CO5</b> | 3   | 3   | 3   | 2   | 3   | 0   | 0   | 0   | 0   | 3    | 0    | 3    | 3    | 3    |



| AVG                         | 3                                                                                          | 3 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 3 | 3 |
|-----------------------------|--------------------------------------------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRODUCT BASED OUTCOME       |                                                                                            |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                           | Design solar-wind-diesel system optimizing energy use, minimizing environmental impact.    |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2                           | Develop microgrid integrating SCIG, DFIG, PMSG for renewable energy.                       |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3                           | Construct stand-alone solar PV system with proper sizing, storage, inverter.               |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4                           | Implement bi-directional converter enabling grid interaction, efficient hybrid management. |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5                           | Design hybrid system demonstrating reliable energy supply, economic feasibility.           |   |   |   |   |   |   |   |   |   |   |   |   |   |
| PRODUCT-BASED TEAM PROJECTS |                                                                                            |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1                           | Design solar-wind-diesel system for rural electricity.                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2                           | Develop micro-hydel-PV hybrid system for remote areas.                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3                           | Create tool comparing performance of hybrid systems.                                       |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4                           | Build simulation model evaluating environmental energy impacts.                            |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5                           | Develop dashboard showing conventional and renewable energy trends.                        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6                           | Construct multi-source prototype with solar PV, hydrogen.                                  |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7                           | Design miniature microgrid using SCIG, DFIG, PMSG.                                         |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8                           | Implement stand-alone solar PV with converters, storage.                                   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 9                           | Develop bi-directional AC-DC-AC converter for grid.                                        |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 10                          | Design Wind-PV-Fuel-cell system with performance monitoring                                |   |   |   |   |   |   |   |   |   |   |   |   |   |



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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EEP63                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | DESIGN & MODELLING OF RENEWABLE<br>ENERGY SYSTEMS                                                                  | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                    |   |   |   |   |
| At the end of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                    |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Understand the state-of-the-art, challenges, and future trends in renewable energy technologies.                   |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Analyze and design single-phase grid-connected PV systems using transformer-less and module-integrated converters. |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Model and implement three-phase PV inverter structures, control strategies, and MPPT techniques.                   |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Evaluate and select turbines and generators for small-scale wind energy applications.                              |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Model and analyze doubly-fed induction generator-based wind energy conversion systems.                             |   |   |   |   |
| UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW<br>AND PERSPECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                    |   |   |   | 9 |
| Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends<br><br>Experiential Learning (Activity Based Learning): Demonstrate different renewable energy technologies (solar, wind, hydro, biomass) using small working models or simulation tools.<br><br>Industrial Application: Integrated renewable energy parks for sustainable power generation.<br><br>Content Beyond Syllabus: Case study on India’s renewable energy roadmap and future targets for 2030.                                                                                                                                                                                             |                                                                                                                    |   |   |   |   |
| UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                    |   |   |   | 9 |
| Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single- Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems.<br><br>Experiential Learning (Activity Based Learning): Simulate a single-phase grid-connected PV system using MATLAB or Simulink to analyze power flow and inverter control.<br><br>Industrial Application: Rooftop solar PV systems connected to residential and commercial grids.<br><br>Content Beyond Syllabus: Study of emerging transformer-less inverter technologies for improved efficiency. |                                                                                                                    |   |   |   |   |
| UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES,<br>TOPOLOGIES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                    |   |   |   | 9 |



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|                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                 |
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| Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking. |                                                                                                 |
| Experiential Learning (Activity Based Learning): Develop and analyze a three-phase PV inverter control model with MPPT and grid synchronization.                                                                                                                                                                                                                                           |                                                                                                 |
| Industrial Application: Utility-scale solar farms using three-phase inverter systems for high-capacity grid integration. Content Beyond Syllabus: Research on AI-based control strategies for three-phase PV inverters.                                                                                                                                                                    |                                                                                                 |
| <b>UNIT IV SMALL WIND ENERGY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                   | <b>9</b>                                                                                        |
| Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems- Magnus Turbine–Based Wind Energy System.                                                   |                                                                                                 |
| Experiential Learning (Activity Based Learning): Build a small wind turbine prototype and measure generated voltage under varying wind speeds.                                                                                                                                                                                                                                             |                                                                                                 |
| Industrial Application: Small-scale wind power generation for rural and remote electrification. Content Beyond Syllabus: Case study on hybrid wind-solar microgrids for off-grid applications.                                                                                                                                                                                             |                                                                                                 |
| <b>UNIT V DOUBLY-FED INDUCTION GENERATOR-BASED WECS</b>                                                                                                                                                                                                                                                                                                                                    | <b>9</b>                                                                                        |
| Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.                                                                                                                                                                                                                                         |                                                                                                 |
| Experiential Learning (Activity Based Learning): Simulate the modeling of a Doubly-Fed Induction Generator (DFIG) in MATLAB for variable speed operation.                                                                                                                                                                                                                                  |                                                                                                 |
| Industrial Application: DFIG-based wind energy conversion systems in modern wind farms.                                                                                                                                                                                                                                                                                                    |                                                                                                 |
| Content Beyond Syllabus: Study of advanced control algorithms for DFIG performance optimization.                                                                                                                                                                                                                                                                                           |                                                                                                 |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                       | <b>45</b>                                                                                       |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                 |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                               |                                                                                                 |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                 | Explain the technological developments, R&D challenges, and trends in renewable energy systems. |



| TEXT BOOKS |                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1          | Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021       |
| 2          | Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021                                            |
| 3          | Nabil Derbel, Quanmin Zhu, "Modeling, Identification and Control Methods in Renewable Energy Systems", Springer, First Edition, 2019 |

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| 1 | Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.                                             |
| 2 | Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.                                                                     |
| 3 | Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.                                |
| 4 | Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC Press, 2017, 1st Edition. |

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| <p align="center"><b>CO/PO, PSO Mapping</b></p> <p align="center"><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b></p> <p align="center"><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b></p> |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|

[illegible]





| AVG                         | 3                                                                                               | 2 | 3 | 2.8 | 2 | - | - | - | - | - | - | 3 | 3 | 2.8 |
|-----------------------------|-------------------------------------------------------------------------------------------------|---|---|-----|---|---|---|---|---|---|---|---|---|-----|
| PRODUCT BASED OUTCOME       |                                                                                                 |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 1                           | Software tool for evaluating and comparing renewable energy technologies for grid integration.  |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 2                           | Single-phase PV grid-connected inverter simulation and performance analysis tool.               |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 3                           | Three-phase PV inverter control and MPPT testing platform with grid synchronization capability. |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 4                           | Prototype small wind energy generation and monitoring system.                                   |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 5                           | DFIG modeling and analysis toolkit for wind energy conversion systems.                          |   |   |     |   |   |   |   |   |   |   |   |   |     |
| PRODUCT-BASED TEAM PROJECTS |                                                                                                 |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 1                           | Renewable Energy Technology Assessment Dashboard                                                |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 2                           | Single-Phase Grid-Connected PV Inverter Emulator                                                |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 3                           | Transformer-less PV Inverter Topology Analyzer                                                  |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 4                           | Three-Phase PV Inverter Control Suite with MPPT                                                 |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 5                           | AI-Based MPPT and Grid Synchronization Module                                                   |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 6                           | Small Wind Turbine Generation & Monitoring Prototype                                            |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 7                           | Magnus Turbine Mini Wind Energy System                                                          |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 8                           | Hybrid Wind–Solar Microgrid Demonstrator                                                        |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 9                           | DFIG Modeling and Variable-Speed Operation Simulator                                            |   |   |     |   |   |   |   |   |   |   |   |   |     |
| 10                          | DFIG Grid-Side Converter and Rotor-Side Converter Control Tester                                |   |   |     |   |   |   |   |   |   |   |   |   |     |



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| U24EEP64                                                                                                                                                                                                                                                       | GRID INTEGRATING TECHNIQUES AND CHALLENGES                                                                 | L | T | P  | C |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---|---|----|---|
|                                                                                                                                                                                                                                                                |                                                                                                            | 2 | 0 | 2  | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                              |                                                                                                            |   |   |    |   |
| At the end of the course, the students will be able to                                                                                                                                                                                                         |                                                                                                            |   |   |    |   |
| 1                                                                                                                                                                                                                                                              | Understand the current status and characteristics of conventional and renewable power generation in India. |   |   |    |   |
| 2                                                                                                                                                                                                                                                              | Analyze the structure, components, and modeling of power grid and microgrid systems.                       |   |   |    |   |
| 3                                                                                                                                                                                                                                                              | Design and model DC/AC and DC/DC converters for distributed and renewable energy systems.                  |   |   |    |   |
| 4                                                                                                                                                                                                                                                              | Evaluate power quality and integration issues for wind energy systems in the grid.                         |   |   |    |   |
| 5                                                                                                                                                                                                                                                              | Explain and apply grid codes and integration techniques for PV and WECS systems.                           |   |   |    |   |
| UNIT I PRESENT POWER SCENARIO IN INDIA                                                                                                                                                                                                                         |                                                                                                            |   |   | 9  |   |
| Introduction - Thermal Power Plant, Components of Thermal Power Plant, Major Thermal Power Plants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy – Power plants India. |                                                                                                            |   |   |    |   |
| Experiential Learning (Activity Based Learning): Students build a mini India power map marking all major thermal, hydro, nuclear and solar parks.                                                                                                              |                                                                                                            |   |   |    |   |
| Industrial Application : Real-world use in load dispatch centers for energy mix optimization.                                                                                                                                                                  |                                                                                                            |   |   |    |   |
| Content Beyond Syllabus : Green hydrogen integration in Indian power sector.                                                                                                                                                                                   |                                                                                                            |   |   |    |   |
| UNIT II POWER GRIDS                                                                                                                                                                                                                                            |                                                                                                            |   |   | 12 |   |
| Introduction -Electric Power, Background, The Construction of a Power Grid System, Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a Microgrid System.                                                           |                                                                                                            |   |   |    |   |
| Experiential Learning (Activity Based Learning): simulation using MATLAB/Simulink to model a basic grid.                                                                                                                                                       |                                                                                                            |   |   |    |   |
| Industrial Application : Microgrid deployment in industries, airports, IT parks and hospitals.                                                                                                                                                                 |                                                                                                            |   |   |    |   |
| Content Beyond Syllabus : FACTS devices (STATCOM, UPFC) and grid modernization.                                                                                                                                                                                |                                                                                                            |   |   |    |   |
| Lab Component:                                                                                                                                                                                                                                                 |                                                                                                            |   |   |    |   |
| 1. Develop a model for the control of DC micro grid for nonlinear loads                                                                                                                                                                                        |                                                                                                            |   |   |    |   |
| UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS                                                                                                                                                                                   |                                                                                                            |   |   | 15 |   |



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Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, Pulse Width Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse Width Modulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation, The Sizing of DC/DC Converters for Micro grid.

Experiential Learning (Activity Based Learning): Build a PWM-controlled DC–DC converter using Arduino. Analyze inverter output waveform using oscilloscope/DSO.

Industrial Application: Converter modeling used in microgrid EMS (Energy Management Systems).

Content Beyond Syllabus: Role of SiC/GaN devices in next-gen converters.

**Lab Component:**

1. Simulation study of three phase inverters with fixed and sine PWM techniques,

**UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION**

**12**

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

Experiential Learning (Activity Based Learning): Measure THD of a wind generator using Arduino FFT.

Industrial Application: wind farms for power quality monitoring.

Content Beyond Syllabus: Role of STATCOM in wind farm grid integration.

**Lab Component:**

1. Simulate a basic Wind Energy System with Grid Connection

**UNIT V GRID INTER CONNECTION**

**12**

Grid Code Requirements-Grid integration of WECS-Grid Integration of PV systems.

Experiential Learning (Activity Based Learning): Grid code compliance by simulating frequency/voltage variations.

Industrial Application: Inverters in EV fast-charging and microgrids.

Content Beyond Syllabus: IEEE 1547 standards for Distributed Energy Resources (DER).

**Lab Component:**

1. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement in power quality.

**TOTAL PERIODS**

**60**

**COURSE OUTCOMES**



|                                                                         |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, the student will be able to                   |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                                     | Explain the operation and characteristics of thermal, gas, nuclear, hydro, wind, and solar power plants in India.                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                     | Analyze power grid components, load models, transformers, and microgrid systems.                                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                     | Design and simulate single-phase and three-phase inverters, DC/DC converters, and microgrid interfaces.                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                     | Evaluate power quality issues and the role of custom power devices in grid-connected wind systems.                                                               |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                     | Apply grid codes and integration strategies for wind and PV systems in distributed generation networks.                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                              |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Brian D’Andrade “The Power Grid”, Academic Press, 1st Edition, 2017.                                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications", Springer, 1st Edition 2022.                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems", John Wiley & Sons, Ltd, 2014, 3rd Edition.                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                              |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                       | Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                       | Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                       | Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.                                                                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping                                                      |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| Programme Outcomes (POs) and Programme Specific Outcomes PSOs'          |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                         | PO1                                                                                                                                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                     | 3                                                                                                                                                                | 2   | 1   | –   | –   | 3   | 1   | –   | 2   | 1    | 2    | 3    | 1    | 2    |
| CO2                                                                     | 3                                                                                                                                                                | 3   | 2   | 2   | 3   | 2   | –   | 2   | 1   | 1    | 2    | 3    | 3    | 2    |
| CO3                                                                     | 3                                                                                                                                                                | 3   | 3   | 2   | 3   | 1   | –   | 1   | 1   | 1    | 2    | 3    | 3    | 3    |
| CO4                                                                     | 3                                                                                                                                                                | 3   | 2   | 2   | 2   | 3   | 1   | 1   | 1   | 1    | 2    | 3    | 2    | 2    |
| CO5                                                                     | 3                                                                                                                                                                | 2   | 2   | 3   | 3   | 1   | –   | 1   | 1   | –    | 3    | 3    | 3    | 2    |



| AVG                         | 3                                                                                 | 2.6 | 2 | 2.3 | 2.8 | 2 | 1 | 1.3 | 1.2 | 1 | 2.2 | 3 | 2.4 | 2.2 |
|-----------------------------|-----------------------------------------------------------------------------------|-----|---|-----|-----|---|---|-----|-----|---|-----|---|-----|-----|
| PRODUCT BASED OUTCOME       |                                                                                   |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 1                           | Demonstrates grid protection, grid stability and safety logic.                    |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 2                           | Links to power grid operation & interconnection topics.                           |     |   |     |     |   |   |     |     |   |     |   |     |     |
| PRODUCT-BASED TEAM PROJECTS |                                                                                   |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 1                           | Hybrid Mini Power Plant Demonstrator (Thermal + Solar + Wind Model)               |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 2                           | Smart Microgrid Prototype with Automatic Load Management                          |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 3                           | Low-Cost Inverter & DC–DC Converter Testing Platform                              |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 4                           | Wind Turbine With Power Quality Analyzer (Mini Model)                             |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 5                           | Grid-Tied Solar Micro-Inverter Prototype (Simulated Grid)                         |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 6                           | Smart Energy Mix Visualizer for India (Real-Time Data Dashboard + Physical Model) |     |   |     |     |   |   |     |     |   |     |   |     |     |
| 7                           | Low-Cost Grid Fault Detection & Auto-Isolation Demonstrator                       |     |   |     |     |   |   |     |     |   |     |   |     |     |



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|                                                                                                                                                                                                                                        |                                                                                                          |   |   |   |   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EEP65                                                                                                                                                                                                                               | BATTERIES AND MANAGEMENT SYSTEM                                                                          | L | T | P | C |
|                                                                                                                                                                                                                                        |                                                                                                          | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                      |                                                                                                          |   |   |   |   |
| At the end of the course, the students will be able to                                                                                                                                                                                 |                                                                                                          |   |   |   |   |
| 1                                                                                                                                                                                                                                      | Understand the working principles, types, and characteristics of advanced batteries.                     |   |   |   |   |
| 2                                                                                                                                                                                                                                      | Design and evaluate battery packs including sizing, peak power, and smart charging methods.              |   |   |   |   |
| 3                                                                                                                                                                                                                                      | Model and compare batteries using equivalent circuit, electrochemical, and neural network approaches.    |   |   |   |   |
| 4                                                                                                                                                                                                                                      | Estimate and analyze battery state-of-charge (SOC) using various measurement and algorithmic techniques. |   |   |   |   |
| 5                                                                                                                                                                                                                                      | Implement and evaluate battery management system architectures and real-time components.                 |   |   |   |   |
| UNIT I ADVANCED BATTERIES                                                                                                                                                                                                              |                                                                                                          |   |   | 9 |   |
| The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management.                                                                               |                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Battery Monitoring and Balancing using MATLAB Simulation                                                                                                                              |                                                                                                          |   |   |   |   |
| Industrial Application: Li-ion Battery Industrial applications                                                                                                                                                                         |                                                                                                          |   |   |   |   |
| Content Beyond Syllabus: Emerging cell formats & advanced chemistry                                                                                                                                                                    |                                                                                                          |   |   |   |   |
| UNIT II BATTERY PACK                                                                                                                                                                                                                   |                                                                                                          |   |   | 9 |   |
| Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging. |                                                                                                          |   |   |   |   |
| Experiential Learning (Activity Based Learning): Battery Modelling, Thermal analysis of Li-ion battery                                                                                                                                 |                                                                                                          |   |   |   |   |
| Industrial Application: Battery pack industrial application.                                                                                                                                                                           |                                                                                                          |   |   |   |   |
| Content Beyond Syllabus: Industrial standards for Battery pack testing                                                                                                                                                                 |                                                                                                          |   |   |   |   |
| UNIT III BATTERY MODELLING                                                                                                                                                                                                             |                                                                                                          |   |   | 9 |   |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frameworks<br><a href="#">Experiential Learning (Activity Based Learning): Simple ECM Model using MATLAB</a><br><a href="#">Industrial Application: Study of BMS Modelling in EV industry</a><br><a href="#">Content Beyond Syllabus: Introduction to Physics based &amp; AI driven battery modelling</a> |                                                                                                                          |
| <b>UNIT IV BATTERY STATE ESTIMATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>9</b>                                                                                                                 |
| SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.<br><a href="#">Experiential Learning (Activity Based Learning): SOC Estimation - Kalman filter</a><br><a href="#">Industrial Application: SOC estimation in EV industry</a><br><a href="#">Content Beyond Syllabus: Fuzzy Logic in BMS</a>                                                 |                                                                                                                          |
| <b>UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>9</b>                                                                                                                 |
| Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex RayCANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.<br><br><a href="#">Experiential Learning (Activity Based Learning): ARBIN battery Tester</a><br><a href="#">Industrial Application: BMS in EV industry</a><br><a href="#">Content Beyond Syllabus: Digital twin Technology</a>                            |                                                                                                                          |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>45</b>                                                                                                                |
| <b>COURSE OUTCOMES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                          |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                          |
| <b>CO1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Explain the working, performance, and characteristics of different battery technologies.                                 |
| <b>CO2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Design and analyze battery packs, including power, temperature, and internal resistance considerations.                  |
| <b>CO3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Develop and compare battery models using ECM, electrochemical, neural network, and state-space methods.                  |
| <b>CO4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Estimate and evaluate SOC of single and series batteries using voltage, impedance, Ah counting, and algorithmic methods. |



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|            |                                                                                                           |
|------------|-----------------------------------------------------------------------------------------------------------|
| <b>CO5</b> | Implement and analyze BMS architecture with real-time ICs, communication modules, and model-based design. |
|------------|-----------------------------------------------------------------------------------------------------------|

**TEXT BOOKS**

|   |                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015. |
| 2 | Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.                                |

**REFERENCES**

|   |                                                                                       |
|---|---------------------------------------------------------------------------------------|
| 1 | Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper |
| 2 | Panasonic NCR18650B- DataSheet                                                        |
| 3 | bq76PL536A-Q1- IC DataSheet                                                           |
| 4 | CC2662R-Q1- IC DataSheet                                                              |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | –   | –   | 1   | 2   | 1   | –   | –   | –    | 2    |      | 3    | 2    |
| <b>CO2</b> | 3   | 3   | 3   | 2   | 3   | 2   | –   | 1   | –   | 2    | 2    |      | 3    | 3    |
| <b>CO3</b> | 2   | 3   | 2   | 3   | 3   | –   | –   | –   | –   | –    | 3    |      | 2    | 3    |
| <b>CO4</b> | 2   | 3   | –   | 3   | 3   | 1   | –   | –   | –   | –    | 3    |      | 2    | 3    |
| <b>CO5</b> | 2   | 2   | 3   | 2   | 3   | 3   | 2   | 2   | 2   | 3    | 3    |      | 3    | 2    |
| <b>AVG</b> | 2.4 | 2.6 | 2.7 | 2.5 | 2.6 | 2   | 1.5 | 1.5 | 2   | 2.5  | 2.6  |      | 2.6  | 2.6  |

**PRODUCT BASED OUTCOME**

|   |                                                                                         |
|---|-----------------------------------------------------------------------------------------|
| 1 | To design and develop a working battery health monitoring product                       |
| 2 | To develop a battery pack design and sizing product                                     |
| 3 | To build a battery modelling product that implements and compares with different models |
| 4 | To develop a real-time battery state estimation product using SOC estimation algorithms |





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|                                    |                                                                       |
|------------------------------------|-----------------------------------------------------------------------|
| 5                                  | To design and implement a real-time Battery Management System product |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                                       |
| 1                                  | Smart Li-ion Battery Health Monitoring Device                         |
| 2                                  | Intelligent Active & Passive Cell Balancing BMS Module                |
| 3                                  | Battery Pack Design, Sizing & Optimization Software Tool              |
| 4                                  | Smart Battery Pack with Cloud & Local Charging Control                |
| 5                                  | Peak Power & Internal Resistance Characterization System              |
| 6                                  | Comparative Battery Modelling Simulator (Rint, Thevenin, PNGV)        |
| 7                                  | Electrochemical Battery Model & Parameter Estimation Tool             |
| 8                                  | Neural Network Based Battery Voltage & SOC Predictor                  |
| 9                                  | Multi-Algorithm SOC Estimation & Validation Platform                  |
| 10                                 | Kalman Filter Based SOC Estimator for Series Battery Packs            |



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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
| U24EEP66                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ENERGY MANAGEMENT & AUDITING                                                                                                    | L | T | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                 | 3 | 0 | 0 | 3 |
| COURSE OBJECTIVES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                 |   |   |   |   |
| At the end of the course, the students will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                 |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Understand energy consumption patterns, energy conservation principles, and energy audit methodologies.                         |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Analyze material and energy flows, and apply financial techniques for energy management planning.                               |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Implement and evaluate electrical utility systems including motors, transformers for energy efficiency.                         |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Implement and evaluate electrical utility systems including pumps, fans, and lighting for energy efficiency.                    |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Assess and optimize boilers,furnaces ,compressed air, refrigeration, cooling, and diesel generation systems for energy savings. |   |   |   |   |
| UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                 |   |   | 9 |   |
| Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit – Energy management/audit approach- understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments. |                                                                                                                                 |   |   |   |   |
| Experiential Learning: Conduct a mini energy audit in a classroom or lab (lighting, fans, computers).                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                 |   |   |   |   |
| Industrial Application: Basis for ISO 50001 Energy Management System implementation.                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                 |   |   |   |   |
| Content Beyond Syllabus: Smart energy monitoring using IoT sensors.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                 |   |   |   |   |
| UNIT II MATERIAL AND ENERGY BALANCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                 |   |   | 9 |   |
| Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return.                                                                                                                                                                                  |                                                                                                                                 |   |   |   |   |
| Experiential Learning: Case study on different types of metering for different forms of energies.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                 |   |   |   |   |
| Industrial Application: Applied in process industries (cement, steel, chemical, food processing) for                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                 |   |   |   |   |



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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| optimizing raw material and energy use.<br>Content Beyond Syllabus: Use of digital twins for process optimization.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |
| <b>UNIT III ENERGY MANAGEMENT AND EFFICIENCY IN ELECTRICAL SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>9</b> |
| Electrical load management and maximum demand control - power factor improvement and its benefit<br>- selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver.<br><br>Experiential Learning: Conduct power factor improvement experiment using capacitors.<br>Industrial Application: Electrical energy management in thermal power plants, cement plants, sugar mills, paper mills, and steel industries.<br>Content Beyond Syllabus: AI-based predictive maintenance for electrical drives and motors.                                                                                        |          |
| <b>UNIT IV Energy Efficiency in Pumps, Pumping, and Lighting Systems</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>9</b> |
| variable speed drives– Fans and blowers: Types - efficient system operation – flow control strategies<br>Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast – occupancy sensors - energy efficient lighting controls - energy conservation avenues.<br><br>Experiential Learning: Perform <b>pump performance and flow control analysis</b> using system curves<br>Industrial Application: Implementation of energy-efficient pumps and lighting in factories and commercial facilities.<br>Content Beyond Syllabus: Evaluate lighting system efficiency with different light sources and occupancy sensors.                                                                                                                                                                                                             |          |
| <b>UNIT V Industrial Energy Efficiency and Utility System Optimization</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>9</b> |
| Basics of fuels and combustion – overview of boilers and performance evaluation – steam system losses and energy-saving opportunities – furnaces and waste heat recovery – introduction to cogeneration and saving potential.<br><br>Compressed air systems: types, components and efficiency improvement methods – basics of refrigeration and air-conditioning systems and COP – cooling tower performance and energy-saving measures – diesel generator system performance and conservation opportunities – identification of energy-saving opportunities through simple energy audit and case studies in industrial utility systems.<br><br>Experiential Learning: Performance analysis of Compressors and utility systems.<br>Industrial Application: Energy management in thermal power plants, cement, paper, steel, textile, and chemical industries.<br>Content Beyond Syllabus: IoT-based monitoring of compressor systems. |          |

|                                                                                                                                                                                                                                                  |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| TOTAL PERIODS                                                                                                                                                                                                                                    |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      | 45   |      |      |      |
| COURSE OUTCOMES                                                                                                                                                                                                                                  |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of the course, the student will be able to                                                                                                                                                                                            |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO1                                                                                                                                                                                                                                              | Explain energy pricing, energy conservation acts, audit approaches, and energy management instruments.                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO2                                                                                                                                                                                                                                              | Prepare and analyze material and energy balance diagrams and evaluate financial feasibility of energy projects.                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO3                                                                                                                                                                                                                                              | Implement and analyze energy-efficient practices in motors, transformers.                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO4                                                                                                                                                                                                                                              | Implement and analyze energy-efficient practices in pumps, fans, and lighting systems.                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO5                                                                                                                                                                                                                                              | Assess and optimize boiler, furnace, compressed air, refrigeration, cooling tower, and diesel systems for energy conservation.                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXT BOOKS                                                                                                                                                                                                                                       |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                | Mehmet Kanoglu, Yunus A Cengel, "Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                                                                                                                                       |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                                                                                                | Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition, CRC Press, Dec.2020                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                                                                                                | Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.                                                                    |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                                                                                                | Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011. |     |     |     |     |     |     |     |     |      |      |      |      |      |
| <p align="center"><b>CO/PO, PSO Mapping</b></p> <p align="center"><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak</b></p> <p align="center"><b>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</b></p> |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                                                                                                  | PO 1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 2   | –   | –   | 1   | 2   | –   | –   | –   | –    | 2    | 3    | 1    | –    |
| CO2                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 3   | 2   | –   | 1   | 2   | –   | –   | –   | 3    | 2    | 2    | 2    | –    |
| CO3                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 3   | 3   | 2   | 2   | 2   | –   | –   | –   | 1    | 2    | 3    | 2    | 1    |
| CO4                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 3   | 2   | 2   | 2   | 2   | –   | –   | –   | 1    | 2    | 3    | 2    | 1    |
| CO5                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 2   | 3   | 1   | 2   | 3   | –   | 1   | 1   | 2    | 2    | 3    | 2    | 2    |
| AVG                                                                                                                                                                                                                                              | 3                                                                                                                                                                | 2.6 | 2.5 | 1.7 | 1.6 | 2.2 |     | 1   | 1   | 1.8  | 2    | 2.8  | 1.3  | 1.3  |
| PRODUCT BASED OUTCOME                                                                                                                                                                                                                            |                                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |

|                                    |                                                        |
|------------------------------------|--------------------------------------------------------|
| 1                                  | Functional Energy Analysis Product                     |
| 2                                  | Energy Optimization & Cost Reduction Tool              |
| 3                                  | Industry-Ready Monitoring & Control System             |
| 4                                  | Sustainable Energy & Emission Reduction Product        |
| <b>PRODUCT-BASED TEAM PROJECTS</b> |                                                        |
| 1                                  | Smart Energy Audit Toolkit for Commercial Buildings    |
| 2                                  | Energy Cost Optimization Software Tool                 |
| 3                                  | Industrial Process Energy & Material Balance Simulator |
| 4                                  | Energy Management Dashboard for Small Industries       |
| 5                                  | Boiler Efficiency Monitoring and Loss Analysis System  |
| 6                                  | Waste Heat Recovery System Prototype                   |
| 7                                  | Compressed Air Leakage Detection & Savings Calculator  |
| 8                                  | Energy Efficient Refrigeration & Cooling Tower Model   |
| 9                                  | Automatic Power Factor Correction (APFC) Panel         |
| 10                                 | Energy Efficient Motor & VFD Performance Analyzer      |



# Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Department: Electrical and Electronics Engineering, R2024, CBCS

## OPEN ELECTIVE COURSES

| SI. NO. | COURSE CODE | COURSE TITLE                       | CATEGORY | TCP | PERIODS PER WEEK |   |   | CREDITS |
|---------|-------------|------------------------------------|----------|-----|------------------|---|---|---------|
|         |             |                                    |          |     | L                | T | P |         |
| 1       | U24EE011    | INTRODUCTION TO CONTROL SYSTEMS    | OEC      | 3   | 3                | 0 | 0 | 3       |
| 2       | U24EE012    | INTRODUCTION TO PLC PROGRAMMING    | OEC      | 3   | 3                | 0 | 0 | 3       |
| 3       | U24EE021    | ENERGY CONSERVATION AND MANAGEMENT | OEC      | 3   | 3                | 0 | 0 | 3       |
| 4       | U24EE022    | ELECTRIC VEHICLE TECHNOLOGY        | OEC      | 3   | 3                | 0 | 0 | 3       |
| 5       | U24EE031    | ENERGY AUDITING & CONSERVATION     | OEC      | 3   | 3                | 0 | 0 | 3       |



|                                                                                                                                                                                                                                                                                                                                             |                                                                                  |   |   |   |          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---|---|---|----------|
| U24EE011                                                                                                                                                                                                                                                                                                                                    | INTRODUCTION TO CONTROL SYSTEMS                                                  | L | T | P | C        |
|                                                                                                                                                                                                                                                                                                                                             |                                                                                  | 3 | 0 | 0 | 3        |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                    |                                                                                  |   |   |   |          |
| At the end of the course, the student is expected                                                                                                                                                                                                                                                                                           |                                                                                  |   |   |   |          |
| 1                                                                                                                                                                                                                                                                                                                                           | To impart knowledge on various representations of systems.                       |   |   |   |          |
| 2                                                                                                                                                                                                                                                                                                                                           | To familiarize time response analysis of LTI systems and steady state error.     |   |   |   |          |
| 3                                                                                                                                                                                                                                                                                                                                           | To analyze the frequency responses and stability of the systems                  |   |   |   |          |
| 4                                                                                                                                                                                                                                                                                                                                           | To analyze the stability of linear systems in frequency domain and time domain   |   |   |   |          |
| 5                                                                                                                                                                                                                                                                                                                                           | To develop linear models mainly state variable model and transfer function model |   |   |   |          |
| <b>UNIT 1 MATHEMATICAL MODELS OF PHYSICAL SYSTEMS</b>                                                                                                                                                                                                                                                                                       |                                                                                  |   |   |   | <b>9</b> |
| Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.                                                                                                                     |                                                                                  |   |   |   |          |
| <a href="#">Experiential Learning (Activity Based Learning): case study on Transfer Function of a Human Leg</a><br><a href="#">Industrial Application : Synchro- Transmitter- Receiver</a><br><a href="#">Content Beyond Syllabus : Determine the transfer function of Thermal System</a>                                                   |                                                                                  |   |   |   |          |
| <b>UNIT 2 TIME RESPONSE ANALYSIS &amp; ROOT LOCUS TECHNIQUE</b>                                                                                                                                                                                                                                                                             |                                                                                  |   |   |   | <b>9</b> |
| Standard test signals – Steady state error & error constants – Time Response of I and II order system– Root locus–Rules for sketching root loci                                                                                                                                                                                             |                                                                                  |   |   |   |          |
| <a href="#">Experiential Learning (Activity Based Learning): Case Study on Unmanned Free-Swimming Submersible (UFSS) Vehicle: Transient Design via Gain</a><br><a href="#">Industrial Application : Process of Temperature control (First order system)</a><br><a href="#">Content Beyond Syllabus : Adaptive Control</a>                   |                                                                                  |   |   |   |          |
| <b>UNIT 3 FREQUENCY RESPONSE ANALYSIS</b>                                                                                                                                                                                                                                                                                                   |                                                                                  |   |   |   | <b>9</b> |
| Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.                                                                                                                                                                                                               |                                                                                  |   |   |   |          |
| <a href="#">Experiential Learning (Activity Based Learning): Case Study on Unmanned Free-Swimming Submersible (UFSS) Vehicle: Pitch-Angle Control Representation</a><br><a href="#">Industrial Application : Machinery fault diagnosis from vibration signals</a><br><a href="#">Content Beyond Syllabus : Noise cancellation technique</a> |                                                                                  |   |   |   |          |
| <b>UNIT 4 STABILITY CONCEPTS &amp; ANALYSIS</b>                                                                                                                                                                                                                                                                                             |                                                                                  |   |   |   | <b>9</b> |
| Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response.                                                                                                                          |                                                                                  |   |   |   |          |
| <a href="#">Experiential Learning (Activity Based Learning): Case Study on Antenna Control: Cascade Compensation Design</a><br><a href="#">Industrial Application : Voltage stability analysis of Power System</a><br><a href="#">Content beyond Syllabus : Design specifications – Lag-lead compensators using Root Locus plot</a>         |                                                                                  |   |   |   |          |
| <b>UNIT 5 STATE VARIABLE ANALYSIS</b>                                                                                                                                                                                                                                                                                                       |                                                                                  |   |   |   | <b>9</b> |
| Concept of state – State Variable & State Model – State models for linear & continuous time systems– Solution of state & output equation–controllability & observability                                                                                                                                                                    |                                                                                  |   |   |   |          |



**Meenakshi Sundararajan Engineering College**  
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Experiential Learning (Activity Based Learning): Case Study on State space Approach of Pharmaceutical Drug Absorption  
 Industrial Application : State-space models to simulate the transient behavior of power systems.  
 Content Beyond Syllabus : Model Predictive Control

**TOTAL      45 Periods**

**Course Outcomes**

After completion the above subject, students will be able to

|            |                                                           |
|------------|-----------------------------------------------------------|
| <b>CO1</b> | Design the basic mathematical model of physical System    |
| <b>CO2</b> | Analyze the time response analysis and techniques         |
| <b>CO3</b> | Analyze the transfer function from different plots.       |
| <b>CO4</b> | Apply the stability concept in various criterion.         |
| <b>CO5</b> | Assess the state models for linear and continuous Systems |

**TEXT BOOKS**

|   |                                                                                                           |
|---|-----------------------------------------------------------------------------------------------------------|
| 1 | Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.      |
| 2 | Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition 2015.                                 |
| 3 | J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018. |

**REFERENCES**

|   |                                                                                                                                      |
|---|--------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.                                               |
| 2 | Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.                                                      |
| 3 | John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5th Edition, CRC PRESS, 2003 |
| 4 | S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.                                                  |
| 5 | Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.                                           |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO      | PO1        | PO2        | PO3        | PO4        | PO5        | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1       | PSO2       | PSO3       |
|------------|------------|------------|------------|------------|------------|-----|-----|-----|-----|------|------|------------|------------|------------|
| <b>CO1</b> | 3          | 2          | 2          | 1          | 2          | –   | –   | –   | –   | –    | –    | 2          | 2          | 1          |
| <b>CO2</b> | 3          | 3          | 2          | 2          | 2          | –   | –   | –   | –   | –    | –    | 2          | 2          | 2          |
| <b>CO3</b> | 3          | 3          | 2          | 2          | 2          | –   | –   | –   | –   | –    | –    | 2          | 3          | 2          |
| <b>CO4</b> | 3          | 3          | 3          | 2          | 2          | –   | –   | –   | –   | –    | –    | 3          | 3          | 2          |
| <b>CO5</b> | 3          | 2          | 3          | 3          | 2          | –   | –   | –   | –   | –    | –    | 3          | 3          | 3          |
| <b>AVG</b> | <b>3.0</b> | <b>2.6</b> | <b>2.4</b> | <b>2.0</b> | <b>2.0</b> | –   | –   | –   | –   | –    | –    | <b>2.4</b> | <b>2.6</b> | <b>2.0</b> |

**Product Based Outcomes**

|   |                                                                                                                           |
|---|---------------------------------------------------------------------------------------------------------------------------|
| 1 | Develop mathematical and dynamic models of real-time physical systems using transfer function and state-space approaches. |
|---|---------------------------------------------------------------------------------------------------------------------------|





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|                                          |                                                                                                                           |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| 2                                        | Analyze and design controllers to improve transient and steady-state performance of engineering systems.                  |
| 3                                        | Evaluate system stability using time-domain and frequency-domain techniques for practical applications                    |
| 4                                        | Implement frequency-response-based control solutions for vibration, motion, and process control systems.                  |
| 5                                        | Apply state-space modeling concepts to multidisciplinary applications such as biomedical, robotic, and power systems      |
| <b>Product Based Projects ( in Team)</b> |                                                                                                                           |
| 1                                        | Vehicle Cruise Control                                                                                                    |
| 2                                        | Water Tank Level Control System                                                                                           |
| 3                                        | Antenna Position Control Model                                                                                            |
| 4                                        | Fan Speed Controller                                                                                                      |
| 5                                        | Light Intensity Control System                                                                                            |
| 6                                        | Prosthetic Joint Motion Control Model                                                                                     |
| 7                                        | Vibration and stability analysis of a Submersible vehicle using Frequency response                                        |
| 8                                        | Stabilization of Antenna Servo System using Phase Lead Compensators.                                                      |
| 9                                        | State-space modeling of Drug Absorption and distribution in the Human Body                                                |
| 10                                       | AI adjusts control signals in a robotic arm using an electrical analogy of mechanical movement, ensuring smoother motion. |



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           |   |   |   |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---|---|---|-----------|
| U24EE012                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | INTRODUCTION TO PLC PROGRAMMING                                                           | L | T | P | C         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                           | 3 | 0 | 0 | 3         |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                           |   |   |   |           |
| At the end of the course, the student is expected                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                           |   |   |   |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To understand basic PLC terminologies digital principles, PLC architecture and operation. |   |   |   |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To familiarize different programming language of PLC.                                     |   |   |   |           |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To develop PLC logic for simple applications using ladder logic.                          |   |   |   |           |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To understand the hardware and software behind PLC and SCADA.                             |   |   |   |           |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | To exposures about communication architecture of PLC/SCADA.                               |   |   |   |           |
| <b>UNIT 1 INTRODUCTION TO PLC</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                           |   |   |   | <b>12</b> |
| <p>Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types.</p> <p>Experiential Learning (Activity Based Learning): Identify PLC hardware modules and prepare block diagram for a small automation system</p> <p>Industrial Application : PLC-based control in manufacturing assembly lines</p> <p>Content Beyond Syllabus : Soft PLCs and open-source PLC platforms (OpenPLC)</p>                                                                                  |                                                                                           |   |   |   |           |
| <b>UNIT 2 PLC INSTRUCTIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                           |   |   |   | <b>12</b> |
| <p>PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples.</p> <p>Experiential Learning (Activity Based Learning): Develop ladder logic for Start–Stop motor control with interlock</p> <p>Industrial Application : Motor starters and safety interlocks in industrial drives</p> <p>Content Beyond Syllabus : Introduction to IEC 61131-3 programming standards</p>    |                                                                                           |   |   |   |           |
| <b>UNIT 3 PLC PROGRAMMING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                           |   |   |   | <b>12</b> |
| <p>Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions,sequencer instructions</p> <p>Experiential Learning (Activity Based Learning): Design ladder logic for timer/counter based conveyor sequencing</p> <p>Industrial Application : Batch processing systems in process industries</p> <p>Content Beyond Syllabus : Structured Text (ST) programming basics</p> |                                                                                           |   |   |   |           |
| <b>UNIT 4 COMMUNICATION OF PLC AND SCADA</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                           |   |   |   | <b>15</b> |
| <p>Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardwareand software, Remote terminal units, Master Station and Communication architectures</p>                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                           |   |   |   |           |



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Experiential Learning (Activity Based Learning): Simulate PLC–SCADA data exchange using Modbus protocol

Industrial Application : SCADA monitoring in power plants and substations

Content Beyond Syllabus : IIoT-based PLC integration using MQTT

**UNIT 5 CASE STUDIES**

**9**

Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems

Experiential Learning (Activity Based Learning): Implement PLC logic for elevator or conveyor control

Industrial Application : Automation in warehouses and CNC machines

Content Beyond Syllabus : Digital twin of PLC-controlled systems

**TOTAL 45 Periods**

**SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)**

**5**

Market survey of the recent PLCs and comparison of their features

Summarize the PLC standards

Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)

Market survey of Communication Network Used for PLC/SCADA

**Course Outcomes**

After completion the above subject, students will be able to

**CO1** Enumerate the basic requirement of a PLC input/output devices and architecture.

**CO2** Apply Basics Instruction Sets used for ladder Logic and Function Block Programming.

**CO3** Design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.

**CO4** Develop a PLC logic for a specific application on real world problem.

**CO5** Classify the communication concepts and protocols used in PLC and SCADA systems.

**TEXT BOOKS**

1 Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition

2 John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

**REFERENCES**

1 MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd

2 J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers PrinciplesandApplications, Pearson publication

**List of Open Source Software/ Learning website:**

1 <https://nptel.ac.in/courses/108105063>



|                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                           |            |             |            |            |            |            |            |            |             |             |             |             |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| 2                                                                                                                                                                                                                    | <a href="https://www.electrical4u.com/industrial-automation/">https://www.electrical4u.com/industrial-automation/</a>                                                                                                                                     |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                    | <a href="https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf">https://www.etf.ues.rs.ba/~slubura/Procesni%20racunari/Programmable%20Logic%20Controllers%20Programming%20Methods.pdf</a> |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 4                                                                                                                                                                                                                    | <a href="https://www.electrical4u.com/industrial-automation/">https://www.electrical4u.com/industrial-automation/</a>                                                                                                                                     |            |             |            |            |            |            |            |            |             |             |             |             |             |
| <p align="center"><b>CO/PO, PSO Mapping</b><br/>           (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br/>           Programme Outcomes (POs) and Programme Specific Outcomes PSOs'</p> |                                                                                                                                                                                                                                                           |            |             |            |            |            |            |            |            |             |             |             |             |             |
| <b>CO/PO</b>                                                                                                                                                                                                         | <b>PO1</b>                                                                                                                                                                                                                                                | <b>PO2</b> | <b>PO3</b>  | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
| <b>CO1</b>                                                                                                                                                                                                           | 3                                                                                                                                                                                                                                                         | 2          | –           | –          | 2          | –          | –          | –          | –          | –           | –           | 2           | 1           | –           |
| <b>CO2</b>                                                                                                                                                                                                           | 3                                                                                                                                                                                                                                                         | 3          | 2           | –          | 2          | –          | –          | –          | –          | –           | –           | 2           | 2           | –           |
| <b>CO3</b>                                                                                                                                                                                                           | 3                                                                                                                                                                                                                                                         | 3          | 3           | 2          | 2          | –          | –          | –          | –          | –           | –           | 3           | 2           | 1           |
| <b>CO4</b>                                                                                                                                                                                                           | 3                                                                                                                                                                                                                                                         | 3          | 3           | 3          | 2          | –          | –          | –          | –          | 1           | –           | 3           | 3           | 2           |
| <b>CO5</b>                                                                                                                                                                                                           | 2                                                                                                                                                                                                                                                         | 2          | –           | –          | 2          | –          | –          | –          | –          | –           | –           | 2           | 1           | –           |
| <b>AVG</b>                                                                                                                                                                                                           | <b>2.8</b>                                                                                                                                                                                                                                                | <b>2.6</b> | <b>2.67</b> | <b>2.5</b> | <b>2.0</b> | –          | –          | –          | –          | <b>1</b>    | –           | <b>2.4</b>  | <b>1.8</b>  | <b>1.5</b>  |
| <b>Product Based Outcomes</b>                                                                                                                                                                                        |                                                                                                                                                                                                                                                           |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 1                                                                                                                                                                                                                    | Design PLC ladder logic for basic industrial automation tasks.                                                                                                                                                                                            |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 2                                                                                                                                                                                                                    | Implement real-time control logic using timers, counters, and interlocks.                                                                                                                                                                                 |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                    | Integrate PLC with SCADA/communication protocols for monitoring.                                                                                                                                                                                          |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 4                                                                                                                                                                                                                    | Analyze industrial automation problems and propose PLC-based solutions.                                                                                                                                                                                   |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 5                                                                                                                                                                                                                    | Demonstrate readiness for entry-level automation and PLC engineering roles.                                                                                                                                                                               |            |             |            |            |            |            |            |            |             |             |             |             |             |
| <b>Product Based Projects ( in Team)</b>                                                                                                                                                                             |                                                                                                                                                                                                                                                           |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 1                                                                                                                                                                                                                    | PLC-Based Start–Stop Motor Control Panel                                                                                                                                                                                                                  |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 2                                                                                                                                                                                                                    | Traffic Signal Control System using PLC                                                                                                                                                                                                                   |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 3                                                                                                                                                                                                                    | Conveyor Belt Automation with Object Counting                                                                                                                                                                                                             |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 4                                                                                                                                                                                                                    | PLC-Based Elevator Control System                                                                                                                                                                                                                         |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 5                                                                                                                                                                                                                    | Automatic Water Tank Level Controller                                                                                                                                                                                                                     |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 6                                                                                                                                                                                                                    | Bottle Filling and Packaging Control System                                                                                                                                                                                                               |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 7                                                                                                                                                                                                                    | PLC–SCADA Based Industrial Monitoring System                                                                                                                                                                                                              |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 8                                                                                                                                                                                                                    | CNC Machine Tool Sequence Control                                                                                                                                                                                                                         |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 9                                                                                                                                                                                                                    | Automated Car Parking System using PLC                                                                                                                                                                                                                    |            |             |            |            |            |            |            |            |             |             |             |             |             |
| 10                                                                                                                                                                                                                   | Factory Safety Interlock System                                                                                                                                                                                                                           |            |             |            |            |            |            |            |            |             |             |             |             |             |



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|          |                    |   |   |   |   |
|----------|--------------------|---|---|---|---|
| U24EE013 | Drone Technologies | L | T | P | C |
|          |                    | 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES**

|   |                                                                                          |
|---|------------------------------------------------------------------------------------------|
| 1 | To understand the basics of drone concepts                                               |
| 2 | To learn and understand the fundamentals of design, fabrication and programming of drone |
| 3 | To impart the knowledge of flying and operation of drone.                                |
| 4 | To know about the various applications of drone                                          |
| 5 | To understand the safety risks and guidelines of fly safely                              |

|                                               |            |
|-----------------------------------------------|------------|
| <b>UNIT1 INTRODUCTION TO DRONE TECHNOLOGY</b> | <b>9+3</b> |
|-----------------------------------------------|------------|

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

**Lab Component:**

Experiential Learning (Activity Based Learning): Hands-on exploration of drone types and their propulsion systems; analyze the history and evolution of drones, Study and identify different types of drones; create a vocabulary chart of drone terminology

Industrial Application: Understanding drone impact on businesses; entrepreneurship opportunities in drone startups

Content Beyond Syllabus : Advanced drone applications in logistics, surveillance, and environmental monitoring

|                                                         |            |
|---------------------------------------------------------|------------|
| <b>UNIT2 DRONE DESIGN, FABRICATION AND PROGRAMMING9</b> | <b>9+3</b> |
|---------------------------------------------------------|------------|

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Dronesconfigurations -The methods of programming drone- Download program - Install program on computer-Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection

**Lab Component:**

Experiential Learning (Activity Based Learning): Learn the technical characteristics of drone components; practice programming and stabilizing a multi-rotor drone, Assemble a basic multi-rotor drone and test Wi-Fi connectivity

Industrial Application: Drone manufacturing and design in industry; understanding energy sources and autonomy levels

Content Beyond Syllabus : Explore AI-assisted drone programming; advanced autopilot and swarm Algorithms

|                                          |            |
|------------------------------------------|------------|
| <b>UNIT3 DRONE FLYING AND OPERATION9</b> | <b>9+3</b> |
|------------------------------------------|------------|





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Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

**Lab Component:**

Experiential Learning (Activity Based Learning): Simulate flight operations, sensor integration, and mobile application linkage, Operate a small drone in a controlled environment, testing different flight modes

Industrial Application: Drone operations in surveillance, mapping, and data collection

Content Beyond Syllabus : Study autonomous drone navigation and obstacle avoidance systems

**UNIT4 DRONE COMMERCIAL APPLICATION**

**9+3**

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

**Lab Component:**

Experiential Learning (Activity Based Learning): Hands-on evaluation of drones for industry-specific applications, Case study analysis: Select a drone for a specific commercial task (e.g., agriculture or delivery)

Industrial Application: Drones in insurance, agriculture, cargo delivery, infrastructure inspection, and media

Content Beyond Syllabus : Explore emerging commercial drone sectors and regulatory challenges

**UNIT5 FUTURE DRONES AND SAFETY**

**9+3**

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license-Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

**Lab Component:**

Experiential Learning (Activity Based Learning): Learn risk mitigation strategies and safe drone operation, Conduct a safety assessment and flight planning exercise following aviation regulations

Industrial Application: Industrial safety compliance; licensing and regulatory considerations

Content Beyond Syllabus : Study miniaturization, drone swarms, and AI-driven autonomous drones

**TOTAL: 60**

**At the end of the course, the student will be able to**

**CO1** Analyse the applications of drones

**CO2** Design a drone for an application

**CO3** Operate a drone environment

**CO4** Develop a drone mechanism for specific applications

**CO5** Create the programs for various drones



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**TEXT BOOKS**

|   |                                                                                                                                                                                                                         |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | TEXT BOOKS: 1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc. |
| 2 | Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones ", Maker Media, Inc, 2016                                                                                                                             |
| 3 | John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016. Zavrnsnik                                                                                                |

**REFERENCES**

|   |                                                                                                                    |
|---|--------------------------------------------------------------------------------------------------------------------|
| 1 | "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018. |
|---|--------------------------------------------------------------------------------------------------------------------|

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Programme

Outcomes (POs) and Programme Specific Outcomes PSOs'

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |
| CO2 | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |
| CO3 | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |
| CO4 | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |
| CO5 | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |
| AVG | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2   | 2    | 2    | 1    | 1    | 1    |

**Product based Projects ( in Team)**

|   |                                                            |
|---|------------------------------------------------------------|
| 1 | Survey & Mapping Drone for Precision Agriculture           |
| 2 | Custom Payload Delivery Drone Design                       |
| 3 | Indoor Navigation and Control for Warehouse Drone System   |
| 4 | Mechanical Actuation System for Drone-Based Parcel Pickup  |
| 5 | Autonomous Obstacle Avoidance Program for Quadrotor Drones |



This syllabus has been verified and  
approved by Auraa Aerospace Private Limited

S. Jais

29/04/2026.



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| U24EE021                                                                                                                                                                                                                                                                                                                | ENERGY CONSERVATION AND MANAGEMENT                                    | L | T | P | C        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|---|---|---|----------|
|                                                                                                                                                                                                                                                                                                                         |                                                                       | 3 | 0 | 0 | 3        |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                |                                                                       |   |   |   |          |
| At the end of the course, the student is expected to                                                                                                                                                                                                                                                                    |                                                                       |   |   |   |          |
| 1                                                                                                                                                                                                                                                                                                                       | Understand and analyse the energy data of industries                  |   |   |   |          |
| 2                                                                                                                                                                                                                                                                                                                       | Carryout energy accounting and balancing                              |   |   |   |          |
| 3                                                                                                                                                                                                                                                                                                                       | Conduct energy audit and suggest methodologies for energy savings and |   |   |   |          |
| 4                                                                                                                                                                                                                                                                                                                       | Utilise the available resources in optimal ways                       |   |   |   |          |
| <b>UNIT I INTRODUCTION</b>                                                                                                                                                                                                                                                                                              |                                                                       |   |   |   | <b>9</b> |
| Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.                                                      |                                                                       |   |   |   |          |
| Experiential Learning (Activity Based Learning): Conduct a <b>mini energy survey</b> of the college block (lighting, fans, ACs).<br>Industrial Application: Energy auditing practices in <b>manufacturing industries, IT parks, hospitals.</b><br>Content Beyond Syllabus: ISO 50001: <b>Energy Management Systems.</b> |                                                                       |   |   |   |          |
| <b>UNIT II ELECTRICAL SYSTEMS</b>                                                                                                                                                                                                                                                                                       |                                                                       |   |   |   | <b>9</b> |
| Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination. |                                                                       |   |   |   |          |
| Experiential Learning (Activity Based Learning): Measurement of <b>power factor, harmonics, and energy consumption</b> using power analyzer.<br>Industrial Application: Harmonic mitigation in <b>VFD-driven loads.</b><br>Content Beyond Syllabus :Energy monitoring through <b>SCADA and EMS.</b>                     |                                                                       |   |   |   |          |
| <b>UNIT III THERMAL SYSTEMS</b>                                                                                                                                                                                                                                                                                         |                                                                       |   |   |   | <b>9</b> |
| Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories                                                                                               |                                                                       |   |   |   |          |
| Experiential Learning (Activity Based Learning): Insulation effectiveness comparison using heat loss calculations.<br>Industrial Application: Condensate recovery systems in <b>paper and sugar industries.</b><br>Content Beyond Syllabus: Waste heat recovery systems (Economizers, Air Pre-heaters).                 |                                                                       |   |   |   |          |
| <b>Unit IV ENERGY CONSERVATION IN MAJOR UTILITIES</b>                                                                                                                                                                                                                                                                   |                                                                       |   |   |   | <b>9</b> |
| Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets                                                                                                                                                                                                    |                                                                       |   |   |   |          |
| Experiential Learning (Activity Based Learning): Performance evaluation of <b>pumps and fans</b> using affinity laws.<br>Industrial Application: HVAC energy management in <b>malls and airports.</b><br>Content Beyond Syllabus: Hydrogen and biodiesel fueled DG sets.                                                |                                                                       |   |   |   |          |
| <b>UNIT V ECONOMICS</b>                                                                                                                                                                                                                                                                                                 |                                                                       |   |   |   | <b>9</b> |
| Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept.                                                                                                                                                                                         |                                                                       |   |   |   |          |
| Experiential Learning (Activity Based Learning): Cost–benefit analysis of LED replacement project.                                                                                                                                                                                                                      |                                                                       |   |   |   |          |





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Industrial Application: Financial evaluation of energy efficiency projects.

Content Beyond Syllabus: Carbon trading & energy credits.

|              |                   |
|--------------|-------------------|
| <b>TOTAL</b> | <b>45 Periods</b> |
|--------------|-------------------|

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Analyse global and national energy scenarios, environmental impacts, and the necessity of energy conservation and energy auditing.                            |
| <b>CO2</b> | Compute and Evaluate energy consumption, billing components, power factor, motor efficiency, and illumination performance in electrical systems.              |
| <b>CO3</b> | Apply stoichiometric and thermodynamic principles to calculate and assess the efficiency of boilers, furnaces, thermic fluid heaters, and steam systems.      |
| <b>CO4</b> | Analyse energy conservation measures for major utilities including pumps, fans, compressed air systems, refrigeration, air-conditioning systems, and DG sets. |
| <b>CO5</b> | Evaluate energy conservation projects using economic analysis tools such as payback period, NPV, IRR, and life cycle costing.                                 |

**TEXT BOOKS**

|   |                                                                                                                                                                                                                                                                              |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Energy Manager Training Manual (4 Volumes) available at <a href="http://www.energymanagertraining.com">www.energymanagertraining.com</a> . a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004. |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**REFERENCES**

|   |                                                                                                                          |
|---|--------------------------------------------------------------------------------------------------------------------------|
| 1 | Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988. |
| 2 | Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.                            |
| 3 | Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982                                                 |
| 4 | Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.                                                      |
| 5 | Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987                                               |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
**Programme Outcomes (POs) and Programme Specific Outcomes PSOs'**

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 3   | 2   | –   | –   | –   | 2   | 3   | –   | –   | 1    | –    | 3    | –    | –    |
| <b>CO2</b> | 3   | 3   | 2   | –   | 1   | –   | 2   | –   | –   | –    | –    | 3    | 2    | 2    |
| <b>CO3</b> | 3   | 3   | 2   | –   | –   | –   | 2   | –   | –   | –    | –    | 3    | 2    | 2    |
| <b>CO4</b> | 3   | 3   | 3   | –   | 1   | –   | 3   | –   | –   | –    | –    | 3    | 3    | 3    |
| <b>CO5</b> | 3   | 2   | 2   | –   | –   | –   | 2   | –   | –   | –    | 3    | 3    | 2    | 2    |
| <b>AVG</b> | 3.0 | 2.6 | 2.2 | –   | 1.0 | 2.0 | 2.4 | –   | –   | 1.0  | 3.0  | 3    | 2.2  | 2.2  |

**Product Based Outcomes**

|   |                                                                                                                      |
|---|----------------------------------------------------------------------------------------------------------------------|
| 1 | Analyse real energy consumption data and identify energy saving opportunities in electrical and thermal systems.     |
| 2 | Perform energy audits and recommend technically and economically viable conservation measures.                       |
| 3 | Design energy-efficient solutions for utilities such as lighting, motors, HVAC, boilers, and compressed air systems. |
| 4 | Evaluate energy projects economically using payback period, NPV, IRR, and life-cycle costing.                        |



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|                                          |                                                                                                               |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| 5                                        | Develop implementable energy management solutions aligned with industrial standards and sustainability goals. |
| <b>Product Based Projects ( in Team)</b> |                                                                                                               |
| 1                                        | Smart Energy Audit Report for an Academic/Commercial Building                                                 |
| 2                                        | Energy-Efficient Lighting System Design                                                                       |
| 3                                        | Power Factor Improvement & Harmonic Mitigation Solution                                                       |
| 4                                        | Boiler & Steam System Energy Optimization Model                                                               |
| 5                                        | Energy Loss Reduction in Electrical Distribution System                                                       |
| 6                                        | Carbon Footprint & Energy Reduction Assessment                                                                |
| 7                                        | Pump & Fan Energy Optimization using Affinity Laws                                                            |
| 8                                        | Energy Benchmarking Tool for Industries                                                                       |
| 9                                        | Smart Meter Data Analysis for Energy Savings                                                                  |
| 10                                       | ESCO Business Model for Energy Efficiency Project                                                             |



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| U24EE022                                                                                                                                                                                                                                                                                                                                                                        | ELECTRIC VEHICLE TECHNOLOGY                                                                           | L | T | P | C |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                       | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                               |                                                                                                       |   |   |   |   |
| At the end of the course, the student is expected                                                                                                                                                                                                                                                                                                                               |                                                                                                       |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                               | To provide knowledge about electric machines and special machine                                      |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                               | To understand the basics of power converters                                                          |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                               | To know the concepts of controlling DC and AC drive systems                                           |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                               | To understand the architecture and power train components.                                            |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                               | To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs) |   |   |   |   |
| UNIT 1 ROTATING POWER CONVERTERS                                                                                                                                                                                                                                                                                                                                                |                                                                                                       |   |   | 9 |   |
| Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.                                                                                                         |                                                                                                       |   |   |   |   |
| Experiential Learning (Activity Based Learning): Case study on selection of motor for electric two-wheeler                                                                                                                                                                                                                                                                      |                                                                                                       |   |   |   |   |
| Industrial Application : Traction motors in electric two-wheelers, three-wheelers and electric buses                                                                                                                                                                                                                                                                            |                                                                                                       |   |   |   |   |
| Content Beyond Syllabus : Axial flux motors for electric vehicles                                                                                                                                                                                                                                                                                                               |                                                                                                       |   |   |   |   |
| UNIT 2 STATIC POWER CONVERTERS                                                                                                                                                                                                                                                                                                                                                  |                                                                                                       |   |   | 9 |   |
| Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.                                                                                                                              |                                                                                                       |   |   |   |   |
| Experiential Learning (Activity Based Learning): Simulation study of DC chopper and inverter operation                                                                                                                                                                                                                                                                          |                                                                                                       |   |   |   |   |
| Industrial Application : Inverters and DC–DC converters in EV powertrains and charging systems                                                                                                                                                                                                                                                                                  |                                                                                                       |   |   |   |   |
| Content Beyond Syllabus : Wide bandgap devices (SiC, GaN) in EV power converters                                                                                                                                                                                                                                                                                                |                                                                                                       |   |   |   |   |
| UNIT 3 CONTROL OF DC AND AC MOTOR DRIVES                                                                                                                                                                                                                                                                                                                                        |                                                                                                       |   |   | 9 |   |
| Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives |                                                                                                       |   |   |   |   |
| Experiential Learning (Activity Based Learning): Case study on regenerative braking control                                                                                                                                                                                                                                                                                     |                                                                                                       |   |   |   |   |
| Industrial Application : Vector-controlled motor drives in electric cars and metro rail systems                                                                                                                                                                                                                                                                                 |                                                                                                       |   |   |   |   |
| Content Beyond Syllabus : AI-based motor control and predictive torque control                                                                                                                                                                                                                                                                                                  |                                                                                                       |   |   |   |   |
| UNIT 4 HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS                                                                                                                                                                                                                                                                                                          |                                                                                                       |   |   | 9 |   |
| History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – 246 Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.                                                            |                                                                                                       |   |   |   |   |
| Experiential Learning (Activity Based Learning): Powertrain layout analysis of commercial electric                                                                                                                                                                                                                                                                              |                                                                                                       |   |   |   |   |



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|                                                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|------|------|------------|------|
| vehicles<br>Industrial Application : EV powertrain design used by Tesla, Tata Motors, Hyundai, BYD<br>Content Beyond Syllabus : Battery thermal management systems in EVs.                                                                                                                                                |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| UNIT 5 MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES                                                                                                                                                                                                                                                      |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      | 9          |      |
| Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| Experiential Learning (Activity Based Learning): Calculation of tractive force and battery capacity for a standard EV drive cycle<br>Industrial Application : Drive cycle-based vehicle control used in hybrid electric vehicles<br>Content Beyond Syllabus : Autonomous vehicle control integration with EV powertrains  |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| TOTAL                                                                                                                                                                                                                                                                                                                     |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      | 45 Periods |      |
| Course Outcomes                                                                                                                                                                                                                                                                                                           |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| After completion the above subject, students will be able to                                                                                                                                                                                                                                                              |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| CO1                                                                                                                                                                                                                                                                                                                       |     | Analyse the principles of conventional and special electrical machines.                                                                                      |     |     |     |     |     |     |     |      |      |      |            |      |
| CO2                                                                                                                                                                                                                                                                                                                       |     | Analyse the concepts of power devices and power converters                                                                                                   |     |     |     |     |     |     |     |      |      |      |            |      |
| CO3                                                                                                                                                                                                                                                                                                                       |     | Implement and Analyse the control strategies for DC and AC drive systems.                                                                                    |     |     |     |     |     |     |     |      |      |      |            |      |
| CO4                                                                                                                                                                                                                                                                                                                       |     | Evaluate the electric vehicle architecture and determine the sizing requirement power train components.                                                      |     |     |     |     |     |     |     |      |      |      |            |      |
| CO5                                                                                                                                                                                                                                                                                                                       |     | Design supervisory control strategies for hybrid electric vehicles                                                                                           |     |     |     |     |     |     |     |      |      |      |            |      |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| 1                                                                                                                                                                                                                                                                                                                         |     | Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021                                                                                       |     |     |     |     |     |     |     |      |      |      |            |      |
| 2                                                                                                                                                                                                                                                                                                                         |     | Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017                                                                  |     |     |     |     |     |     |     |      |      |      |            |      |
| 3                                                                                                                                                                                                                                                                                                                         |     | James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition, Wiley, 2012                                                          |     |     |     |     |     |     |     |      |      |      |            |      |
| REFERENCES                                                                                                                                                                                                                                                                                                                |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| 1                                                                                                                                                                                                                                                                                                                         |     | Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.                                                         |     |     |     |     |     |     |     |      |      |      |            |      |
| 2                                                                                                                                                                                                                                                                                                                         |     | Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011               |     |     |     |     |     |     |     |      |      |      |            |      |
| 3                                                                                                                                                                                                                                                                                                                         |     | Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013. |     |     |     |     |     |     |     |      |      |      |            |      |
| 4                                                                                                                                                                                                                                                                                                                         |     | Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.                                         |     |     |     |     |     |     |     |      |      |      |            |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'                                                                                                                                                           |     |                                                                                                                                                              |     |     |     |     |     |     |     |      |      |      |            |      |
| CO/PO                                                                                                                                                                                                                                                                                                                     | PO1 | PO2                                                                                                                                                          | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2       | PSO3 |
| CO1                                                                                                                                                                                                                                                                                                                       | 3   | 2                                                                                                                                                            | –   | –   | –   | –   | 2   | –   | –   | –    | –    | 3    | 2          | –    |



## Product Based Outcomes

### Product Based Projects ( in Team)

|    |                                                                |
|----|----------------------------------------------------------------|
| 1  | Design of BLDC Motor Drive for Electric Two-Wheeler            |
| 2  | Simulation of EV Inverter with Regenerative Braking            |
| 3  | Powertrain Modeling of a Battery Electric Vehicle              |
| 4  | Drive Cycle Analysis and Battery Sizing for Electric Car       |
| 5  | Design of DC–DC Converter for EV Auxiliary Systems             |
| 6  | Speed Control of PMSM for Electric Vehicle Application         |
| 7  | Comparative Study of EV, HEV and PHEV Architectures            |
| 8  | Energy Flow and Efficiency Analysis of Hybrid Electric Vehicle |
| 9  | Motor Selection and Rating Calculation for Electric Bus        |
| 10 | Supervisory Control Strategy for Hybrid Electric Vehicle       |



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| U24EE031                                                                                                                                                                                                                                                                                                                                                                                       | ENERGY AUDITING & CONSERVATION                                                                                         | L | T | P | C |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                        | 3 | 0 | 0 | 3 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                        |   |   |   |   |
| At the end of the course, the student is expected                                                                                                                                                                                                                                                                                                                                              |                                                                                                                        |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                              | To understand the principles and methodologies of energy auditing and conservation in industrial and building systems. |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                              | To analyze energy consumption patterns and identify energy saving opportunities.                                       |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                              | To study energy efficiency practices in buildings, motors, lighting, and utilities.                                    |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                              | To apply energy audit instruments and evaluate energy-efficient technologies.                                          |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                              | To assess economic feasibility of energy conservation projects using standard financial tools.                         |   |   |   |   |
| UNIT 1 ENERGY AUDIT PRINCIPLES                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                        |   |   | 9 |   |
| Energy audit - Definitions, Concept, Types of audit, Energy index, Cost index, Pie charts, Sankey diagrams; Load profiles, Energy audit of industries, Energy saving potential, Energy audit of process industry, Building energy audit, IE rules and regulations for energy audit.                                                                                                            |                                                                                                                        |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Case study on industrial energy audit using Sankey diagram</a>                                                                                                                                                                                                                                                                    |                                                                                                                        |   |   |   |   |
| <a href="#">Industrial Application : Energy audits in manufacturing and process industries</a>                                                                                                                                                                                                                                                                                                 |                                                                                                                        |   |   |   |   |
| <a href="#">Content Beyond Syllabus : ISO 50001 – Energy Management Systems</a>                                                                                                                                                                                                                                                                                                                |                                                                                                                        |   |   |   |   |
| UNIT 2 ENERGY CONSERVATION PRINCIPLES                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                        |   |   | 9 |   |
| Rules for efficient energy conservation, Technologies for energy conservation, Energy scenario, Principles of energy conservation, Resource availability, Energy savings, Current energy consumption in India, Roles and responsibilities of energy managers in industries.                                                                                                                    |                                                                                                                        |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Analysis of energy consumption data of an industrial unit</a>                                                                                                                                                                                                                                                                     |                                                                                                                        |   |   |   |   |
| <a href="#">Industrial Application : Role of certified energy managers in industries</a>                                                                                                                                                                                                                                                                                                       |                                                                                                                        |   |   |   |   |
| <a href="#">Content Beyond Syllabus : National energy conservation policies and star labeling</a>                                                                                                                                                                                                                                                                                              |                                                                                                                        |   |   |   |   |
| UNIT 3 ENERGY EFFICIENCY IN BUILDINGS                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                        |   |   | 9 |   |
| Introduction, Definition and concepts, Energy and water as a resource - Heating, Ventilating and Air conditioning systems; Energy economic analysis, Domestic energy consumption, Savings, Energy use in buildings, Residential and commercial buildings, Green buildings, Smart buildings, Rating of buildings, Efficient use of buildings, Solar passive architecture, Eco-housing concepts. |                                                                                                                        |   |   |   |   |
| Lab Component :                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                        |   |   |   |   |
| <a href="#">Experiential Learning (Activity Based Learning): Comparative study of conventional vs green buildings</a>                                                                                                                                                                                                                                                                          |                                                                                                                        |   |   |   |   |
| <a href="#">Industrial Application : Energy-efficient building design in IT parks and malls</a>                                                                                                                                                                                                                                                                                                |                                                                                                                        |   |   |   |   |
| <a href="#">Content Beyond Syllabus : Net-zero energy buildings</a>                                                                                                                                                                                                                                                                                                                            |                                                                                                                        |   |   |   |   |
| UNIT 4 ENERGY AUDIT INSTRUMENTS AND ENERGY EFFICIENT MOTORS                                                                                                                                                                                                                                                                                                                                    |                                                                                                                        |   |   | 9 |   |
| Energy Audit Instruments: Watt meter, Data loggers, Thermocouples, Pyrometers, Lux meters, Tongue testers, PLCs and applications. Energy Efficient Motors: Factors affecting efficiency, Loss distribution, Constructional details, Characteristics, Variable speed, Variable duty cycle systems, Applications of life cycle costing analysis, Return on investment.                           |                                                                                                                        |   |   |   |   |



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|                                                                                                                                                                                                                                                                     |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------------|------|
| Experiential Learning (Activity Based Learning): Demonstration of lux meter, power analyzer, and thermal sensors<br>Industrial Application : Energy-efficient motor selection in industries<br>Content Beyond Syllabus : AI-based predictive maintenance for motors |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| UNIT 5 ECONOMIC ASPECTS AND ANALYSIS                                                                                                                                                                                                                                |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      | 9          |      |
| Economic concepts, Computation of economic aspects calculation of simple payback method, Net present worth method, Depreciation Methods, Time value of money, Rate of return, Present worth method, Replacement analysis, Life cycle costing analysis.              |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| Experiential Learning (Activity Based Learning): Cost–benefit analysis of LED replacement project<br>Industrial Application : Financial appraisal of industrial energy efficiency projects<br>Content Beyond Syllabus : Carbon credits and energy trading           |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| TOTAL                                                                                                                                                                                                                                                               |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      | 45 Periods |      |
| Course Outcomes                                                                                                                                                                                                                                                     |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| After completion the above subject, students will be able to                                                                                                                                                                                                        |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO1                                                                                                                                                                                                                                                                 | Analyse energy audit concepts, types, indices, and regulatory requirements.                                                                                     |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO2                                                                                                                                                                                                                                                                 | Analyse energy conservation principles to identify energy saving opportunities.                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO3                                                                                                                                                                                                                                                                 | Evaluate energy efficiency measures in residential and commercial buildings.                                                                                    |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO4                                                                                                                                                                                                                                                                 | Measure, analyse, and assess energy performance using audit instruments and energy-efficient motors.                                                            |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO5                                                                                                                                                                                                                                                                 | Compute energy conservation projects using economic analysis tools such as payback period, NPV, IRR, and life cycle costing.                                    |     |     |     |     |     |     |     |     |      |      |      |            |      |
| TEXT BOOKS                                                                                                                                                                                                                                                          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 1                                                                                                                                                                                                                                                                   | Albert Thumann, William J. Younger, Handbook of Energy Audits, Taylor & Francis Ltd, 7th Edition, 2008                                                          |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 2                                                                                                                                                                                                                                                                   | Nilesh Y. Jadhav, Green and Smart Buildings: Advanced Technology Options, Springer Science Business Media, Singapore, 2016                                      |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 3                                                                                                                                                                                                                                                                   | Energy Efficiency In Buildings, CIBSE Guide F, 3rd Edition, May, 2012.                                                                                          |     |     |     |     |     |     |     |     |      |      |      |            |      |
| REFERENCES                                                                                                                                                                                                                                                          |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 1                                                                                                                                                                                                                                                                   | Ashok V. Desai, Wiley Eastern, Energy Demand – Analysis, Management and Conservation Hand Book on Energy Auditing - TERI (Tata Energy Research Institute), 2005 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 2                                                                                                                                                                                                                                                                   | Dale R. Patrick, Stephen W. Fardo, Ray E. Richardson, Steven R. Patrick, Energy Conservation Guide Book, Taylor & Francis Ltd, 2nd Edition,2007.                |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 3                                                                                                                                                                                                                                                                   | Ashok V.Desai, Energy Economics, Wiley Eastern, 1st Edition, 1990                                                                                               |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 4                                                                                                                                                                                                                                                                   | Industrial Energy Conservation Manuals, Cambridge, MIT Press, 1982.                                                                                             |     |     |     |     |     |     |     |     |      |      |      |            |      |
| 5                                                                                                                                                                                                                                                                   | Frank Kreith, Ronald E. West, Handbook of Energy Efficiency, CRC Press, 1st Edition, 1996.                                                                      |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs'                                                                                                     |                                                                                                                                                                 |     |     |     |     |     |     |     |     |      |      |      |            |      |
| CO/PO                                                                                                                                                                                                                                                               | PO1                                                                                                                                                             | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2       | PSO3 |
| CO1                                                                                                                                                                                                                                                                 | 3                                                                                                                                                               | 2   | –   | –   | –   | 2   | 3   | –   | –   | 1    | –    | 3    | –          | –    |





| Product Based Outcomes            |                                                                                          |
|-----------------------------------|------------------------------------------------------------------------------------------|
| 1                                 | Ability to perform a complete energy audit for a small industry or building.             |
| 2                                 | Capability to evaluate energy efficiency of motors, lighting, and utilities.             |
| 3                                 | Skill to use energy audit instruments and interpret measurement data.                    |
| 4                                 | Competence in proposing technically and economically viable energy saving solutions.     |
| 5                                 | Readiness for roles such as Energy Auditor, Energy Manager, and Sustainability Engineer. |
| Product Based Projects ( in Team) |                                                                                          |
| 1                                 | Energy audit of an academic building with energy saving recommendations                  |
| 2                                 | Energy efficiency analysis of lighting systems (LED vs conventional)                     |
| 3                                 | Motor efficiency improvement and life cycle cost analysis                                |
| 4                                 | HVAC energy consumption study and optimization proposal                                  |
| 5                                 | Solar passive design analysis for residential buildings                                  |
| 6                                 | Power factor improvement project for an industrial load                                  |
| 7                                 | Compressed air system leakage audit                                                      |
| 8                                 | Boiler efficiency and waste heat recovery analysis                                       |
| 9                                 | Economic feasibility study of energy conservation measures                               |
| 10                                | Smart energy monitoring system for buildings                                             |





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| U24ED011                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                            | IGNITE - ENTREPRENEURSHIP AND NEW VENTURE CREATION |  | L | T | P | C |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|--|---|---|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                            |                                                    |  | 1 |   | 2 | 2 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Develop entrepreneurial mind-set and attributes; entrepreneurial skill sets for venture creation and entrepreneurial leadership                                                                                                                            |                                                    |  |   |   |   |   |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Apply process of problem-opportunity identification and feasibility assessment through developing a macro perspective of the real market, industries, domains and customers while using design thinking principles to refine and pivot their venture idea. |                                                    |  |   |   |   |   |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Analyse Customer and Market segmentation, estimate Market size, develop and validate Customer Persona..                                                                                                                                                    |                                                    |  |   |   |   |   |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Initiate Solution design, Prototype for Proof of Concept. Understand MVP development and validation techniques to determine Product-Market fit.                                                                                                            |                                                    |  |   |   |   |   |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Craft initial Business and Revenue models, financial planning and pricing strategy for profitability and financial feasibility of a venture. Understand relevance and viability of informal and formal funding with respect to different business models.. |                                                    |  |   |   |   |   |
| 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Understand and develop Go-to-Market strategies with a focus on digital marketing channels.                                                                                                                                                                 |                                                    |  |   |   |   |   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Understand and apply story telling skills in presenting a persuasive and defensible Venture Pitch.                                                                                                                                                         |                                                    |  |   |   |   |   |
| UNIT I ENTREPRENEURSHIP FUNDAMENTALS & CONTEXT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Meaning and concept, attributes and mindset of entrepreneurial and entrepreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus.                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Core Teaching Tool: Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| UNIT II PROBLEM & CUSTOMER IDENTIFICATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Understanding and analysing the macro-Problem and Industry perspective, technological, socio economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problems using Design thinking principles. Analysing problems and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity.              |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Core Teaching Tool: Several types of activities including Class, game, Gen AI, ‘Get out of the building’ and Venture Activity.                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| UNIT III SOLUTION DESIGN, PROTOTYPING & OPPORTUNITY ASSESSMENT AND SIZING                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer’s needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype. Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity. |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Core Teaching Tool: Venture Activity, no-code Innovation tools, Class activity                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| UNIT IV BUSINESS & FINANCIAL MODEL, GO-TO-MARKET PLAN                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |
| Business planning: components of Business plan- Sales plan, People plan and financial plan.<br>Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance.<br>Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy.                                                                                                             |                                                                                                                                                                                                                                                            |                                                    |  |   |   |   |   |



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Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.

**Core Teaching Tool:** Founder Case Studies – Sama and Securely Share; Class activity and discussions; Venture Activities.

**UNIT V SCALE OUTLOOK AND VENTURE PITCH READINESS**

Understand and identify potential and aspiration for scale vis a vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.

**Core Teaching Tool:** Expert talks; Cases; Class activity and discussions; Venture Activities.

**TOTAL PERIODS** 40

**Course Outcomes**

**At the end of the course, students will be able to**

|   |                                                                                                                                                                                                                                                       |
|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Develop an entrepreneurial mindset and appreciate the concepts of entrepreneurship, cultivate essential attributes to become an entrepreneur or Entrepreneur and demonstrate skills such as problem solving, team building, creativity and leadership |
| 2 | Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution                                                                |
| 3 | Analyse and refine business models to ensure sustainability and profitability                                                                                                                                                                         |
| 4 | Build Prototype for Proof of Concept and validate MVP of their practice venture idea                                                                                                                                                                  |
| 5 | Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture                                                                                                                              |
| 6 | Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders                                                                                                                                                        |

**TEXTBOOKS**

|   |                                                                                                                              |
|---|------------------------------------------------------------------------------------------------------------------------------|
| 1 | Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGraw Hill, 11th Edition |
|---|------------------------------------------------------------------------------------------------------------------------------|

**REFERENCE BOOKS**

|   |                                                                                                                                                  |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business |
| 2 | Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons  |
| 3 | Simon Sinek (2011) Start with Why, Penguin Books limited                                                                                         |
| 4 | Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business       |
| 5 | Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited                                               |
| 6 | Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd                                            |

**Web Resources**

|   |                                                                                                                                                                            |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Learning resource- Ignite 5.0 Course Wadhwani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content) |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



# Meenakshi Sundararajan Engineering College

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Department:

, R2024, CBCS

## CO/PO, PSO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO2 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO3 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO4 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO5 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO6 | 1   | 1   | 2   | 1   | 1   | 2   | 1   | 3   | 3   | 3    | 3    |      |      |      |
| AVG | 1   | 1.8 | 2.8 | 1.8 | 1.8 | 2   | 1   | 3   | 3   | 2.2  | 2.2  |      |      |      |



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| U24ED111                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                               | DESIGN THINKING - BUILDING INNOVATION<br>SOLUTIONING MINDSET |  | L | T  | P | C   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|--|---|----|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                               |                                                              |  | 0 | 0  | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                               |                                                              |  |   |    |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                             | Expose the students to the fields of innovation and entrepreneurship and strengthen their interest in these fields.                           |                                                              |  |   |    |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                             | To discuss the relevance and importance of innovation and entrepreneurship to the students to improve their everyday life and future careers. |                                                              |  |   |    |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                             | Illustrate the macro perspective of innovation in entrepreneurship .                                                                          |                                                              |  |   |    |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                             | To Design the entrepreneurship process.                                                                                                       |                                                              |  |   |    |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                             | Develop innovation and entrepreneurship processes to improve students to the skill set .                                                      |                                                              |  |   |    |   |     |
| UNIT 1                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   | 1  |   |     |
| What is innovation - Why is innovation important -Types of innovation - The Innovation process                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                               |                                                              |  |   |    |   |     |
| UNIT 2                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   | 2  |   |     |
| Introduction to Problem Solving-The role of problem - solving in innovation and product development -The importance of real-time problem statements- Problem Identification and Definition                                                                                                                                                                                                                                                    |                                                                                                                                               |                                                              |  |   |    |   |     |
| UNIT 3                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   | 2  |   |     |
| What is entrepreneurship (and how is it different from innovation) -Types of entrepreneurship -The Human side of entrepreneurship                                                                                                                                                                                                                                                                                                             |                                                                                                                                               |                                                              |  |   |    |   |     |
| UNIT 4                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   | 2  |   |     |
| Misconceptions about entrepreneurship -The process of developing entrepreneurship - Module building entrepreneurship mindset- Developing a solution thinking mind set to identify tools and techniques                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   |    |   |     |
| UNIT 5                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                               |                                                              |  |   | 8  |   |     |
| <ul style="list-style-type: none"><li>5 Hours: 60 Students * 5 Minutes Each – Team of Three Students (15 Minutes Per Team) – Collaborative Work To Research &amp; Present 20 Case Studies:<ul style="list-style-type: none"><li>Design Thinking (8 Case Studies),</li><li>Innovation (4 Case Studies) &amp;</li><li>Entrepreneurship (8 Case Studies)</li></ul></li><li>3 Hours: Faculty Facilitated 'Design Thinking' Case Studies</li></ul> |                                                                                                                                               |                                                              |  |   |    |   |     |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                               |                                                              |  |   | 15 |   |     |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                               |                                                              |  |   |    |   |     |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                               |                                                              |  |   |    |   |     |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                           | Understand basic concepts in the fields of innovation and entrepreneurship                                                                    |                                                              |  |   |    |   |     |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                           | Understand what a business model is and the process of problem solving.                                                                       |                                                              |  |   |    |   |     |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                           | Summarize the learning in developing an entrepreneurial idea, formed through innovative practices.                                            |                                                              |  |   |    |   |     |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                           | Model the correct problem solving methodologies with tools and techniques.                                                                    |                                                              |  |   |    |   |     |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                           | Design innovative solutions for real time problems.                                                                                           |                                                              |  |   |    |   |     |



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| TEXTBOOKS                                                                                                                                             |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| 1 Lorraine Marchand,"The Innovation Mindset: Eight Essential Steps to Transform Any Industry",Columbia Business School Publishing (13 September 2022) |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCES                                                                                                                                            |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1. Peter F. Drucker," Innovation and Entrepreneurship" .                                                                                              |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2.Martha Corrales-Estrada "Innovation and Entrepreneurship: A New Mindset for Emerging Markets",Emerald Publishing Limited (27 September 2019)        |                                                                                                                                                                        |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                       | <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes PSOs' |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                       | PO1                                                                                                                                                                    | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                   | 1                                                                                                                                                                      | 1   | 2   | -   | 2   | 1   | 1   | 2   | 2   | 1    | 2    |      |      |      |
| CO2                                                                                                                                                   | 1                                                                                                                                                                      | 2   | 2   | -   | 2   | 1   | -   | 2   | 2   | 1    | 2    |      |      |      |
| CO3                                                                                                                                                   | -                                                                                                                                                                      | 1   | 3   | 1   | 2   | 1   | -   | 2   | 2   | 1    | 2    |      |      |      |
| CO4                                                                                                                                                   | -                                                                                                                                                                      | 2   | 3   | 2   | 3   | -   | -   | 2   | 2   | 1    | 2    |      |      |      |
| CO5                                                                                                                                                   | -                                                                                                                                                                      | 2   | 3   | 2   | 3   | 1   | -   | 2   | 3   | 2    | 2    |      |      |      |
| AVG                                                                                                                                                   | 1                                                                                                                                                                      | 1.6 | 2.6 | 1.6 | 2.4 | 1   | 1   | 2   | 2.2 | 1.2  | 2    |      |      |      |



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| U24ED211                                                                                                                                                                                                                                                                                                                    | DESIGN THINKING – DECODING INNOVATION<br>OPPORTUNITY                                                                                                                                                                                                         | L | T | P | C   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                              | 0 | 0 | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                              |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                           | Understand and apply the five phases of the Stanford Design Thinking Framework (Empathize, Define, Ideate, Prototype, and Test) to identify user needs and create innovative solutions.                                                                      |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                           | Gain knowledge of the five stages of the IDEO Design Thinking Framework (Discover, Interpret, Ideate, Experiment, and Evolve) and explore how to iteratively refine solutions through a human-centered approach.                                             |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                           | Learn the application of Design Thinking tools such as visualization, journey mapping, value chain analysis, brainstorming, and rapid prototyping to generate and refine ideas that meet customer needs.                                                     |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                           | Apply Design Thinking methodologies to identify opportunities for innovation, scope projects, conduct research, generate ideas, and create business case studies and prototypes for real-world problem-solving.                                              |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                           | Analyze and clarify innovation opportunities by understanding the problem, stakeholders, and solution context through frameworks like Doblin’s Ten Types of Innovation and RACI, focusing on the 'Who', 'What', 'How', and 'Why' aspects of problem-solving. |   |   |   |     |
| UNIT – 1: STANFORD DESIGN THINKING FRAMEWORK                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                              |   |   | 3 |     |
| 1. How To `Empathize`?<br>2. How To `Define`<br>3. How To `Ideate`?<br>4. How To `Prototype`?<br>5. How To `Test`?                                                                                                                                                                                                          |                                                                                                                                                                                                                                                              |   |   |   |     |
| UNIT – 2: IDEO DESIGN THINKING FRAMEWORK                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                              |   |   | 3 |     |
| • How To `Discover`?<br>• How To `Interpret`?<br>• How To `Ideate`?<br>• How To `Experiment`?<br>• How To `Evolve`?                                                                                                                                                                                                         |                                                                                                                                                                                                                                                              |   |   |   |     |
| UNIT – 3: DESIGN THINKING & DESIGN DOING                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                              |   |   | 2 |     |
| • `What Is`? - Overview About Visualization, Journey Mapping, Value Chain Analysis & Mind Mapping<br>• `What If`? - Overview About BrainStorming & Concept Development<br>• `What Wows`? - Overview About Assumption Testing & Rapid Prototyping<br>• `What Works`? - Overview About Customer Co-Creation & Learning Launch |                                                                                                                                                                                                                                                              |   |   |   |     |
| UNIT – 4: DESIGN THINKING IN PRACTICE – Identify An Opportunity & Becoming Aware Of Next Steps For Innovation – Overview                                                                                                                                                                                                    |                                                                                                                                                                                                                                                              |   |   | 2 |     |



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- Before You Begin: Identify An Opportunity – Scope Your Project – Draft Your Design Brief – Make Your Plans
- `What Is' Focus: Do Your Research – Identify Insights – Establish Design Criteria
- What If' Focus: BrainStorm Ideas – Develop Concepts – Create Business Case Studies
- `What Wows' Focus: Surface Key Assumptions – Make Prototypes
- `What Works' Focus: Get Feedback From Stakeholders – Run Learning Launches – Design The On-Ramp

**UNIT – 5: CLARIFYING PROBLEM STATEMENT & PRIORITIES BY IDENTIFYING & DECODING THE INNOVATION OPPORTUNITY**

**5**

- Overview Of Doblin's Ten Types Of Innovation With Brief-Cases Towards Identifying Innovation Opportunity & Clarifying Problem Statement and Priorities
- Opportunity / Problem Clarity About `Who'? (Who're we solving the problem for?)
- Opportunity / Problem Clarity About `What'? (What is the Problem Or EGO – Expectation, Goal & Objective?)
- Opportunity / Problem Clarity About `HOW'? (How's the Overall Problem Solving Approach Help Highlighting RACI – Who's Responsible, Accountable, Consulted & Informed?)
- Opportunity / Problem Clarity About `WHY'? (Why's this Solution or Product or Service or Process beneficial to the stakeholders?)

**TOTAL PERIODS**

**15**

**Course Outcomes**

**At the end of the course, the student will be able to**

|            |                                                                                                                                                                                                                              |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CO1</b> | Apply Design Thinking frameworks, tools, and techniques to real-world problems, identifying opportunities for innovation and creating effective solutions.                                                                   |
| <b>CO2</b> | Empathize with users, define problems, ideate solutions, prototype, and test, ensuring that solutions meet customer needs and are feasible, viable, and desirable.                                                           |
| <b>CO3</b> | Analyze problems, stakeholders, and solution contexts using frameworks like Doblin's Ten Types of Innovation and RACI, focusing on the 'Who', 'What', 'How', and 'Why' aspects of problem-solving.                           |
| <b>CO4</b> | Generate and refine ideas using Design Thinking tools like visualization, journey mapping, value chain analysis, brainstorming, and rapid prototyping, creating innovative solutions that meet customer needs.               |
| <b>CO5</b> | Develop effective problem-solving skills, including the ability to scope projects, conduct research, generate ideas, and create business case studies and prototypes, preparing them to tackle complex real-world problems.. |

**TEXT BOOKS**

|   |                                                                                                                                |
|---|--------------------------------------------------------------------------------------------------------------------------------|
| 1 | Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Publications, 2009 |
| 2 | Don Norman, "The Design of Everyday Things", Basic Books, 2013                                                                 |
| 3 | Tom Kelley, David Kelley, "Creative Confidence: Unleashing the Creative Potential Within Us All", Currency, 2013               |



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**REFERENCES**

|   |                                                                                                                                            |
|---|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Hasso Plattner, Christoph Meinel, Larry Leifer, "Design Thinking: Understand – Improve – Apply (Understanding Innovation)", Springer, 2011 |
| 2 | Jakob Schneider, Marc Stickdorn, "This Is Service Design Thinking: Basics, Tools, Cases", John Wiley & Sons, 2011                          |
| 3 | Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency, 2001                          |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO6 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| <b>CO2</b> | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| <b>CO3</b> | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| <b>CO4</b> | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| <b>CO5</b> | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| <b>AVG</b> | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |





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| U24ED311                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                        | INNOVATION TOOLKITS | L | T | P | C   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|---------------------|---|---|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                        |                     | 0 | 0 | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                        |                     |   |   |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To familiarize students with structured innovation and problem-solving toolkits used in industry and entrepreneurship. |                     |   |   |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To apply analytical and creative tools to diagnose problems and generate solution directions.                          |                     |   |   |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop competency in using digital, AI-based, and no-code tools for innovation support..                           |                     |   |   |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To analyze complex challenges using systematic frameworks such as TRIZ, Root Cause Analysis, and Decision matrices.    |                     |   |   |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To select and justify appropriate innovation tools based on problem type, stakeholders, and constraints                |                     |   |   |   |     |
| UNIT I – INNOVATION TOOLKIT FOUNDATIONS                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                        |                     |   |   | 1 |     |
| <ul style="list-style-type: none"><li>• Role of toolkits in innovation and entrepreneurship.</li><li>• Difference between frameworks, methods, and tools.</li><li>• Classification of tools:<ul style="list-style-type: none"><li>○ Problem analysis tools</li><li>○ Idea generation tools</li><li>○ Decision-making tools</li><li>○ Digital innovation tools</li></ul></li></ul> <p>When and why to use each toolkit in the innovation lifecycle.</p> |                                                                                                                        |                     |   |   |   |     |
| UNIT II – PROBLEM ANALYSIS & DIAGNOSTIC TOOLS                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                        |                     |   |   | 2 |     |
| <ul style="list-style-type: none"><li>• Root Cause Analysis (5 Whys, Fishbone Diagram).</li><li>• Systems thinking tools.</li><li>• Stakeholder Mapping and Empathy Maps (tool usage only).</li><li>• Value Chain Analysis.</li><li>• Problem framing using structured templates.</li></ul>                                                                                                                                                            |                                                                                                                        |                     |   |   |   |     |
| UNIT III – SYSTEMATIC INNOVATION & CREATIVE TOOLS                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                        |                     |   |   | 4 |     |
| <ul style="list-style-type: none"><li>• TRIZ principles and contradiction matrix.</li><li>• Six Thinking Hats for parallel thinking.</li><li>• Lateral thinking tools and forced association.</li><li>• Tool comparison and selection.</li></ul>                                                                                                                                                                                                       |                                                                                                                        |                     |   |   |   |     |
| UNIT IV – DIGITAL, AI & NO-CODE INNOVATION TOOLS                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                        |                     |   |   | 4 |     |
| Digital collaboration tools (Miro, Jamboard, Notion – overview).<br>Visualization tools (Canva, Figma).<br>No-code tools for simulation and concept modeling.<br>Use of AI tools for: <ul style="list-style-type: none"><li>• Idea generation</li><li>• Research support</li><li>• Concept refinement</li><li>• Ethical and responsible use of digital tools.</li></ul>                                                                                |                                                                                                                        |                     |   |   |   |     |
| UNIT V – TOOL INTEGRATION & DECISION TOOLKITS                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                        |                     |   |   | 4 |     |
| <ul style="list-style-type: none"><li>• Decision matrices and prioritization tools (MoSCoW, ICE, RICE).</li><li>• Risk assessment and feasibility tools.</li><li>• Mapping problems to appropriate toolkits.</li><li>• Developing an <b>Innovation Toolkit Canvas</b>.</li><li>• Presentation of toolkit-driven solution strategy.</li></ul>                                                                                                           |                                                                                                                        |                     |   |   |   |     |



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| TOTAL PERIODS                                                                                                                              |                                                                                                                                                  |     |     |     |     |     |     |     |     |      | 15   |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| Course Outcomes                                                                                                                            |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| At the end of the course, students will be able to                                                                                         |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                          | Explain different categories of innovation toolkits and their purpose.                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                          | Apply diagnostic tools to analyze real-world problems.                                                                                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                          | Use systematic innovation tools such as TRIZ and SCAMPER to explore solution directions                                                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                          | Demonstrate the use of digital and AI tools for innovation support and visualization.                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                          | Select and justify appropriate innovation toolkits to solve practical challenges                                                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXTBOOKS                                                                                                                                  |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                          | Hasso Plattner, Christoph Meinel, Larry Leifer, <i>Design Thinking: Understand – Improve – Apply (Understanding Innovation)</i> , Springer, 2011 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                          | Tim Brown, “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Publications, 2009                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                          | Don Norman, “The Design of Everyday Things”, Basic Books, 2013                                                                                   |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                          | Tom Kelley, David Kelley, “Creative Confidence: Unleashing the Creative Potential Within Us All”, Currency, 2013                                 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCE BOOKS                                                                                                                            |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                          | Hasso Plattner, Christoph Meinel, Larry Leifer, “Design Thinking: Understand – Improve – Apply (Understanding Innovation)”, Springer, 2011       |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                          | Jakob Schneider, Marc Stickdorn, “This Is Service Design Thinking: Basics, Tools, Cases”, John Wiley & Sons, 2011                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                          | Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency, 2001                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping                                                                                                                         |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                                                                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                            | PO1                                                                                                                                              | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|                                                                                                                                            |                                                                                                                                                  |     |     |     |     |     |     |     |     |      | 1    |      |      |      |
| CO1                                                                                                                                        | 1                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO2                                                                                                                                        | 1                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO3                                                                                                                                        | -                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO4                                                                                                                                        | -                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO5                                                                                                                                        | -                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| AVG                                                                                                                                        | 1                                                                                                                                                | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |



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| U24ED411                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                      | IDEA AND SIMULATION LAB |  | L | T | P  | C   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--|---|---|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                      |                         |  | 0 | 0 | 1  | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                      |                         |  |   |   |    |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To understand the purpose and process of ideation and how to transition effectively from empathy and definition phases.              |                         |  |   |   |    |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To apply structured idea generation techniques such as Brainwriting and Brainstorming to foster creative solutions.                  |                         |  |   |   |    |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To analyze and facilitate idea selection by evaluating desirability, feasibility, and viability of solutions.                        |                         |  |   |   |    |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To evaluate and refine solutions using the SCAMPER framework and other ideation techniques to address real-world needs.              |                         |  |   |   |    |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | To create actionable solution models by defining concepts, mapping processes, and outlining requirements for market-ready offerings. |                         |  |   |   |    |     |
| UNIT I IDEATE MODE                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                      |                         |  |   |   | 1  |     |
| <ul style="list-style-type: none"><li>Transitioning from Empathize and Define Modes</li><li>What is the IDEATE Mode?</li><li>Why Ideate?</li><li>How to Ideate?</li><li>How to transition and move from “Ideate” to “Prototype” Modes</li></ul>                                                                                                                                                                                                                                          |                                                                                                                                      |                         |  |   |   |    |     |
| UNIT II IDEA GENERATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                      |                         |  |   |   | 2  |     |
| <ul style="list-style-type: none"><li>How to generate ideas?</li><li>How to Brainwrite? (6-3-5 and 3-3-5 techniques)</li><li>How to prepare for Brainstorming?</li><li>Prepare a checklist for Brainstorming</li><li>Prepare Brainstorming rules</li></ul>                                                                                                                                                                                                                               |                                                                                                                                      |                         |  |   |   |    |     |
| UNIT III BRAINSTORMING FACILITATION                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |                         |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Prepare warmup questions to facilitate effective brainstorming</li><li>Prepare focus areas and topics for brainstorming</li><li>Discuss desirability, feasibility and viability perspectives plus point-of-views</li><li>Document desirability, feasibility and viability ratings and rankings</li><li>Select promising ideas that has potential to become solutions</li></ul>                                                                     |                                                                                                                                      |                         |  |   |   |    |     |
| UNIT IV SKETCH TO THINK BEYOND                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                      |                         |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Introduction to “SCAMPER” Framework to improve solutions to promising products and services</li><li>Refine ideas to become potential solutions with stakeholder acceptable results</li><li>Do a reality check by assessing value, needs, challenges, and barriers</li><li>Improve and form new concepts leading to products and services</li><li>Write a one-sentence concept description (Why? Why is this solution the best in class?)</li></ul> |                                                                                                                                      |                         |  |   |   |    |     |
| UNIT V TRANSLATE SOLUTIONS TO PRODUCTS AND SERVICES                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                      |                         |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Describe your idea with concept name</li><li>Draw a sketch or mind map reflecting at least Business, People, Process, Technology and Stakeholders / Customers</li><li>Describe how the product will work and produce the intended Output, Outcomes and Results</li><li>Evaluate resources and infrastructure requirements to build the products and services</li><li>Detail a plan to arrive at Market-Ready Product / Service</li></ul>           |                                                                                                                                      |                         |  |   |   |    |     |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                      |                         |  |   |   | 15 |     |



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| Course Outcomes                                                                                                                                                  |                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| At the end of the course, students will be able to                                                                                                               |                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                | Describe the IDEATE mode, explain its role in design thinking, and illustrate the transition from ideate to prototype.                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                | Demonstrate the use of Brainwriting (6-3-5, 3-3-5) and construct effective brainstorming rules and checklists.                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                | Analyze ideas based on desirability, feasibility, and viability, and select high-potential ideas for further development.                  |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                | Evaluate ideas using SCAMPER, refine them by assessing value and barriers, and formulate concise concept descriptions.                     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 5                                                                                                                                                                | Design a product/service concept with clear stakeholder mapping, develop a detailed action plan, and justify its readiness for market.     |     |     |     |     |     |     |     |     |      |      |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                | An Introduction to Design Thinking PROCESS GUIDE, Hasso Plattner, d. School                                                                |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                | Tim Brown, “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Publications, 2009             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                | Don Norman, “The Design of Everyday Things”, Basic Books, 2013                                                                             |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 4                                                                                                                                                                | Tom Kelley, David Kelley, “Creative Confidence: Unleashing the Creative Potential Within Us All”, Currency, 2013                           |     |     |     |     |     |     |     |     |      |      |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 1                                                                                                                                                                | Hasso Plattner, Christoph Meinel, Larry Leifer, “Design Thinking: Understand – Improve – Apply (Understanding Innovation)”, Springer, 2011 |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 2                                                                                                                                                                | Jakob Schneider, Marc Stickdorn, “This Is Service Design Thinking: Basics, Tools, Cases”, John Wiley & Sons, 2011                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| 3                                                                                                                                                                | Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency, 2001                          |     |     |     |     |     |     |     |     |      |      |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                                                            |     |     |     |     |     |     |     |     |      |      |      |      |      |
|                                                                                                                                                                  | PO1                                                                                                                                        | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              | 1                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO2                                                                                                                                                              | 1                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |
| CO3                                                                                                                                                              | -                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO4                                                                                                                                                              | -                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| CO5                                                                                                                                                              | -                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2    |      |      |      |
| AVG                                                                                                                                                              | 1                                                                                                                                          | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2    |      |      |      |



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| U24ED511                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       | PROTOTYPE AND MARKET VALUATION |  | L | T | P  | C   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|--|---|---|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                       |                                |  | 0 | 0 | 1  | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                       |                                |  |   |   |    |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To understand the purpose, process, and transition from ideation to prototyping in the design thinking framework.                     |                                |  |   |   |    |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop the ability to plan and perform testing processes for validating prototypes and iterating for improvement.                 |                                |  |   |   |    |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To analyze and create various forms of rapid and resource-efficient experimentation methods including risk and failure analysis       |                                |  |   |   |    |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To evaluate and incorporate feedback through structured methods for refining the prototype based on stakeholder insights.             |                                |  |   |   |    |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | To create a strategic roadmap for evolving prototypes into validated market-ready solutions through metrics and stakeholder planning. |                                |  |   |   |    |     |
| UNIT I PROTOTYPE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   | 1  |     |
| <ul style="list-style-type: none"><li>Transitioning from Ideate Mode</li><li>What is the Prototype mode?</li><li>Why Prototype?</li><li>How to Prototype?</li><li>How to seamlessly transition from Prototype to Test?</li></ul>                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   |    |     |
| UNIT II TEST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                       |                                |  |   |   | 2  |     |
| <ul style="list-style-type: none"><li>What is the Test Mode?</li><li>How to Test?</li><li>How to iterate for continuous improvements?</li><li>Deciding how to move forward (Persevere or Pivot)</li><li>How to make the process to repetitively lead to product / service improvements</li></ul>                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   |    |     |
| UNIT III EXPERIMENTATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                       |                                |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Make prototypes (Fast &amp; Cheap / Simulate &amp; Stimulate)</li><li>Create and Try, Experience Prototypes by shrinking big things down</li><li>Rapid Concept Development</li><li>Assumptions, Constraints, Limitations, Potential point of failures and Risk Analysis</li><li>Test prototypes by Customer Co-Creation</li></ul>                                                                                                                                                                |                                                                                                                                       |                                |  |   |   |    |     |
| UNIT IV FEEDBACK                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Identify potential sources of feedback</li><li>Obtain feedback from select participants (Client / Customer / Consumer / Stakeholder)</li><li>Build a questionnaire guide by starting specific to moving broad</li><li>Probe deep, facilitate feedback prompts, capture input and integrate overall feedback</li><li>Identify costs, resources, infrastructure, features and functionalities to iterate based on what is available vs. needed at the institution to decide buying needs</li></ul> |                                                                                                                                       |                                |  |   |   |    |     |
| UNIT V EVOLUTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                       |                                |  |   |   | 4  |     |
| <ul style="list-style-type: none"><li>Track learnings and establish Learning Launches</li><li>Define success with Impact Guidance</li><li>Identify methods of tracking (Measures / Metrics – Lag or Lead)</li><li>Document progress and asset needs iteratively by effective stakeholder engagement to plan next steps</li><li>Define RASCI / RACI Chart to prepare and pitch product or service concept for Market Valuation by Storytelling</li></ul>                                                                                |                                                                                                                                       |                                |  |   |   |    |     |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                       |                                |  |   |   | 15 |     |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                       |                                |  |   |   |    |     |



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**At the end of the course students will be able to**

|          |                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Explain the importance of prototyping and describe how to create and transition from ideate to prototype and then to test mode. |
| <b>2</b> | Apply appropriate testing techniques to evaluate prototypes and determine whether to persevere or pivot based on test results.  |
| <b>3</b> | Analyze assumptions, constraints, and risks in experimental prototypes and develop effective rapid concept models.              |
| <b>4</b> | Evaluate feedback using probing tools like questionnaires and integrate the insights to modify their solution.                  |
| <b>5</b> | Design a market-pitch-ready concept using tools like RASCI/RACI, impact tracking, and storytelling.                             |

**TEXTBOOKS**

|   |                                                                                                                                |
|---|--------------------------------------------------------------------------------------------------------------------------------|
| 1 | An Introduction to Design Thinking PROCESS GUIDE, Hasso Plattner, d. School                                                    |
| 2 | Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Publications, 2009 |
| 3 | Don Norman, "The Design of Everyday Things", Basic Books, 2013                                                                 |
| 4 | Tom Kelley, David Kelley, "Creative Confidence: Unleashing the Creative Potential Within Us All", Currency, 2013               |

**REFERENCE BOOKS**

|   |                                                                                                                                            |
|---|--------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Hasso Plattner, Christoph Meinel, Larry Leifer, "Design Thinking: Understand – Improve – Apply (Understanding Innovation)", Springer, 2011 |
| 2 | Jakob Schneider, Marc Stickdorn, "This Is Service Design Thinking: Basics, Tools, Cases", John Wiley & Sons, 2011                          |
| 3 | Tom Kelley, The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm, Currency, 2001                          |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|            | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> | <b>PO11</b> | <b>PSO1</b> | <b>PSO2</b> | <b>PSO3</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|
| <b>CO1</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO2</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO3</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO4</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>CO5</b> | -          | 2          | 3          | 2          | 2          | 2          | -          | 3          | 3          | 2           | 2           |             |             |             |
| <b>AVG</b> | 1          | 2          | 3          | 2          | 2          | 2          | 1          | 3          | 3          | 2           | 2           |             |             |             |



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|                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    |   |    |   |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|---|----|---|-----|
| U24ED611                                                                                                                                                                                                                                                                                                                                                                                     | Business Management: Go-To-Market & Startup Journey                                                                | L | T  | P | C   |
|                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    | 0 | 0  | 1 | 0.5 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                    |   |    |   |     |
| 1                                                                                                                                                                                                                                                                                                                                                                                            | To understand the fundamentals of business management and the startup lifecycle from idea to market entry.         |   |    |   |     |
| 2                                                                                                                                                                                                                                                                                                                                                                                            | To analyze and design business models and revenue models suitable for innovative products and services.            |   |    |   |     |
| 3                                                                                                                                                                                                                                                                                                                                                                                            | To develop go-to-market strategies including marketing, sales, and customer acquisition planning                   |   |    |   |     |
| 4                                                                                                                                                                                                                                                                                                                                                                                            | To understand financial planning, funding options, and legal aspects of starting and scaling a venture.            |   |    |   |     |
| 5                                                                                                                                                                                                                                                                                                                                                                                            | To prepare students to present and manage a startup journey through effective pitching and stakeholder engagement. |   |    |   |     |
| UNIT I IDEATE MODE                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   | 1  |   |     |
| <ul style="list-style-type: none"><li>• Meaning and scope of business management.</li><li>• Startup lifecycle: idea, validation, launch, growth, and scale.</li><li>• Role of entrepreneurship in economic development.</li><li>• Overview of startup ecosystem: incubators, accelerators, investors, and government initiatives.</li><li>• Ethics and sustainability in business.</li></ul> |                                                                                                                    |   |    |   |     |
| UNIT II IDEA GENERATION                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                    |   | 2  |   |     |
| <ul style="list-style-type: none"><li>• Business Model Canvas and value proposition design.</li><li>• Customer segments, channels, and customer relationships.</li><li>• Revenue models: subscription, freemium, licensing, transaction-based models.</li><li>• Cost structure and key resources.</li><li>• Lean startup and effectuation principles.</li></ul>                              |                                                                                                                    |   |    |   |     |
| UNIT III BRAINSTORMING FACILITATION                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                    |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Market segmentation, targeting, and positioning.</li><li>• Marketing mix and branding basics.</li><li>• Digital marketing channels and customer acquisition strategies.</li><li>• Sales strategy and distribution channels.</li><li>• Pricing strategies and competitive positioning.</li></ul>                                                      |                                                                                                                    |   |    |   |     |
| UNIT IV SKETCH TO THINK BEYOND                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                    |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Basics of financial planning and budgeting.</li><li>• Understanding unit economics and break-even analysis.</li><li>• Sources of funding: bootstrapping, angel investors, venture capital, and government schemes.</li><li>• Legal forms of business organization.</li><li>• Intellectual Property Rights (IPR) and regulatory compliance.</li></ul> |                                                                                                                    |   |    |   |     |
| UNIT V TRANSLATE SOLUTIONS TO PRODUCTS AND SERVICES                                                                                                                                                                                                                                                                                                                                          |                                                                                                                    |   | 4  |   |     |
| <ul style="list-style-type: none"><li>• Operational planning and team building.</li><li>• Risk management and decision-making.</li><li>• Performance metrics and growth tracking.</li><li>• Storytelling and investor pitch deck preparation.</li><li>• Preparing for market launch and scaling strategy.</li></ul>                                                                          |                                                                                                                    |   |    |   |     |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                    |   | 15 |   |     |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                    |   |    |   |     |
| At the end of the course, students will be able to                                                                                                                                                                                                                                                                                                                                           |                                                                                                                    |   |    |   |     |



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|   |                                                                                      |
|---|--------------------------------------------------------------------------------------|
| 1 | Explain the concepts of business management and the stages of the startup journey.   |
| 2 | Design appropriate business and revenue models for innovative products and services. |
| 3 | Develop effective go-to-market strategies including marketing and sales plans.       |
| 4 | Apply financial planning and legal knowledge to assess venture feasibility.          |
| 5 | Prepare and present a structured business pitch for launching and scaling a startup. |

**TEXTBOOKS**

|   |                                                                                                                             |
|---|-----------------------------------------------------------------------------------------------------------------------------|
| 1 | Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, <i>Entrepreneurship</i> , McGraw Hill Education, 11th Edition, 2020 |
|---|-----------------------------------------------------------------------------------------------------------------------------|

**REFERENCE BOOKS**

|   |                                                                             |
|---|-----------------------------------------------------------------------------|
| 1 | Kotler, P. & Keller, K. L., <i>Marketing Management</i> , Pearson Education |
|---|-----------------------------------------------------------------------------|

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO1<br>1 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|----------|------|------|------|
| CO1 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2        |      |      |      |
| CO2 | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2        |      |      |      |
| CO3 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2        |      |      |      |
| CO4 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2        |      |      |      |
| CO5 | -   | 2   | 3   | 2   | 2   | 2   | -   | 3   | 3   | 2    | 2        |      |      |      |
| AVG | 1   | 2   | 3   | 2   | 2   | 2   | 1   | 3   | 3   | 2    | 2        |      |      |      |





# MEENAKSHI SUNDARARAJAN ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION



INSTITUTION'S  
INNOVATION  
COUNCIL  
(Ministry of Education Initiative)

**RECOGNIZED AS  
RESEARCH INSTITUTE  
BY ANNA UNIVERSITY**

## PROSKILL – TECHNOLOGY & TOOL CENTRIC CURRICULUM

**BRIDGING CURRICULUM & INDUSTRY COMPETENCE**

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**





**Meenakshi Sundararajan Engineering College**  
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Department : ELECTRICAL AND ELECTRONICS ENGINEERING, R2025

**VAC- VALUE ADDED COURSES –EMERGING TECHNOLOGY**

| SEMESTER | COURSE CODE | COURSE TITLE                                                    | TCP |
|----------|-------------|-----------------------------------------------------------------|-----|
| 2        | U24EEV11    | Biology for Electrical and Electronics Engineers                | 30  |
| 3        | U24EEV12    | Value Education                                                 | 30  |
| 4        | U24EEV13    | Interfacing Sensors and Actuators with Arduino and Raspberry Pi | 30  |
| 5        | U24EEV14    | Analog and Digital Circuit Design with Proteus                  | 30  |
| 6        | U24EEV15    | VLSI system design using Cadence                                | 30  |
| 7        | U24EEV16    | Digital Power System Engineering with ETAP                      | 30  |
| 8        | U24EEV17    | Project Report Writing using LATEX                              | 30  |



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**SELF- LEARNING COURSE-CORE**

| SEMESTER | COURSE CODE | COURSE TITLE                                               | TCP |
|----------|-------------|------------------------------------------------------------|-----|
| 2        | U24CE204    | Matlab & Simulink : Modeling and Applications              | 45  |
| 3        | U24EE303    | Build MATLAB Proficiency                                   | 45  |
| 4        | U24EE402    | PCB Design and Product Development using KiCad             | 45  |
| 5        | U24EE501    | OrCAD : From Schematic Design to PCB Implementation        | 45  |
| 6        | U24EE603    | LabVIEW & Virtual Instrumentation: Motor Modeling, Control | 45  |
| 7        | U24EE702    | Siemens PLC Programming                                    | 45  |



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**CERTIFICATION COURSES**

| SEMESTER | COURSE TITLE                                                                              |
|----------|-------------------------------------------------------------------------------------------|
| 1        | Programming in C                                                                          |
| 2        | Python for Electrical Engineers                                                           |
| 3        | Electrical CADD                                                                           |
| 4        | VLSI Design using Verilog/VHDL (Xilinx ISE, Cadence)                                      |
| 5        | Design and analysis of electrical machines using MAGNET                                   |
| 6        | Renewable Energy Simulation with PVsyst and HOMER                                         |
| 7        | ANSYS / COMSOL & SOLID WORK (Electromagnetics & Thermal Analysis) for Electrical Machines |
| 8        | AI for Electrical Engineering                                                             |



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**SELF-LEARNING COURSES-EEC**

| <b>SEMESTER</b> | <b>COURSE TITLE</b>                                                            | <b>TCP</b> |
|-----------------|--------------------------------------------------------------------------------|------------|
| 1               | C Language Mastery – Self-Learning Program                                     | 45         |
| 2               | Independent Study Module (ISM) in Python Programming                           | 45         |
| 3               | Java Essentials: Academic Independent Study                                    | 45         |
| 4               | Data Structures: Learner-Centred Self-Instructional Module                     | 45         |
| 5               | Essentials of SQL: Self-Paced Academic Unit                                    | 45         |
| 6               | Web Design and Scripting: Independent Study Curriculum (HTML, CSS, JavaScript) | 45         |



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**TECHNICAL SKILLING**

| SE<br>ME<br>STE<br>R | VAC            |                                                                             | SELF LEARNING<br>(CORE) |                                                              | SELF LEARNING<br>(EEC)                                            | CERTIFICATI ON                                                   | PROJECT DRIVEN |                                       |
|----------------------|----------------|-----------------------------------------------------------------------------|-------------------------|--------------------------------------------------------------|-------------------------------------------------------------------|------------------------------------------------------------------|----------------|---------------------------------------|
|                      | COURSE<br>CODE | COURSE<br>TITLE                                                             | COURSE<br>CODE          | COURSE TITLE                                                 | COURSE TITLE                                                      | COURSE<br>TITLE                                                  | COURSE<br>CODE | COURSE TITLE                          |
| 1                    |                |                                                                             |                         |                                                              | C Language Mastery –<br>Self-Learning Program                     | Programming in<br>C                                              | U24CS101       | Programming in C                      |
|                      |                |                                                                             |                         |                                                              |                                                                   |                                                                  | U24PH104       | Physics for Electrical<br>Engineering |
| 2                    | U24EEV11       | Biology for<br>Electrical and<br>Electronics<br>Engineers                   | U24CE204                | Matlab &<br>Simulink :<br>Modeling and<br>Applications       | Independent Study<br>Module (ISM) in Python<br>Programming        | Python for<br>Electrical<br>Engineers                            | U24CS201       | Python Programming                    |
|                      |                |                                                                             |                         |                                                              |                                                                   |                                                                  | U24CY201       | Green and Sustainable<br>Chemistry    |
| 3                    | U24EEV12       | Value<br>Education                                                          | U24EE303                | Build MATLAB<br>Proficiency                                  | Java Essentials:<br>Academic Independent<br>Study                 | Electrical CADD                                                  | U24EE302       | Electronic Devices and<br>Circuit     |
|                      |                |                                                                             |                         |                                                              |                                                                   |                                                                  | U24CS308       | Data Structure                        |
| 4                    | U24EEV13       | Interfacing<br>Sensors and<br>Actuators with<br>Arduino and<br>Raspberry Pi | U24EE404                | PCB Design and<br>Product<br>Development<br>using KiCad      | Data Structures:<br>Learner-Centred Self-<br>Instructional Module | VLSI Design<br>using<br>Verilog/VHDL<br>(Xilinx ISE,<br>Cadence) | U24EE403       | Electrical Machines - II              |
|                      |                |                                                                             |                         |                                                              |                                                                   |                                                                  | U24EE402       | Digital Logic Circuits                |
| 5                    | U24EEV14       | Analog and<br>Digital Circuit<br>Design with<br>Proteus                     | U24EE501                | OrCAD : From<br>Schematic<br>Design to PCB<br>Implementation | Essentials of SQL:<br>Self-Paced Academic<br>Unit                 | Design and<br>analysis of electrical<br>machines using<br>MAGNET | U24EE503       | Microprocessor and<br>Microcontroller |



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|   |          |                                            |          |                                                            |                                                                                |                                                                                           |          |                           |
|---|----------|--------------------------------------------|----------|------------------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------|---------------------------|
|   |          |                                            |          |                                                            |                                                                                |                                                                                           |          | Professional Elective     |
| 6 | U24EEV15 | VLSI system design using Cadence           | U24EE603 | LabVIEW & Virtual Instrumentation: Motor Modeling, Control | Web Design and Scripting: Independent Study Curriculum (HTML, CSS, JavaScript) | Renewable Energy Simulation with PVsyst and HOMER                                         | U24EE602 | Digital Signal Processing |
|   |          |                                            |          |                                                            |                                                                                |                                                                                           |          | Professional Elective     |
| 7 | U24EEV16 | Digital Power System Engineering with ETAP | U24EE702 | Siemens PLC Programming                                    |                                                                                | ANSYS / COMSOL & SOLID WORK (Electromagnetics & Thermal Analysis) for Electrical Machines | U24EE701 | Renewable Energy Systems  |
|   |          |                                            |          |                                                            |                                                                                |                                                                                           |          | Professional Elective     |
| 8 | U24EEV17 | Project Report Writing using LATEX         |          |                                                            |                                                                                | AI for Electrical Engineering                                                             |          |                           |





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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                               |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------|
| <b>U24EEV11</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>BIOLOGY FOR ELECTRICAL AND ELECTRONICS ENGINEERS</b>                                       | <b>30</b> |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                               |           |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To introduce bioelectrical phenomena and different imaging techniques                         |           |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To explore the electrical properties of biological systems                                    |           |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | To study about micro electromechanical systems and various signal processing techniques       |           |
| <b>MODUE I Bioelectrical Phenomena</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               | <b>10</b> |
| <p>Technological developments like electrocardiograms (ECGs), electroencephalograms (EEGs), and electromyography (EMG), which measure the electrical activity of the heart, brain, and muscles.</p> <p>Imaging technologies including MRI, CT scans, and ultrasound and Pacemaker, Cochlear implant, Endoscopy/Cameras and Working Principles, Signal processing.</p> <p>Case Study: ECG-Based Early Detection of Cardiac Abnormalities</p>                                                                                                                      |                                                                                               |           |
| <b>MODUE II Emulating biological processes &amp; Electrophysiology</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               | <b>10</b> |
| <p>Emulating biological processes in engineering design. Electrical properties of the nervous system or sensory organs, to inspire new technologies like bio-inspired robotics, adaptive control systems, and sensory networks.</p> <p>Electrophysiology involves studying the electrical properties of cells and tissues, especially neurons and muscle cells, designing equipment for recording bioelectrical signals.</p> <p>Case Study: Bio-Inspired Neural Signal Processing for Prosthetic Control.</p>                                                    |                                                                                               |           |
| <b>MODULE III Bio-MEMS (Microelectromechanical Systems) &amp; Signal Processing in Biological Systems</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                               | <b>10</b> |
| <p>Miniature devices that can be used in biological applications, such as lab-on-a-chip systems for diagnostics or microfluidic devices that manipulate tiny amounts of fluids for biomedical research.</p> <p>Generation of signals that can be analyzed for medical diagnosis or research (e.g., heart rate variability analysis for cardiovascular health).</p> <p>Techniques such as filtering, Fourier analysis, and machine learning applied to interpret complex biological data.</p> <p>Case Study: Lab-on-a-Chip Device for Rapid Disease Diagnosis</p> |                                                                                               |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                               | <b>30</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                               |           |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                               |           |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Differentiate bioelectrical phenomena and evaluate various biomedical imaging techniques.     |           |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Analyze the electrical properties of biological systems                                       |           |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Develop knowledge on microelectro mechanical systems and various signal processing techniques |           |





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**TEXT BOOKS**

|   |                                                                                                                                                     |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Physics for Paramedical and Allied Health Science Courses, G Purushothaman, S Qairunnisa, CBS Publishers & Distributors Pvt Ltd, 2023, 1st Edition. |
| 2 | Biomedical Engineering: Bridging Medicine and Technology", W. Mark Saltzman Publisher: Oxford University Press, 2015, 2nd Edition                   |

**REFERENCES BOOKS**

|   |                                                                                                          |
|---|----------------------------------------------------------------------------------------------------------|
| 1 | Introduction to Biomedical Engineering" John Enderle, Joseph Bronzino Elsevier, Year: 2026, 4th Edition  |
| 2 | Medical Instrumentation: Application and Design", John G. Webster, Wiley 2009, 4th Edition               |
| 3 | BioMEMS: Technologies and Applications", H. Z. Zhao, H. G. Zhang, Y. F. Zhang Springer 2007, 1st Edition |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes PSOs'

| CO/PO | PO1  | PO2  | PO3  | PO4 | PO5  | PO6  | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-------|------|------|------|-----|------|------|-----|-----|-----|------|------|------|------|------|
| CO1   | 2    | 2    | 1    | –   | 2    | 2    | –   | –   | –   | –    | –    | 2    | –    | 1    |
| CO2   | 3    | 2    | 2    | –   | 2    | 2    | –   | –   | –   | –    | –    | 2    | –    | 1    |
| CO3   | 3    | 3    | 2    | –   | 3    | 1    | –   | –   | –   | –    | –    | 3    | –    | 1    |
| AVG   | 2.67 | 2.33 | 1.67 | –   | 2.33 | 1.67 | –   | –   | –   | –    | –    | 2.33 | –    | 1    |

**List Product based Projects (Teamwork)**

|                                         |
|-----------------------------------------|
| 1. LED Heartbeat Monitor                |
| 2. Basic ECG Signal Simulator           |
| 3. Temperature-Controlled Fan           |
| 4. Simple EMG Muscle Activity Detector  |
| 5. Basic Biofeedback Stress Indicator   |
| 6. Obstacle Alert System (Bio-inspired) |
| 7. Temperature Logger                   |
| 8. Heartbeat Alarm                      |
| 9. Soil Moisture Alert System           |
| 10. LED Cochlear Implant Simulator      |

**Assessment Plan**

| Sl.No. | Evaluation Component            | Description                                                   | Weightage (%) |
|--------|---------------------------------|---------------------------------------------------------------|---------------|
| 1      | MCQ / Concept Test (Internal)   | Objective-based short test to assess conceptual understanding | 25            |
| 2      | Project Presentation (Internal) | Product demonstration, innovation, teamwork, and viva voce    | 75            |



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|                                                                                                                                                                                                                                              |                                                                                                                                                           |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| U24EEV13                                                                                                                                                                                                                                     | Interfacing Actuators and Sensors with Arduino and Rasberry Pi                                                                                            | 30 |
| Course Objectives                                                                                                                                                                                                                            |                                                                                                                                                           |    |
| 1                                                                                                                                                                                                                                            | To introduce students to the role of electronics, sensors, and actuators in solving real-world engineering problems                                       |    |
| 2                                                                                                                                                                                                                                            | To develop students' understanding of programming logic through algorithms, pseudocode, and hands-on implementation using open-source development boards. |    |
| 3                                                                                                                                                                                                                                            | To enable students to design and execute real-time interface applications using Arduino and Raspberriy Pi for practical problem-solving.                  |    |
| MODULE 1                                                                                                                                                                                                                                     |                                                                                                                                                           | 10 |
| Electronics - as a solution to existing problems - An Introduction<br>Introduction to Various Actuators and sensors to measure electrical and non-electrical quantities.                                                                     |                                                                                                                                                           |    |
| MODULE II                                                                                                                                                                                                                                    |                                                                                                                                                           | 10 |
| Need for Programming - Pseudo codes and Algorithm Generation<br>Comparison of various development boards - From 8085 to FPGA, Role of Open-Source Platforms in Digital System Design.                                                        |                                                                                                                                                           |    |
| MODULE III                                                                                                                                                                                                                                   |                                                                                                                                                           | 10 |
| Hands-on Programming techniques using Arduino and Rasberry Pi.<br><br>Real-time projects using Arduino and Rasberry Pi - Design of IOT system for Speed control of DC motor, Datalogger for DC generator, Performance report on transformer. |                                                                                                                                                           |    |
| TOTAL PERIODS                                                                                                                                                                                                                                |                                                                                                                                                           | 30 |
| Course Outcomes                                                                                                                                                                                                                              |                                                                                                                                                           |    |
| At the end of the course, the student will be able to                                                                                                                                                                                        |                                                                                                                                                           |    |
| CO1                                                                                                                                                                                                                                          | Identify suitable sensors, actuators, and interfacing methods to measure and control various electrical and non-electrical physical quantities            |    |
| CO2                                                                                                                                                                                                                                          | Design basic algorithms/pseudocode and implement interfacing programs using Arduino and Raspberriy Pi                                                     |    |
| CO3                                                                                                                                                                                                                                          | Develop and demonstrate real-time embedded projects that integrate sensors, actuators, and microcontroller/microprocessor platforms                       |    |
| TEXT BOOKS                                                                                                                                                                                                                                   |                                                                                                                                                           |    |
| 1                                                                                                                                                                                                                                            | A Hands-On Course in Sensors Using the Arduino and Raspberriy Pi — by Volker Ziemann.                                                                     |    |
| 2                                                                                                                                                                                                                                            | Programming and Interfacing with Arduino — by Yogesh Misra.                                                                                               |    |
| REFERENCES                                                                                                                                                                                                                                   |                                                                                                                                                           |    |
| 1                                                                                                                                                                                                                                            | Embedded Microcontroller Interfacing: Designing Integrated Projects — by Gourab Sen Gupta & Subhas Chandra Mukhopadhyay                                   |    |
| 2                                                                                                                                                                                                                                            | Advanced Interfacing Techniques for Sensors: Measurement Circuits and Systems for Intelligent Sensors — (edited volume).                                  |    |



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**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Program Outcomes (POs) and Program Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1<br>0 | PO1<br>1 | PO<br>S01 | PO<br>S02 | PO<br>S03 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------|-----------|-----------|-----------|
| <b>CO1</b> | 3   | 2   | 1   | 1   | 1   | -   | -   | -   | 1   | -        | -        | 2         | 2         | 3         |
| <b>CO2</b> | 2   | 2   | 3   | 1   | 3   | -   | -   | -   | 1   | -        | 2        | 2         | 3         | 3         |
| <b>CO3</b> | 1   | 2   | 2   | 2   | 3   | -   | -   | 1   | 1   | 2        | 3        | 2         | 3         | 3         |
| <b>AVG</b> | 2   | 2   | 2   | 1.3 | 2.3 | -   | -   | 1   | 1   | 2        | 2.5      | 2         | 2.67      | 3         |

**List Product based Projects (Teamwork)**

1. Smart Automatic Street Light System using LDR and Arduino
2. Temperature-Controlled Fan System using LM35/DHT11
3. Automatic Water Level Controller with ultrasonic sensor
4. Gas Leakage Detection and Alarm System using MQ sensor
5. Obstacle Avoiding Robot using IR/Ultrasonic sensors
6. Smart Door Lock System using keypad/RFID and servo motor
7. Fire Detection and Alarm System using flame sensor
8. Soil Moisture-Based Irrigation System
9. Automatic Hand Sanitizer Dispenser
10. Smart Dustbin using ultrasonic sensor and servo motor

**Assessment Plan**

| Sl.No. | Evaluation Component            | Description                                                                                                                                                                                 | Weightage (%) |
|--------|---------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1      | MCQ / Concept Test (Internal)   | Objective-based short test to assess conceptual understanding                                                                                                                               | 25            |
| 2      | Project Presentation (Internal) | Product demonstration, hardware integration, team work and Viva Voce and project report (block diagrams, circuit analysis, sensor & actuator selection, innovation, real-time application). | 75            |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|----|
| U24EEV14                                                                                                                                                                                                                                                                                                                                                                                                                               | Analog and Digital Circuit Design<br>with Proteus                                                                                            | 30 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                              |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                      | To provide knowledge of analog and digital circuit design and simulation using Proteus Design Suite.                                         |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                      | To develop skills in analyzing electronic circuits using various simulation techniques and microcontroller-based applications.               |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                      | To introduce PCB design concepts, schematic development, and circuit implementation using Proteus tools                                      |    |
| MODULE 1 Introduction to Proteus & Analog Circuit Design                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                              | 10 |
| <ul style="list-style-type: none"><li>• Acquaintance with Proteus environment</li><li>• Designing a rectifier circuit that enables to choose negative or positive peak</li><li>• A simple example one led charger circuit by a capacitor</li><li>• Different analysis of AC, AC Sweep, DC, DC Sweep, Frequency and Noise (C Emitter)</li><li>• Different analysis of AC,AC Sweep, DC, DC Sweep, Frequency and Noise (C Bais)</li></ul> |                                                                                                                                              |    |
| MODULE II Digital Circuits Design                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                              | 10 |
| <ul style="list-style-type: none"><li>• Designing and simulating digital circuit in Proteus Software</li><li>• Designing a half-adder circuit in NFP</li><li>• Increasing and decreasing counter circuit by Micro Atmega using LCD</li><li>• simulation of controller circuit of a motor using Micro Atmega</li></ul>                                                                                                                  |                                                                                                                                              |    |
| MODULE III PCB Design in Basic Approach                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                              | 10 |
| <ul style="list-style-type: none"><li>• Methods of decreasing wires in the circuit</li><li>• Designing sub-circuit for clear understanding of schematic</li><li>• Apply changes in schematic and PCB devices</li><li>• PCB environment and designing PCB files in the Proteus</li></ul>                                                                                                                                                |                                                                                                                                              |    |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                              | 30 |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |    |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                              |    |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                    | Design and simulate analog and digital electronic circuits using Proteus Design Suite.                                                       |    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                    | Analyze electronic circuits using AC, DC, frequency, sweep, and noise analysis techniques, and implement basic microcontroller applications. |    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                    | Create PCB layouts, optimize circuit schematics, and develop complete electronic circuit designs in Proteus.                                 |    |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                              |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                                                      | Electronic Circuit Design Ideas, McGraw-Hill Education, 2000.                                                                                |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                                      | PCB Design Using AutoCAD, Newnes Publication, 1998                                                                                           |    |
| REFERENCE BOOKS                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              |    |



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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|------|------|-------|-------|---------------|-------|
| 1                                                                                                                                                                      | The Art of Electronics, Cambridge University Press, <b>2015</b> .                              |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 2                                                                                                                                                                      | Microcontroller and Embedded Systems, Pearson Education, <b>2007</b> .                         |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 3                                                                                                                                                                      | Printed Circuit Boards: Design, Fabrication and Assembly, McGraw-Hill Education, <b>2005</b> . |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| <b>CO/PO, PSO Mapping</b><br><b>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Program Outcomes (POs) and Program Specific Outcomes PSOs'</b> |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
|                                                                                                                                                                        | PO1                                                                                            | PO2  | PO3  | PO4                                                                                                                                                                                 | PO5 | PO6  | PO7 | PO8  | PO9  | PO10 | PO 11 | PSO 1 | PSO 2         | PSO 3 |
| CO1                                                                                                                                                                    | 3                                                                                              | 2    | 2    | 1                                                                                                                                                                                   | 3   | –    | –   | –    | –    | –    | 1     | 2     | 3             | 1     |
| CO2                                                                                                                                                                    | 3                                                                                              | 3    | 2    | 2                                                                                                                                                                                   | 3   | –    | –   | –    | –    | –    | 1     | 3     | 3             | 2     |
| CO3                                                                                                                                                                    | 2                                                                                              | 2    | 3    | 2                                                                                                                                                                                   | 3   | 1    | –   | 1    | 1    | 1    | 1     | 2     | 3             | 3     |
| AV G                                                                                                                                                                   | 2.66                                                                                           | 2.33 | 2.33 | 1.66                                                                                                                                                                                | 3   | 0.33 | -   | 0.33 | 0.33 | 0.33 | 1     | 2.33  | 3             | 2     |
| <b>List Product based Projects (Teamwork)</b>                                                                                                                          |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 1.Digital Temperature Monitoring System                                                                                                                                |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 2. Automatic Street Light Controller                                                                                                                                   |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 3. Smart Battery Charger with Charging Indicator                                                                                                                       |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 4. Digital Visitor Counter                                                                                                                                             |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 5. Electronic Voting Machine                                                                                                                                           |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 6. Automatic Water Tank Level Controller                                                                                                                               |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 7. Traffic Signal Controller System                                                                                                                                    |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 8. Home Security Alarm System                                                                                                                                          |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 9. PWM-Based DC Motor Speed Controller                                                                                                                                 |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| 10. Digital Frequency Meter                                                                                                                                            |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| <b>Assessment Plan</b>                                                                                                                                                 |                                                                                                |      |      |                                                                                                                                                                                     |     |      |     |      |      |      |       |       |               |       |
| Sl.No                                                                                                                                                                  | Evaluation Component                                                                           |      |      | Description                                                                                                                                                                         |     |      |     |      |      |      |       |       | Weightage (%) |       |
| 1                                                                                                                                                                      | MCQ / Concept Test (Internal)                                                                  |      |      | Objective-based short test to assess conceptual understanding                                                                                                                       |     |      |     |      |      |      |       |       | 25            |       |
| 2                                                                                                                                                                      | Project Presentation (Internal)                                                                |      |      | Proteus simulation and hardware integration, teamwork, viva voce, and project report (block diagrams, PCB design, sensor/actuator interfacing, innovation, real-time applications). |     |      |     |      |      |      |       |       | 75            |       |



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|                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                   |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| U24EEV15                                                                                                                                                                                                                                                                                                                                                                          | Digital & Analog IC Design with Cadence Tools                                                                                                                                                     | 30 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                   |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                 | To understand and apply the Cadence Virtuoso environment                                                                                                                                          |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                 | To analyze and optimize analog circuit performance                                                                                                                                                |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                 | To design, layout, and verify integrated circuits                                                                                                                                                 |    |
| MODULE 1 Introduction to Cadence & Circuit Design Basics                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                   | 10 |
| Overview of Cadence design tools and applications - Cadence Virtuoso environment and design flow - Library Manager, Schematic Editor & Symbol Editor - Analog circuit components and models - Schematic entry of basic circuits: (Resistor, Capacitor, Inductor networks - Diode and BJT circuits - MOSFET basics) - DC analysis using Spectre - Netlisting and simulation setup. |                                                                                                                                                                                                   |    |
| MODULE II Analog Circuit Simulation & Performance Analysis                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                   | 10 |
| AC analysis and frequency response - Transient analysis - Analog circuit performance parameters: (Gain, bandwidth, phase margin - Power dissipation) - Design and simulation of: (Amplifiers (CE, CS, Differential amplifier) - Current mirrors) - Noise analysis (introductory) - Parametric sweep and corner analysis                                                           |                                                                                                                                                                                                   |    |
| MODULE III Advanced Design, Layout & Verification                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                   | 10 |
| Introduction to IC layout design - Layout editor and design rules - Layout of basic analog blocks - Design Rule Check (DRC) - Layout Versus Schematic (LVS) - Parasitic extraction (basic) - Post-layout simulation - Case studies and mini project using Cadence                                                                                                                 |                                                                                                                                                                                                   |    |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                   | 30 |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                   |    |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                   |    |
| CO1                                                                                                                                                                                                                                                                                                                                                                               | Understand and utilize the Cadence Virtuoso environment to create, simulate, and analyze basic analog and digital circuits, including DC and transient analysis.                                  |    |
| CO2                                                                                                                                                                                                                                                                                                                                                                               | Perform detailed analog circuit simulation and performance evaluation using Cadence tools, including AC analysis, transient analysis, frequency response, and optimization of circuit parameters. |    |
| CO3                                                                                                                                                                                                                                                                                                                                                                               | Design, layout, and verify integrated circuits using Cadence, including Design Rule Check (DRC), Layout Versus Schematic (LVS), parasitic extraction, and post-layout simulation.                 |    |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                   |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                 | Digital VLSI Chip Design with Cadence and Synopsys CAD Tools Erik Brunvand & David Money Harris, 2009                                                                                             |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                 | Electronics Design Automation: Synthesis, verification & Test (System on Silicon), Laung Terng Wang, Morgan Kaufmann,2009                                                                         |    |
| REFERENCES                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                   |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                 | Electronics Design Automation: Synthesis, verification & Test (System on Silicon)-Laung Terng Wang, Morgan Kaufmann,2009                                                                          |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                 | Essential Electronics design Automation (EDA)- Mark D.Birnbaum, Prentice Hall,2004                                                                                                                |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                 | CADENCE Official Website                                                                                                                                                                          |    |



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**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Program Outcomes (POs) and Program Specific Outcomes PSOs'

| CO/PO | PO1  | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8  | PO9  | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 |
|-------|------|-----|-----|-----|-----|-----|-----|------|------|-------|-------|-------|-------|-------|
| CO1   | 3    | 2   | -   | -   | 3   | -   | -   | 1    | 1    | -     | 2     | 3     | 2     | 1     |
| CO2   | 3    | 3   | -   | 2   | 3   | 1   | -   | 1    | 1    | -     | 2     | 3     | 3     | 1     |
| CO3   | 2    | 2   | 3   | 2   | 3   | 2   | 1   | 2    | 2    | 1     | 2     | 3     | 2     | 2     |
| AVG   | 2.67 | 2.3 | 3   | 2   | 3   | 2.5 | 1   | 1.33 | 1.33 | 1     | 2     | 3     | 2.33  | 1.33  |
|       |      |     |     |     |     |     |     |      |      |       |       |       |       |       |

**List Product based Projects (Teamwork)**

1. Low-Power Energy Monitoring IC
2. Solar Power Management IC (Basic PMIC)
3. Battery Health Monitoring IC
4. Water Quality Sensor Interface IC
5. Environmental Temperature & Humidity Sensor IC
6. Fire Detection Analog Front-End IC
7. Gas Leakage Detection Interface IC
8. Medical Sensor Interface IC
9. Body Temperature Monitoring IC
10. Low-Power ECG Signal Conditioning IC

**Assessment Plan**

| Sl. No | Evaluation Component            | Description                                                                                                                                                                                                                                                                                  | Weightage (%) |
|--------|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1      | MCQ / Concept Test (Internal)   | Objective-based short test to assess conceptual understanding                                                                                                                                                                                                                                | 25            |
| 2      | Project Presentation (Internal) | Product demonstration and validation through hardware integration, assessment of teamwork and collaboration, viva voce examination, and project report evaluation including system block diagrams, IC-based PCB design, innovation features, and real-time societal/industrial applications. | 75            |





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|                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                      |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| U24EEV16                                                                                                                                                                                                                                                                                                                                                                                                   | Digital Power System Engineering with ETAP                                                                                                                           | 30 |
| Course Objectives                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                      |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                          | To understand and model electrical power system components for practical engineering applications.                                                                   |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                          | To analyze power system performance under normal and fault conditions                                                                                                |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                          | To design and evaluate protection and coordination schemes                                                                                                           |    |
| MODULE 1 Introduction & Power System Modeling (Basics)                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                      | 10 |
| Introduction to ETAP software -Applications of ETAP in power system engineering -ETAP interface and workspace overview -Creating a new project -One-line diagram basics -Modeling of power system components:(Bus-bars, Generators, Transformers, Transmission lines & cables, Loads) – Data entry and equipment libraries- Setting system base values (KV, MVA).                                          |                                                                                                                                                                      |    |
| MODULE II Power Flow & Short Circuit Analysis                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                      | 10 |
| Load Flow (Power Flow) Analysis using ETAP (Newton-Raphson method, Gauss-Seidel method (overview), Interpreting load flow results) - Bus voltage profiles and power losses - Short Circuit analysis using ETAP (Types of faults: Symmetrical fault, Unsymmetrical faults (LG, LL, LLG)) - IEC & ANSI fault standards - Circuit breaker rating calculations - Fault current analysis and reports using ETAP |                                                                                                                                                                      |    |
| MODULE III Protection, Coordination & Advanced Studies                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                      | 10 |
| Introduction to power system protection - Protective devices in ETAP: (Relays, Circuit Breakers, Fuses) - Protection coordination (TCC curves) - Relay settings and grading - Arc Flash Analysis (basic overview) - Case studies and industrial applications - ETAP report generation - Mini project / case study using ETAP                                                                               |                                                                                                                                                                      |    |
| TOTAL PERIODS                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                      | 30 |
| Course Outcomes                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                      |    |
| At the end of the course, the student will be able to                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                      |    |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                        | Model and simulate electrical power system networks using ETAP by developing one-line diagrams and configuring system components for practical engineering analysis. |    |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                        | Perform load flow and short-circuit analyses using ETAP to evaluate system performance, voltage profiles, and fault levels under various operating conditions.       |    |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                        | Design and assess power system protection and coordination schemes using ETAP to ensure reliability, selectivity, and safety in electrical power networks.           |    |
| TEXT BOOKS                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                      |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                          | Power Systems Analysis Illustrated with Matlab and ETAP (Hb 2019) Hemchandra Madhusudan Shertukde, Taylor & Francis                                                  |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                          | Power System Analysis Using ETAP Software, Julius D. Salutan, ETAPSOF2                                                                                               |    |
| REFERENCES                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                      |    |
| 1                                                                                                                                                                                                                                                                                                                                                                                                          | <a href="https://www.irejournals.com/formatedpaper/1703560.pdf">https://www.irejournals.com/formatedpaper/1703560.pdf</a>                                            |    |
| 2                                                                                                                                                                                                                                                                                                                                                                                                          | Load Flow Analysis of 66 kV substation using ETAP Software Kanchana Baby1, K. L. Sreekumar                                                                           |    |
| 3                                                                                                                                                                                                                                                                                                                                                                                                          | Interactive simulation of power systems: ETAP applications and techniques, K. Brown; F. Shokooh; H. Abcede; G. Donner                                                |    |





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**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Program Outcomes (POs) and Program Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4  | PO5 | PO6 | PO7  | PO8  | PO9  | PO 10 | PO 11 | PS O1 | PS O2 | PS O3 |
|------------|-----|-----|-----|------|-----|-----|------|------|------|-------|-------|-------|-------|-------|
| <b>CO1</b> | 3   | 2   | -   | -    | 3   | -   | -    | 1    | 1    | -     | 2     | 3     | 2     | 1     |
| <b>CO2</b> | 3   | 3   | -   | 2    | 3   | 1   | -    | 1    | 1    | -     | 2     | 3     | 3     | 1     |
| <b>CO3</b> | 2   | 2   | 3   | 2    | 3   | 2   | 1    | 2    | 2    | 1     | 2     | 3     | 2     | 2     |
| <b>AVG</b> | 2.6 | 2.3 | 1   | 1.33 | 3   | 1   | 0.33 | 1.33 | 1.33 | 0.33  | 2     | 3     | 2.3   | 1.3   |

**List Product based Projects (Teamwork)**

1. Substation Load Management System
2. Protection Coordination Product for Distribution Network
3. Industrial Plant Power System Design
4. Motor Starting Impact Analysis
5. Power Factor Improvement Product
6. Solar PV Integration into Distribution Network
7. Battery Energy Storage System (BESS) Integration
8. Smart Distribution Automation System
9. Arc Flash Hazard Analysis Tool
10. Earthing & Grounding System Design

**Assessment Plan**

| Sl.No. | Evaluation Component            | Description                                                                                                                                                                                      | Weightage (%) |
|--------|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1      | MCQ / Concept Test (Internal)   | Objective-based short test to assess conceptual understanding                                                                                                                                    | 25            |
| 2      | Project Presentation (Internal) | ETAP model demo, system simulation validation, teamwork, viva voce, and project report (single-line diagrams, load flow, fault, protection, optimization, innovation and real-time application). | 75            |



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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                    |           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------|
| <b>U24EEV17</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>Project Report Writing using LATEX</b>                          | <b>30</b> |
| <b>Course Objectives</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                    |           |
| <b>1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To introduce the fundamentals of technical project report writing. |           |
| <b>2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To familiarize students with LaTeX for professional documentation. |           |
| <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | To enable preparation of a complete project report using LaTeX.    |           |
| <b>MODULE 1 Fundamentals of Project Report Writing</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                    | <b>10</b> |
| <ul style="list-style-type: none"> <li>Purpose and importance of project reports</li> <li>Types of technical and academic reports</li> <li>Standard project report format</li> <li>Abstract, Introduction, Literature Review</li> <li>Methodology, Results, Conclusion</li> <li>Ethics in technical writing and plagiarism</li> </ul> Activities : <ul style="list-style-type: none"> <li>Identification of components of a standard project report</li> <li>Preparation of report outline (chapter-wise structure) for a given problem statement</li> <li>Writing Abstract and Introduction for a sample project</li> <li>Drafting Literature Review using proper citations (manual referencing)</li> <li>Case study on plagiarism detection and ethical writing practices</li> </ul> |                                                                    |           |
| <b>MODULE II Introduction to LaTeX and Document Formatting</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                    | <b>10</b> |
| <ul style="list-style-type: none"> <li>Overview and advantages of LaTeX</li> <li>LaTeX environment and tools (Overleaf, TeX Live)</li> <li>Basic document structure and compilation</li> <li>Text formatting, sections, lists</li> <li>Tables, figures, and page layout</li> </ul> Activities : <ul style="list-style-type: none"> <li>Creating an account in Overleaf</li> <li>Writing and compiling a basic LaTeX document</li> <li>Creating sections, subsections, lists, and formatted text</li> <li>Inserting tables and figures with captions</li> <li>Page layout settings (margins, headers, footers)</li> </ul>                                                                                                                                                               |                                                                    |           |
| <b>MODULE III Advanced LaTeX for Project Report Preparation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                    | <b>10</b> |
| <ul style="list-style-type: none"> <li>Mathematical equations and symbols</li> <li>Cross-referencing and indexing</li> <li>Bibliography and citations using BibTeX</li> <li>Project report templates</li> <li>Preparation and compilation of a complete project report</li> </ul> Activities : <ul style="list-style-type: none"> <li>Writing mathematical equations using amsmath</li> <li>Cross-referencing sections, tables, figures, and equations</li> <li>Creating bibliography using BibTeX/BibLaTeX</li> <li>Using project report templates</li> <li>Final compilation and debugging of LaTeX errors</li> </ul>                                                                                                                                                                |                                                                    |           |
| <b>TOTAL PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                    | <b>30</b> |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                    |           |
| <b>At the end of the course, the student will be able to</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                    |           |



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|            |                                                                                |
|------------|--------------------------------------------------------------------------------|
| <b>CO1</b> | Identify the structure and essential components of a technical project report. |
| <b>CO2</b> | Apply LaTeX commands to format technical documents.                            |
| <b>CO3</b> | Develop a complete project report using LaTeX.                                 |

**TEXT BOOKS**

|          |                                                                                                                                              |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> | Frank Mittelbach, Michel Goossens, The LaTeX Companion, 3rd Edition, Pearson Education, 2023.                                                |
| <b>2</b> | Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, Chris Rowley, The LaTeX Companion, 2nd Edition, Pearson Education, 2004. |

**REFERENCES BOOKS**

|          |                                                                              |
|----------|------------------------------------------------------------------------------|
| <b>1</b> | Kopka, H., Daly, P. W., A Guide to LaTeX, 5th Edition, Addison-Wesley, 2021. |
| <b>2</b> | George Grätzer, More Math into LaTeX, 6th Edition, Springer, 2016.           |
| <b>3</b> | Overleaf, Overleaf Documentation and LaTeX Tutorials, Online Resource, 2023. |

**CO/PO, PSO Mapping**  
 (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Program Outcomes (POs) and Program Specific Outcomes PSOs'

|            | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| <b>CO1</b> | 1   | –   | –   | –   | –   | –   | –   | 3   | –   | 2    | –    | 1    | 3    | 1    |
| <b>CO2</b> | –   | –   | 2   | –   | 3   | –   | –   | –   | –   | 2    | –    | 3    | 2    | 1    |
| <b>CO3</b> | –   | –   | 3   | –   | 3   | –   | –   | –   | 2   | 3    | 2    | 3    | 3    | 2    |
| <b>AVG</b> | 1   | -   | 2.5 | -   | 3   | -   | -   | 3   | 2   | 2.33 | 2    | 2.33 | 2.67 | 1.33 |

**List Product based Projects (Teamwork)**

|                                                           |
|-----------------------------------------------------------|
| 1. IEEE Conference Paper Preparation using LaTeX          |
| 2. Technical Thesis / Mini-Project Report                 |
| 3. Industry Internship / Training Report using LaTeX      |
| 4. Engineering Data Analysis Report                       |
| 5. Digital & Analog IC Design Report (Cadence Tools)      |
| 6. Power System Simulation Report (ETAP/Matlab)           |
| 7. Embedded System Project Report (Proteus/Arduino Based) |
| 8. Renewable Energy Project Report (Solar/Wind)           |
| 9. IoT-Based Monitoring System Report                     |
| 10. Industrial Motor Control & Protection Report          |

**Assessment Plan**

| Sl.No.   | Evaluation Component           | Description                                                                                                                | Weightage (%) |
|----------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>1</b> | MCQ / Concept Test (Internal)  | Objective-based short test to assess conceptual understanding                                                              | 25            |
| <b>2</b> | Report Presentation (Internal) | LaTeX-based project report preparation covering document structure, tables, figures, equations, references, and viva voce. | 75            |



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|                                                       |                                                                                          |                                                 |                                                                                                                                                                                   |    |
|-------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| U24CE204                                              |                                                                                          | MATLAB & SIMULINK:<br>MODELING AND APPLICATIONS |                                                                                                                                                                                   | 45 |
| Self learning Course Objectives- Product base outcome |                                                                                          |                                                 |                                                                                                                                                                                   |    |
| 1                                                     | To introduce MATLAB and Simulink environments for mathematical modeling and simulation.  |                                                 |                                                                                                                                                                                   |    |
| 2                                                     | To model and simulate electro - physical systems using Simscape .                        |                                                 |                                                                                                                                                                                   |    |
| 3                                                     | To analyze and interpret simulation results for dynamic systems.                         |                                                 |                                                                                                                                                                                   |    |
| 4                                                     | To design and tune controllers using Simulink and PID control techniques.                |                                                 |                                                                                                                                                                                   |    |
| 5                                                     | To apply MATLAB tools for app development and finite element–based engineering analysis. |                                                 |                                                                                                                                                                                   |    |
| Name of the Software : MATLAB Simulink                |                                                                                          |                                                 |                                                                                                                                                                                   |    |
| Module 1- Exercises                                   |                                                                                          |                                                 | Learning Link                                                                                                                                                                     |    |
| 1                                                     | MATLAB Simulink onramp                                                                   |                                                 | <a href="#">Simulink Onramp   Self-Paced Online Courses - MATLAB &amp; Simulink</a>                                                                                               |    |
| 2                                                     | Simulink Fundamentals                                                                    |                                                 | <a href="https://matlabacademy.mathworks.com/details/simulink-fundamentals/slbe">https://matlabacademy.mathworks.com/details/simulink-fundamentals/slbe</a>                       |    |
| 3                                                     | Simulate a first-order system and observe step response.                                 |                                                 |                                                                                                                                                                                   |    |
| Module 2-Exercises                                    |                                                                                          |                                                 | Learning Link                                                                                                                                                                     |    |
| 1                                                     | Simscape Onramp                                                                          |                                                 | <a href="https://matlabacademy.mathworks.com/details/simscape-onramp/simscape">https://matlabacademy.mathworks.com/details/simscape-onramp/simscape</a>                           |    |
| 2                                                     | Simscape Battery Onramp                                                                  |                                                 | <a href="https://matlabacademy.mathworks.com/details/simscape-battery-onramp/orsb">https://matlabacademy.mathworks.com/details/simscape-battery-onramp/orsb</a>                   |    |
| 3                                                     | Model a Battery pack using any specific algorithm                                        |                                                 |                                                                                                                                                                                   |    |
| Module 3-Exercises                                    |                                                                                          |                                                 | Learning Link                                                                                                                                                                     |    |
| 1                                                     | Analyzing Results in Simulink                                                            |                                                 | <a href="https://matlabacademy.mathworks.com/details/analyzing-results-in-simulink/otslars">https://matlabacademy.mathworks.com/details/analyzing-results-in-simulink/otslars</a> |    |
| 2                                                     | PID Control Techniques                                                                   |                                                 | <a href="https://matlabacademy.mathworks.com/details/pid-control-techniques/otmlslpct">https://matlabacademy.mathworks.com/details/pid-control-techniques/otmlslpct</a>           |    |
| 3                                                     | Design and tune a PID controller for a second-order system.                              |                                                 |                                                                                                                                                                                   |    |
| Module 4-Exercises                                    |                                                                                          |                                                 | Learning Link                                                                                                                                                                     |    |
| 1                                                     | App Building Onramp                                                                      |                                                 | <a href="https://matlabacademy.mathworks.com/details/app-building-onramp/orab">https://matlabacademy.mathworks.com/details/app-building-onramp/orab</a>                           |    |
| 2                                                     | Design a simple MATLAB App to control simulation parameters.                             |                                                 |                                                                                                                                                                                   |    |
| Module 5-Exercises                                    |                                                                                          |                                                 | Learning Link                                                                                                                                                                     |    |



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|                                                                                                                                         |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-------|------|------|------|
| 1                                                                                                                                       | Introduction to Finite Element Analysis with MATLAB                                                      | <a href="https://matlabacademy.mathworks.com/details/introduction-to-finite-element-analysis-with-matlab/otmlfea">https://matlabacademy.mathworks.com/details/introduction-to-finite-element-analysis-with-matlab/otmlfea</a> |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                       | Solve a 1D structural or thermal problem using FEM in MATLAB.                                            |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| TOTAL PERIODS                                                                                                                           |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       | 45   |      |      |
| Course Outcomes                                                                                                                         |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| After completion of the course, students will be able to:                                                                               |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                       | Use MATLAB and Simulink environments to model and simulate basic engineering systems.                    |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                       | Develop and simulate electro-physical system models using Simscape                                       |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                       | Analyze simulation results and validate system performance using plots and scopes.                       |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 4                                                                                                                                       | Design, simulate, and tune PID controllers for control system applications.                              |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 5                                                                                                                                       | Build simple MATLAB apps and apply finite element concepts to solve engineering problems.                |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| TEXTBOOKS                                                                                                                               |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                       | Attaway, S., MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier, 5th Edition. |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                       | Brian Hahn & Daniel Valentine, Essential MATLAB for Engineers and Scientists, Academic Press.            |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                       | MathWorks Documentation, MATLAB & Simulink User Guides.                                                  |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| REFERENCE BOOKS                                                                                                                         |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                       | Stephen J. Chapman, MATLAB Programming for Engineers, Cengage Learning.                                  |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                       | Rao, S.S., The Finite Element Method in Engineering, Butterworth-Heinemann                               |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                       | Ogata, K., System Dynamics, Pearson Education (for control and modeling concepts).                       |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| CO/PO, PSO Mapping                                                                                                                      |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                          |                                                                                                                                                                                                                               |     |     |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                         | PO1                                                                                                      | PO2                                                                                                                                                                                                                           | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                     | 3                                                                                                        | 2                                                                                                                                                                                                                             | 2   | 1   | 2   | –   | –   | –   | –   | –    | –     | 2    | 2    | 2    |
| CO2                                                                                                                                     | 2                                                                                                        | 3                                                                                                                                                                                                                             | 2   | 2   | 2   | –   | –   | –   | –   | –    | –     | 2    | 1    | 2    |
| CO3                                                                                                                                     | 3                                                                                                        | 2                                                                                                                                                                                                                             | 3   | 2   | 2   | –   | –   | –   | –   | –    | –     | 2    | 2    | 2    |
| CO4                                                                                                                                     | 2                                                                                                        | 2                                                                                                                                                                                                                             | 2   | 1   | 2   | –   | –   | –   | –   | –    | –     | 1    | 2    | 2    |
| CO5                                                                                                                                     | 3                                                                                                        | 2                                                                                                                                                                                                                             | 3   | 2   | 3   | –   | –   | –   | –   | –    | –     | 2    | 2    | 2    |
| AVG                                                                                                                                     | 2.6                                                                                                      | 2.2                                                                                                                                                                                                                           | 2.4 | 1.6 | 2.2 | –   | –   | –   | –   | –    | –     | 1.8  | 1.8  | 2.0  |



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| Sl.No. | Evaluation Component | Mode of Evaluation                 | Criteria                                  | Weightage (%) |
|--------|----------------------|------------------------------------|-------------------------------------------|---------------|
| 1      | Exercise Uploads     | Upload / Submission                | Accuracy, completeness, timeliness        | 60            |
| 2      | Testing              | Demonstration or practical testing | Functionality, correctness, performance   | 30            |
| 3      | Viva                 | Oral questioning                   | Concept understanding, application skills | 10            |



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|                                                       |                                                                                                                                                                                                                |                                                                                                                                                                                                     |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U24EE303                                              | Build MATLAB Proficiency                                                                                                                                                                                       | 45                                                                                                                                                                                                  |
| Self learning Course Objectives- Product base outcome |                                                                                                                                                                                                                |                                                                                                                                                                                                     |
| 1                                                     | To familiarize students with the MATLAB desktop environment and troubleshooting tools.                                                                                                                         |                                                                                                                                                                                                     |
| 2                                                     | To develop skills in matrix manipulation, data analysis, and visualization using MATLAB.                                                                                                                       |                                                                                                                                                                                                     |
| 3                                                     | To apply programming constructs and user-defined functions for problem solving.                                                                                                                                |                                                                                                                                                                                                     |
| 4                                                     | To introduce data handling techniques using tables and logical indexing.                                                                                                                                       |                                                                                                                                                                                                     |
| 5                                                     | To enable modeling and simulation of electrical circuits and motor systems using Simscape                                                                                                                      |                                                                                                                                                                                                     |
| Name of the Software : MALAB Script                   |                                                                                                                                                                                                                |                                                                                                                                                                                                     |
| Module 1- Exercises                                   |                                                                                                                                                                                                                | Learning Link                                                                                                                                                                                       |
| 1                                                     | MATLAB Desktop Tools and Troubleshooting Scripts<br>Get acquainted with MATLAB tools to help you work more efficiently in the environment.                                                                     | <a href="#">MATLAB Desktop Tools and Troubleshooting Scripts   Self-Paced Online Courses</a>                                                                                                        |
| 2                                                     | Explore Data with MATLAB Plots<br>Customize, annotate, and export a variety of visualizations.                                                                                                                 | <a href="https://matlabacademy.mathworks.com/details/explore-data-with-matlab-plots/otmledp">https://matlabacademy.mathworks.com/details/explore-data-with-matlab-plots/otmledp</a>                 |
| 3                                                     | Build a visualization for daily power usage.                                                                                                                                                                   |                                                                                                                                                                                                     |
| Module 2-Exercises                                    |                                                                                                                                                                                                                | Learning Link                                                                                                                                                                                       |
| 1                                                     | Make and Manipulate Matrices<br>Learn to create arrays in MATLAB with concatenation to build new matrices from existing ones, array creation functions, reshaping arrays, and indexing to extract submatrices. | <a href="https://matlabacademy.mathworks.com/details/make-and-manipulate-matrices/otmlmmm">https://matlabacademy.mathworks.com/details/make-and-manipulate-matrices/otmlmmm</a>                     |
| 2                                                     | Calculations with Vectors and Matrices<br>Apply mathematical and statistical operations to vectors and matrices.                                                                                               | <a href="https://matlabacademy.mathworks.com/details/calculations-with-vectors-and-matrices/otmlcvm">https://matlabacademy.mathworks.com/details/calculations-with-vectors-and-matrices/otmlcvm</a> |
| 3                                                     | Evaluate energy consumption over time using matrix operations.                                                                                                                                                 |                                                                                                                                                                                                     |
| Module 3-Exercises                                    |                                                                                                                                                                                                                | Learning Link                                                                                                                                                                                       |
| 1                                                     | Tables<br>Import, manage, and manipulate tabular data.                                                                                                                                                         | <a href="https://matlabacademy.mathworks.com/details/tables/otmltab">https://matlabacademy.mathworks.com/details/tables/otmltab</a>                                                                 |
| 2                                                     | Find and Extract Subsets of Data<br>Use logical indexing to filter data and count elements.                                                                                                                    | <a href="https://matlabacademy.mathworks.com/details/find-and-extract-subsets-of-data/otmlesd">https://matlabacademy.mathworks.com/details/find-and-extract-subsets-of-data/otmlesd</a>             |
| 3                                                     | Create a table for daily energy consumption                                                                                                                                                                    |                                                                                                                                                                                                     |
| Module 4-Exercises                                    |                                                                                                                                                                                                                | Learning Link                                                                                                                                                                                       |
| 1                                                     | Programming Constructs<br>Explore programming constructs like if-else, switch-case, for, and while.                                                                                                            | <a href="https://matlabacademy.mathworks.com/details/programming-constructs/otmlprc">https://matlabacademy.mathworks.com/details/programming-constructs/otmlprc</a>                                 |
| 2                                                     | The How and Why of Writing Functions<br>Increase the flexibility of your code by writing custom functions.                                                                                                     | <a href="https://matlabacademy.mathworks.com/details/the-how-and-why-of-writing-functions/otmlhwhf">https://matlabacademy.mathworks.com/details/the-how-and-why-of-writing-functions/otmlhwhf</a>   |



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|                                                                                                                                                                  |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-------|------|------|------|
| 3                                                                                                                                                                | Write a program using <b>if-else</b> to calculate electricity bill.                                                                                                            |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| Module 5-Exercises                                                                                                                                               |                                                                                                                                                                                | Learning Link                                                                                                                                                                                           |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Circuit Simulation Onramp<br>Learn the basics of simulating electrical circuits in Simscape.                                                                                   | <a href="https://matlabacademy.mathworks.com/details/circuit-simulation-onramp/circuits">https://matlabacademy.mathworks.com/details/circuit-simulation-onramp/circuits</a>                             |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Motor Modeling with Simscape Electrical<br>Learn to create medium and high-fidelity electric motor models in Simscape Electrical and connect them to a controller in Simulink. | <a href="https://matlabacademy.mathworks.com/details/motor-modeling-with-simscape-electrical/otslmmse">https://matlabacademy.mathworks.com/details/motor-modeling-with-simscape-electrical/otslmmse</a> |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                | Create a <b>DC motor model</b> and plot speed vs time.                                                                                                                         |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| TOTAL PERIODS                                                                                                                                                    |                                                                                                                                                                                | 45                                                                                                                                                                                                      |     |     |     |     |     |     |     |      |       |      |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| After completion of the course, students will be able to:                                                                                                        |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Use MATLAB desktop tools effectively for scripting, debugging, and troubleshooting.                                                                                            |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Create and manipulate matrices and perform numerical computations using MATLAB.                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                | Visualize, analyze, and extract meaningful information from data using MATLAB plots and tables.                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 4                                                                                                                                                                | Develop MATLAB programs using control structures and user-defined functions.                                                                                                   |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 5                                                                                                                                                                | Model and simulate electrical circuits and motor systems using Simscape and Simulink.                                                                                          |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, 6th Edition, Elsevier, 2022.                                                              |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Holly Moore, MATLAB <i>for Engineers</i> , 5th Edition, Pearson Education, 2017.                                                                                               |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | MathWorks, MATLAB Documentation, The MathWorks Inc., 2023.                                                                                                                     |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Brian Hahn & Daniel Valentine, Essential MATLAB for Engineers and Scientists, 6th Edition, Academic Press, 2019.                                                               |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                                                                                                |                                                                                                                                                                                                         |     |     |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                                                  | PO1                                                                                                                                                                            | PO2                                                                                                                                                                                                     | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              | 1                                                                                                                                                                              | -                                                                                                                                                                                                       | -   | -   | 3   | -   | -   | -   | -   | -    | -     | 3    | 1    | -    |
| CO2                                                                                                                                                              | 2                                                                                                                                                                              | 3                                                                                                                                                                                                       | -   | -   | 2   | -   | -   | -   | -   | -    | -     | 2    | 3    | -    |
| CO3                                                                                                                                                              | 1                                                                                                                                                                              | 2                                                                                                                                                                                                       | -   | 3   | 3   | -   | -   | -   | -   | -    | -     | 3    | 2    | -    |
| CO4                                                                                                                                                              | 2                                                                                                                                                                              | 3                                                                                                                                                                                                       | 2   | -   | 3   | -   | -   | -   | -   | -    | -     | 2    | 3    | -    |
| CO5                                                                                                                                                              | 3                                                                                                                                                                              | 3                                                                                                                                                                                                       | 3   | 2   | 3   | -   | -   | -   | 2   | -    | -     | 3    | 2    | 3    |
| AVG                                                                                                                                                              | 1.8                                                                                                                                                                            | 2.75                                                                                                                                                                                                    | 2.5 | 2.5 | 2.8 | -   | -   | -   | 2   | -    | -     | 2.6  | 2.2  | 3    |





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| Sl.No. | Evaluation Component | Mode of Evaluation                 | Criteria                                  | Weightage (%) |
|--------|----------------------|------------------------------------|-------------------------------------------|---------------|
| 1      | Exercise Uploads     | Upload / Submission                | Accuracy, completeness, timeliness        | 60            |
| 2      | Testing              | Demonstration or practical testing | Functionality, correctness, performance   | 30            |
| 3      | Viva                 | Oral questioning                   | Concept understanding, application skills | 10            |



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|                                                              |                                                                                                                                                                                                                                                                                                                                    |                                                                                                                   |
|--------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| U24EE404                                                     | PCB Design and Product Development using KiCAD                                                                                                                                                                                                                                                                                     | 45                                                                                                                |
| <b>Self learning Course Objectives- Product base outcome</b> |                                                                                                                                                                                                                                                                                                                                    |                                                                                                                   |
| 1                                                            | To introduce students to the fundamentals of PCB design flow and KiCad design environment.                                                                                                                                                                                                                                         |                                                                                                                   |
| 2                                                            | To develop skills in schematic capture, circuit validation, and footprint assignment                                                                                                                                                                                                                                               |                                                                                                                   |
| 3                                                            | To enable students to design single-layer and multi-layer PCB layouts following industry standards.                                                                                                                                                                                                                                |                                                                                                                   |
| 4                                                            | To familiarize students with PCB manufacturing outputs such as Gerber and drill files.                                                                                                                                                                                                                                             |                                                                                                                   |
| 5                                                            | To apply PCB design knowledge in developing real-time, product-oriented embedded systems.                                                                                                                                                                                                                                          |                                                                                                                   |
| <b>Name of the Software : KiCAD</b>                          |                                                                                                                                                                                                                                                                                                                                    |                                                                                                                   |
| <b>Module 1- Exercises</b>                                   |                                                                                                                                                                                                                                                                                                                                    | <b>Learning Link</b>                                                                                              |
| 1                                                            | <b>Introduction to KiCad &amp; PCB Design Basics</b>                                                                                                                                                                                                                                                                               | <a href="https://www.kicad.org/">https://www.kicad.org/</a>                                                       |
| 2                                                            | <ul style="list-style-type: none"> <li>Overview of PCB design flow</li> <li>Introduction to KiCad suite (Schematic Editor, PCB Editor, Symbol &amp; Footprint Libraries)</li> <li>Setting up KiCad projects</li> <li>Understanding schematic symbols and footprints</li> <li>Basic electrical rules and design concepts</li> </ul> | <a href="https://youtu.be/8tDqHPajY8o?si=Mt_ru e4KzktLF4ha">https://youtu.be/8tDqHPajY8o?si=Mt_ru e4KzktLF4ha</a> |
| 3                                                            | Design a current-limiting LED circuit using a DC supply in KiCad.                                                                                                                                                                                                                                                                  |                                                                                                                   |
| <b>Module 2-Exercises</b>                                    |                                                                                                                                                                                                                                                                                                                                    | <b>Learning Link</b>                                                                                              |
| 1                                                            | <b>Schematic Capture &amp; Circuit Validation</b>                                                                                                                                                                                                                                                                                  | <a href="https://www.kicad.org/discover/schematic-capture/">https://www.kicad.org/discover/schematic-capture/</a> |
| 2                                                            | <ul style="list-style-type: none"> <li>Creating complete schematics</li> <li>Component annotation and net labeling</li> <li>Power symbols and hierarchical schematics</li> <li>Electrical Rules Check (ERC)</li> <li>Assigning footprints to schematic symbols</li> </ul>                                                          | <a href="https://youtu.be/3E5REDAQk_A?si=KzL4QEtmICKitSWi">https://youtu.be/3E5REDAQk_A?si=KzL4QEtmICKitSWi</a>   |
| 3                                                            | Design a 5V regulated power supply schematic using bridge rectifier, filter capacitor, and 7805 regulator.                                                                                                                                                                                                                         |                                                                                                                   |
| <b>Module 3-Exercises</b>                                    |                                                                                                                                                                                                                                                                                                                                    | <b>Learning Link</b>                                                                                              |
| 1                                                            | <b>PCB Layout Design</b>                                                                                                                                                                                                                                                                                                           | <a href="https://www.kicad.org/discover/pcb-design/">https://www.kicad.org/discover/pcb-design/</a>               |
| 2                                                            | <ul style="list-style-type: none"> <li>PCB editor overview</li> <li>Board outline creation and layer</li> </ul>                                                                                                                                                                                                                    | <a href="https://youtu.be/3FGNw28xBr0?si=3G">https://youtu.be/3FGNw28xBr0?si=3G</a>                               |



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|                                                     |                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                              |  |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                     | management <ul style="list-style-type: none"><li>• Component placement techniques</li><li>• Routing (manual &amp; basic auto-routing)</li><li>• Ground planes and copper pours</li><li>• Design Rule Check (DRC)</li></ul>                                                                                       | <a href="#">00hUugV0vRYKCE</a>                                                                                                                                                                                               |  |
| 3                                                   | Convert the 5V power supply schematic into a single-layer PCB layout.                                                                                                                                                                                                                                            |                                                                                                                                                                                                                              |  |
| Module 4-Exercises                                  |                                                                                                                                                                                                                                                                                                                  | Learning Link                                                                                                                                                                                                                |  |
| 1                                                   | Advanced PCB Design & Manufacturing Outputs                                                                                                                                                                                                                                                                      | <a href="#">KiCad - Schematic Capture &amp; PCB Design Software</a>                                                                                                                                                          |  |
| 2                                                   | <ul style="list-style-type: none"><li>• Multi-layer PCB concepts</li><li>• Differential pairs and impedance basics</li><li>• Thermal reliefs and vias</li><li>• Silkscreen, solder mask, and drill files</li><li>• Generating Gerber and drill files</li><li>• PCB fabrication and assembly guidelines</li></ul> | <a href="https://youtu.be/3E5REDAQk_A?si=LY3Vr9Jhkoo_LKUS">https://youtu.be/3E5REDAQk_A?si=LY3Vr9Jhkoo_LKUS</a>                                                                                                              |  |
| 3                                                   | Upgrade the power supply PCB to a double-layer board and generate fabrication files.                                                                                                                                                                                                                             |                                                                                                                                                                                                                              |  |
| Module 5-Exercises                                  |                                                                                                                                                                                                                                                                                                                  | Learning Link                                                                                                                                                                                                                |  |
| 1                                                   | Product Development & Real-Time Applications                                                                                                                                                                                                                                                                     | <a href="#">KiCad - Schematic Capture &amp; PCB Design Software</a>                                                                                                                                                          |  |
| 2                                                   | <ul style="list-style-type: none"><li>• CB design for embedded systems</li><li>• Power electronics PCB design basics</li><li>• Noise reduction and EMI considerations</li><li>• PCB testing, debugging, and rework</li></ul>                                                                                     | <a href="https://youtu.be/aVUgaB0IMh4?si=Fu5hJifHzfiJY300">https://youtu.be/aVUgaB0IMh4?si=Fu5hJifHzfiJY300</a><br><br><a href="https://www.youtube.com/watch?v=TvA4ut0o4bc">https://www.youtube.com/watch?v=TvA4ut0o4bc</a> |  |
| 3                                                   | Design a sensor-based embedded PCB (e.g., LM35 + microcontroller + 5V supply).                                                                                                                                                                                                                                   |                                                                                                                                                                                                                              |  |
| TOTAL PERIODS                                       |                                                                                                                                                                                                                                                                                                                  | 45                                                                                                                                                                                                                           |  |
| Course Outcomes                                     |                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                              |  |
| At the end of the course, students will be able to: |                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                              |  |
| CO1                                                 | Explain PCB design flow, KiCad tools, and basic electrical design rules.                                                                                                                                                                                                                                         |                                                                                                                                                                                                                              |  |
| CO2                                                 | Create and validate complete schematics with proper annotation and footprint assignment.                                                                                                                                                                                                                         |                                                                                                                                                                                                                              |  |
| CO3                                                 | Design single-layer PCB layouts with effective component placement and routing.                                                                                                                                                                                                                                  |                                                                                                                                                                                                                              |  |
| CO4                                                 | Generate multi-layer PCB designs and fabrication-ready manufacturing files.                                                                                                                                                                                                                                      |                                                                                                                                                                                                                              |  |
| CO5                                                 | Develop product-based embedded PCBs considering EMI, testing, and real-time applications.                                                                                                                                                                                                                        |                                                                                                                                                                                                                              |  |
| TEXTBOOKS                                           |                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                              |  |
| 1                                                   | Peter Dalmaris, <i>KiCad Like a Pro: Fundamentals and Projects</i> , Elektor / Tech Explorations,                                                                                                                                                                                                                |                                                                                                                                                                                                                              |  |



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|                                                                                                                                                                         |                                                                                                                  |      |      |      |      |     |     |     |      |      |       |      |      |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|------|------|------|------|-----|-----|-----|------|------|-------|------|------|------|
|                                                                                                                                                                         | 2024.                                                                                                            |      |      |      |      |     |     |     |      |      |       |      |      |      |
| 2                                                                                                                                                                       | Peter Wilson, <i>The Circuit Designer’s Companion</i> , Elsevier (Newnes), 4th Edition, 2017.                    |      |      |      |      |     |     |     |      |      |       |      |      |      |
| REFERENCE BOOKS                                                                                                                                                         |                                                                                                                  |      |      |      |      |     |     |     |      |      |       |      |      |      |
| 1                                                                                                                                                                       | Paul Scherz & Simon Monk, <i>Practical Electronics for Inventors</i> , McGraw-Hill Education, 4th Edition, 2016. |      |      |      |      |     |     |     |      |      |       |      |      |      |
| 2                                                                                                                                                                       | Bruce R. Archambeault, <i>PCB Design for Real-World EMI Control</i> , Springer / Prentice Hall, 2010.            |      |      |      |      |     |     |     |      |      |       |      |      |      |
| 3                                                                                                                                                                       | Johnson, H. & Graham, M., <i>High-Speed Digital Design</i> , Prentice Hall, 1993.                                |      |      |      |      |     |     |     |      |      |       |      |      |      |
| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                                  |      |      |      |      |     |     |     |      |      |       |      |      |      |
|                                                                                                                                                                         | PO1                                                                                                              | PO2  | PO3  | PO4  | PO5  | PO6 | PO7 | PO8 | PO9  | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                     | 3                                                                                                                | 2    | –    | –    | 2    | –   | –   | –   | –    | –    | –     | 2    | –    | –    |
| CO2                                                                                                                                                                     | 3                                                                                                                | 3    | 2    | 2    | 3    | –   | –   | –   | –    | –    | –     | 3    | 2    | –    |
| CO3                                                                                                                                                                     | 2                                                                                                                | 3    | 3    | 2    | 3    | –   | –   | –   | 2    | –    | –     | 3    | 2    | 2    |
| CO4                                                                                                                                                                     | 2                                                                                                                | 2    | 3    | 3    | 3    | –   | –   | –   | –    | –    | 2     | 3    | 3    | 2    |
| CO5                                                                                                                                                                     | 2                                                                                                                | 3    | 3    | 3    | 3    | 2   | 2   | –   | 3    | 2    | 2     | 3    | 3    | 3    |
| AVG                                                                                                                                                                     | 2.40                                                                                                             | 2.60 | 2.75 | 2.50 | 2.80 | 2   | 2   | –   | 2.50 | 2    | 2     | 2.80 | 2.50 | 2.33 |



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|                                                       |                                                                                                                                                       |                                                                                                                                                                                                                |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U24EE501                                              | OrCAD : From Schematic Design to PCB Implementation                                                                                                   | 45                                                                                                                                                                                                             |
| Self learning Course Objectives- Product base outcome |                                                                                                                                                       |                                                                                                                                                                                                                |
| 1                                                     | To understand the features, tools, and interface of OrCAD software.                                                                                   |                                                                                                                                                                                                                |
| 2                                                     | To develop skills in schematic entry, component management, and PCB layout design.                                                                    |                                                                                                                                                                                                                |
| 3                                                     | To apply advanced PCB techniques, including 3D visualization and power plane management.                                                              |                                                                                                                                                                                                                |
| 4                                                     | To learn design reuse, replication, and finalization techniques for PCB projects.                                                                     |                                                                                                                                                                                                                |
| 5                                                     | To implement and translate power circuit designs, such as buck converters, into PCB layouts.                                                          |                                                                                                                                                                                                                |
| Name of the Software OrCAD                            |                                                                                                                                                       |                                                                                                                                                                                                                |
| Module 1- Exercises                                   |                                                                                                                                                       | Learning Link                                                                                                                                                                                                  |
| 1                                                     | Introduction to OrCAD & Tools Overview                                                                                                                | <a href="https://www.youtube.com/watch?v=8QZsqMVccrs">https://www.youtube.com/watch?v=8QZsqMVccrs</a> )                                                                                                        |
| 2                                                     | Schematic Entry using OrCAD Capture Importing and Adding Parts from Library in OrCAD Capture Part Symbols                                             | <a href="https://www.youtube.com/watch?v=SwKKlfzKtvs">https://www.youtube.com/watch?v=SwKKlfzKtvs</a>                                                                                                          |
| 3                                                     | Component Libraries & Part Management                                                                                                                 | <a href="https://www.youtube.com/watch?v=SwKKlfzKtvs">https://www.youtube.com/watch?v=SwKKlfzKtvs</a>                                                                                                          |
| Module 2-Exercises                                    |                                                                                                                                                       | Learning Link                                                                                                                                                                                                  |
| 1                                                     | From Schematic to PCB Layout                                                                                                                          | <a href="https://www.youtube.com/watch?v=2k-7G8Rvw1M">https://www.youtube.com/watch?v=2k-7G8Rvw1M</a>                                                                                                          |
| 2                                                     | PCB Component Placement & Routing                                                                                                                     | <a href="https://www.youtube.com/watch?v=VCGcHU_3kR8">https://www.youtube.com/watch?v=VCGcHU_3kR8</a>                                                                                                          |
| Module 3-Exercises                                    |                                                                                                                                                       | Learning Link                                                                                                                                                                                                  |
| 1                                                     | Advanced PCB Features (Planes & 3D View)                                                                                                              | <a href="https://www.youtube.com/watch?v=ZDIhdMQbjlw">https://www.youtube.com/watch?v=ZDIhdMQbjlw</a><br><a href="https://www.youtube.com/watch?v=XpkUjFDAC1c">https://www.youtube.com/watch?v=XpkUjFDAC1c</a> |
| Module 4-Exercises                                    |                                                                                                                                                       | Learning Link                                                                                                                                                                                                  |
| 1                                                     | Design Reuse & Replication                                                                                                                            | <a href="https://www.youtube.com/watch?v=GwgPqPuuw2U">https://www.youtube.com/watch?v=GwgPqPuuw2U</a>                                                                                                          |
| 2                                                     | Finalizing PCB & Generating Outputs                                                                                                                   | <a href="https://www.youtube.com/watch?v=2cT5XsfS4xE">https://www.youtube.com/watch?v=2cT5XsfS4xE</a>                                                                                                          |
| Module 5-Exercises                                    |                                                                                                                                                       | Learning Link                                                                                                                                                                                                  |
| 1                                                     | PCB Layout (Optional Advanced Module)<br>Translating a buck converter circuit to PCB using OrCAD PCB Designer<br>Layout guidelines for power circuits | <a href="https://youtu.be/nnkb_gH1zGg">https://youtu.be/nnkb_gH1zGg</a>                                                                                                                                        |
| TOTAL PERIODS                                         |                                                                                                                                                       | 45                                                                                                                                                                                                             |



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| Course Outcomes                                                                                                                            |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|------|------|------|
| At the completion of course students can able to                                                                                           |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 1                                                                                                                                          | Create and manage schematics using OrCAD tools and libraries accurately.          |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 2                                                                                                                                          | Convert schematics into PCB layouts with proper component placement and routing.  |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 3                                                                                                                                          | Implement power/ground planes and visualize PCB designs in 3D.                    |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 4                                                                                                                                          | Replicate design elements and generate fabrication-ready PCB outputs.             |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 5                                                                                                                                          | Design and layout power circuits on PCB following standard guidelines             |     |     |     |     |     |     |     |     |       |       |      |      |      |
| TEXTBOOKS                                                                                                                                  |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 1                                                                                                                                          | PSpice for Basic Circuit Analysis – Tay Vaughan, Wiley, 2010.                     |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 2                                                                                                                                          | ORCAD PSpice for Circuit Theory and Electronic Devices – Azizoğlu, Pearson, 2017. |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 3                                                                                                                                          | PCB Design Using ORCAD Capture & PCB Editor – Kraig Mitzner, Newnes, 2010.        |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 4                                                                                                                                          | Electronic Circuit Simulation with PSpice – M. Mahadevan, McGraw-Hill, 2016.      |     |     |     |     |     |     |     |     |       |       |      |      |      |
| REFERENCE BOOKS                                                                                                                            |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 1                                                                                                                                          | PSpice A/D User’s Guide – Cadence/Orcad Inc., 2023                                |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 2                                                                                                                                          | OrCAD Capture User’s Guide – Cadence/Orcad Inc., 2023.                            |     |     |     |     |     |     |     |     |       |       |      |      |      |
| 3                                                                                                                                          | PCB Design Techniques for EMC – Johnson & Graham, Wiley, 2012.                    |     |     |     |     |     |     |     |     |       |       |      |      |      |
| CO/PO, PSO Mapping                                                                                                                         |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
| (3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                   |     |     |     |     |     |     |     |     |       |       |      |      |      |
| CO/PO                                                                                                                                      | PO1                                                                               | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                        | 3                                                                                 | 2   | 1   | 1   | 3   | –   | –   | –   | 1   | 2     | 1     | 3    | 3    | 2    |
| CO2                                                                                                                                        | 2                                                                                 | 3   | 2   | 1   | 3   | –   | –   | –   | 1   | 2     | 1     | 3    | 3    | 2    |
| CO3                                                                                                                                        | 2                                                                                 | 3   | 2   | 1   | 3   | –   | –   | –   | 1   | 2     | 1     | 3    | 3    | 2    |
| CO4                                                                                                                                        | 2                                                                                 | 2   | 3   | 2   | 3   | –   | –   | –   | 1   | 2     | 1     | 3    | 2    | 2    |
| CO5                                                                                                                                        | 2                                                                                 | 2   | 3   | 2   | 3   | –   | –   | –   | 1   | 2     | 1     | 2    | 2    | 3    |
| AVG                                                                                                                                        | 2.2                                                                               | 2.4 | 2.2 | 1.4 | 3   | -   | -   | -   | 1   | 2     | 1     | 2.8  | 2.6  | 2.2  |

| Sl.No. | Evaluation Component | Mode of Evaluation                 | Criteria                                  | Weightage (%) |
|--------|----------------------|------------------------------------|-------------------------------------------|---------------|
| 1      | Exercise Uploads     | Upload / Submission                | Accuracy, completeness, timeliness        | 60            |
| 2      | Testing              | Demonstration or practical testing | Functionality, correctness, performance   | 30            |
| 3      | Viva                 | Oral questioning                   | Concept understanding, application skills | 10            |



|                                                       |                                                                                                                                                               |                                                            |                                                                                                       |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
| U24EE603                                              |                                                                                                                                                               | LabVIEW & Virtual Instrumentation: Motor Modeling, Control | 45                                                                                                    |
| Self learning Course Objectives- Product base outcome |                                                                                                                                                               |                                                            |                                                                                                       |
| 1                                                     | To understand the fundamentals of LabVIEW and virtual instrumentation concepts.                                                                               |                                                            |                                                                                                       |
| 2                                                     | To model and simulate electrical machines using LabVIEW                                                                                                       |                                                            |                                                                                                       |
| 3                                                     | To analyze speed–torque characteristics of DC, induction, stepper, and BLDC motors.                                                                           |                                                            |                                                                                                       |
| 4                                                     | To implement control strategies for electrical drives using LabVIEW toolkits.                                                                                 |                                                            |                                                                                                       |
| 5                                                     | To interface LabVIEW with real-time hardware for motor drive control and data acquisition.                                                                    |                                                            |                                                                                                       |
| Name of the Software : LABVIEW                        |                                                                                                                                                               |                                                            |                                                                                                       |
| Module 1- Exercises                                   |                                                                                                                                                               |                                                            | Learning Link                                                                                         |
| 1                                                     | Introduction to LabVIEW & Virtual Instrumentation                                                                                                             |                                                            | <a href="https://youtu.be/LXvlo6hkTW8">https://youtu.be/LXvlo6hkTW8</a>                               |
| 2                                                     | DC Motor Characteristics - Build VI to simulate DC motor model<br>Front panel: Armature voltage input, speed output, torque vs speed graph                    |                                                            | <a href="https://www.youtube.com/watch?v=7OgGejC0_3c">https://www.youtube.com/watch?v=7OgGejC0_3c</a> |
| Module 2-Exercises                                    |                                                                                                                                                               |                                                            | Learning Link                                                                                         |
| 1                                                     | Speed Control of DC Drives - Implement open-loop and closed-loop speed control<br>Use PID controller in LabVIEW Control Design toolkit                        |                                                            | <a href="https://youtu.be/11hi7lGEdyU">https://youtu.be/11hi7lGEdyU</a>                               |
| 2                                                     | Induction Motor Modeling - Simulate single-phase and three-phase induction motor equivalent circuit - Display torque–slip characteristics                     |                                                            | <a href="https://youtu.be/hppq75qkIOA">https://youtu.be/hppq75qkIOA</a>                               |
| Module 3-Exercises                                    |                                                                                                                                                               |                                                            | Learning Link                                                                                         |
| 1                                                     | Speed Control of Induction Motor<br>Scalar control (V/f method) implementation in LabVIEW<br>Vector control (FOC) basics demonstration using LabVIEW toolkits |                                                            | <a href="https://youtu.be/5uuaf9XTsAM">https://youtu.be/5uuaf9XTsAM</a>                               |
| 2                                                     | Stepper Motor Control<br>VI for stepper motor excitation sequence (full step, half step)<br>Control of step angle and RPM via LabVIEW front panel             |                                                            | <a href="https://youtu.be/qwvP2AzoB_M">https://youtu.be/qwvP2AzoB_M</a>                               |
| Module 4-Exercises                                    |                                                                                                                                                               |                                                            | Learning Link                                                                                         |
| 1                                                     | BLDC Motor Simulation<br>Modeling BLDC motor with Hall sensor feedback in LabVIEW<br>Speed vs torque characteristic                                           |                                                            | <a href="https://youtu.be/Wnr2REVii8">https://youtu.be/Wnr2REVii8</a>                                 |
| Module 5-Exercises                                    |                                                                                                                                                               |                                                            | Learning Link                                                                                         |
| 1                                                     | Drive Control with Hardware (DAQ / myRIO)<br>Interfacing LabVIEW with real motor drives using NI-DAQ                                                          |                                                            | <a href="https://youtu.be/zk-Z59Gn9aw">https://youtu.be/zk-Z59Gn9aw</a>                               |
|                                                       |                                                                                                                                                               |                                                            | LABVIEW Material:                                                                                     |



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|                                                                                                                                                                  |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|-----|-----|-----|-----|-----|------|-------|------|------|------|
|                                                                                                                                                                  | Acquiring motor speed, voltage, and current                                                                  | <a href="https://drive.google.com/drive/folders/1vzrX7bGWdRxSqfMPX3kHAOStgk0EmgTX">https://drive.google.com/drive/folders/1vzrX7bGWdRxSqfMPX3kHAOStgk0EmgTX</a> |     |      |     |     |     |     |     |      |       |      |      |      |
| TOTAL PERIODS                                                                                                                                                    |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       | 45   |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| At the end of the course, students will be able to                                                                                                               |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Develop basic LabVIEW VIs for motor modeling and virtual instrumentation.                                    |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Simulate DC motor characteristics and analyze speed–torque performance using LabVIEW.                        |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                | Implement speed control and modeling of DC and induction motor drives using LabVIEW toolkits.                |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 4                                                                                                                                                                | Apply scalar, vector, and stepper motor control techniques through LabVIEW-based simulations.                |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 5                                                                                                                                                                | Interface LabVIEW with DAQ/myRIO hardware to acquire and control real-time motor parameters.                 |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Nesimi Ertugrul, LabVIEW for Electric Circuits, Machines, Drives, and Laboratories, Pearson Education, 2002. |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | National Instruments — LabVIEW Student Edition Textbook — Latest edition (updated annually by NI).           |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                | Robert H. Bishop, Learning with LabVIEW (LabVIEW Student Edition Textbook), Pearson Education, 2007.         |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                | Jovitha Jerome, Virtual Instrumentation Using LabVIEW, PHI Learning, 2010.                                   |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                | Gary W. Johnson, LabVIEW Graphical Programming, McGraw-Hill Education, 2006.                                 |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                | James Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun, Prentice Hall, 2007.             |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                              |                                                                                                                                                                 |     |      |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                                                  | PO1                                                                                                          | PO2                                                                                                                                                             | PO3 | PO4  | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              | 3                                                                                                            | 2                                                                                                                                                               | 1   | –    | 3   | –   | –   | –   | –   | 1    | –     | 2    | 3    | –    |
| CO2                                                                                                                                                              | 3                                                                                                            | 3                                                                                                                                                               | 2   | 2    | 3   | –   | –   | –   | –   | –    | –     | 3    | 2    | –    |
| CO3                                                                                                                                                              | 3                                                                                                            | 3                                                                                                                                                               | 3   | 2    | 3   | –   | –   | –   | –   | –    | –     | 3    | 3    | 2    |
| CO4                                                                                                                                                              | 3                                                                                                            | 2                                                                                                                                                               | 3   | 2    | 3   | –   | –   | –   | 1   | –    | –     | 3    | 3    | 2    |
| CO5                                                                                                                                                              | 3                                                                                                            | 2                                                                                                                                                               | 3   | 3    | 3   | –   | –   | –   | 2   | 1    | 2     | 2    | 3    | 3    |
| AVG                                                                                                                                                              | 3                                                                                                            | 2.4                                                                                                                                                             | 2.4 | 2.25 | 3   | -   | -   | -   | 1.5 | 1    | 2     | 2.6  | 2.8  | 2.33 |





## Meenakshi Sundararajan Engineering College

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Department: Electrical and Electronics Engineering, R2024, CBCS

| Sl.No. | Evaluation Component | Mode of Evaluation                 | Criteria                                  | Weightage (%) |
|--------|----------------------|------------------------------------|-------------------------------------------|---------------|
| 1      | Exercise Uploads     | Upload / Submission                | Accuracy, completeness, timeliness        | 60            |
| 2      | Testing              | Demonstration or practical testing | Functionality, correctness, performance   | 30            |
| 3      | Viva                 | Oral questioning                   | Concept understanding, application skills | 10            |



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|                                                       |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| U24EE702                                              |                                                                                                          | PLC Programming |  | 45                                                                                                                                                                                                                                                                                                                                                    |  |
| Self learning Course Objectives- Product base outcome |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 1                                                     | To understand the architecture, components, and applications of PLCs in industrial automation.           |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 2                                                     | To learn basic PLC programming concepts using ladder logic.                                              |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 3                                                     | To develop logic control programs for combinational and sequential systems.                              |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 4                                                     | To design and simulate real-time industrial control applications using PLC software tools.               |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 5                                                     | To apply PLC programming skills to solve practical automation problems.                                  |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| Name of the Software : PLC                            |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| Module 1- Exercises                                   |                                                                                                          |                 |  | Learning Link                                                                                                                                                                                                                                                                                                                                         |  |
| 1                                                     | Introduction to Program Logic Controllers                                                                |                 |  | <a href="https://youtube.com/playlist?list=PLI78ZBihrkE1yvv_ipdsF24RpDF1Pye-z&amp;si=m1SsBONrYFIVcUAP">https://youtube.com/playlist?list=PLI78ZBihrkE1yvv_ipdsF24RpDF1Pye-z&amp;si=m1SsBONrYFIVcUAP</a>                                                                                                                                               |  |
| 2                                                     | Types of PLC                                                                                             |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 2                                                     | Draw the block diagram of a PLC-based BMS system (battery pack, sensors, protection).                    |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| Module 2-Exercises                                    |                                                                                                          |                 |  | Learning Link                                                                                                                                                                                                                                                                                                                                         |  |
| 1                                                     | PLC Programming Languages                                                                                |                 |  | <a href="https://youtu.be/ttYLLi6U1jk?si=dGzHGLkD_EHAtSI8">https://youtu.be/ttYLLi6U1jk?si=dGzHGLkD_EHAtSI8</a>                                                                                                                                                                                                                                       |  |
| 2                                                     | Introduction to Ladder Logic                                                                             |                 |  | <a href="https://youtu.be/-Wln84DKtRw?si=FqWyAAUxJIDTyzcZ">https://youtu.be/-Wln84DKtRw?si=FqWyAAUxJIDTyzcZ</a>                                                                                                                                                                                                                                       |  |
| 3                                                     | Write and simulate a Start/Stop control ladder program for a lamp                                        |                 |  | <a href="https://youtu.be/c4cEeA6mdq0?si=zrXat5udveHCGAHQ">https://youtu.be/c4cEeA6mdq0?si=zrXat5udveHCGAHQ</a>                                                                                                                                                                                                                                       |  |
| Module 3-Exercises                                    |                                                                                                          |                 |  | Learning Link                                                                                                                                                                                                                                                                                                                                         |  |
| 1                                                     | Logic Operations and Control Applications                                                                |                 |  | <a href="https://www.youtube.com/watch?v=C_945K3iyfvY&amp;list=PLI78ZBihrkE1yvv_ipdsF24RpDF1Pye-z&amp;index=8">https://www.youtube.com/watch?v=C_945K3iyfvY&amp;list=PLI78ZBihrkE1yvv_ipdsF24RpDF1Pye-z&amp;index=8</a>                                                                                                                               |  |
| 2                                                     | Implementation of logic gates (AND, OR, NOT, XOR) using Ladder Logic                                     |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| 3                                                     | Traffic Light Control Simulation using Ladder Logic                                                      |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| Module 4-Exercises                                    |                                                                                                          |                 |  | Learning Link                                                                                                                                                                                                                                                                                                                                         |  |
| 1                                                     | PLC-Based Industrial Control Systems                                                                     |                 |  | <a href="https://youtu.be/c0evyu7Mx_M?si=No69ANkqU9aFKONL">https://youtu.be/c0evyu7Mx_M?si=No69ANkqU9aFKONL</a><br><a href="https://youtu.be/5DqD5atDCh0?si=VYJirYLcL8oJvPWH">https://youtu.be/5DqD5atDCh0?si=VYJirYLcL8oJvPWH</a><br><a href="https://youtu.be/qOoHQ0b-d1U?si=BSM0y9BjG9b1YDZm">https://youtu.be/qOoHQ0b-d1U?si=BSM0y9BjG9b1YDZm</a> |  |
| 2                                                     | Automatic street lighting.<br>Conveyor motor control.<br>Tank-level control with alarms.                 |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
|                                                       |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| Module 5-Exercises                                    |                                                                                                          |                 |  | Learning Link                                                                                                                                                                                                                                                                                                                                         |  |
| 1                                                     | PLC programming                                                                                          |                 |  | <a href="https://youtu.be/ksQrkag-nHI?si=N9CAOe0XKHnqhnc8">https://youtu.be/ksQrkag-nHI?si=N9CAOe0XKHnqhnc8</a>                                                                                                                                                                                                                                       |  |
| 2                                                     | Build a PLC-based Battery Management System (BMS) Simulation.<br>Battery Charge and Discharge controller |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| TOTAL PERIODS                                         |                                                                                                          |                 |  | 45                                                                                                                                                                                                                                                                                                                                                    |  |
| Course Outcomes                                       |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |
| After completion of this course, Students are able to |                                                                                                          |                 |  |                                                                                                                                                                                                                                                                                                                                                       |  |



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|   |                                                                            |
|---|----------------------------------------------------------------------------|
| 1 | Explain the architecture, components, and working principles of PLCs.      |
| 2 | Develop basic PLC ladder programs using standard programming instructions. |
| 3 | Implement logic gate operations and sequential control using ladder logic. |
| 4 | Design PLC-based control solutions for industrial automation problems.     |
| 5 | Simulate and validate PLC programs using industrial software tools.        |

**TEXTBOOKS**

|   |                                                                                                        |
|---|--------------------------------------------------------------------------------------------------------|
| 1 | Frank D. Petruzella, <i>Programmable Logic Controllers</i> , McGraw-Hill Education, 5th Edition, 2017. |
| 2 | Hugh Jack, <i>Automating Manufacturing Systems with PLCs</i> , Lulu Press, 2019.                       |
| 3 | Siemens AG, <i>PLC Programming with STEP 7</i> , Siemens Press, 2020.                                  |

**REFERENCE BOOKS**

|   |                                                                                                                   |
|---|-------------------------------------------------------------------------------------------------------------------|
| 1 | W. Bolton, <i>Programmable Logic Controllers</i> , Elsevier / Newnes, 6th Edition, 2015.                          |
| 2 | Gary Dunning, <i>Introduction to Programmable Logic Controllers</i> , Cengage Learning, 2018.                     |
| 3 | on Stenerson, <i>Fundamentals of Programmable Logic Controllers, Sensors, and Communications</i> , Pearson, 2019. |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|
| CO1 | 3   | 2   | –   | –   | 2   | –   | –   | –   | –   | –    | –    | 2    | 2    | –    |
| CO2 | 3   | 2   | 2   | –   | 3   | –   | –   | –   | –   | –    | –    | 2    | 3    | –    |
| CO3 | 3   | 3   | 2   | –   | 3   | –   | –   | –   | 1   | –    | –    | 3    | 3    | 2    |
| CO4 | 3   | 3   | 3   | 2   | 3   | –   | –   | –   | 2   | 1    | –    | 3    | 3    | 3    |
| CO5 | 2   | 2   | 3   | 2   | 3   | –   | –   | –   | 2   | –    | 1    | 2    | 3    | 3    |
| AVG | 2.8 | 2.4 | 2.4 | 2   | 2.8 | -   | -   | -   | 1.8 | 1    | 1    | 2.4  | 2.8  | 2.6  |

| Sl.No. | Evaluation Component | Mode of Evaluation                 | Criteria                                  | Weightage (%) |
|--------|----------------------|------------------------------------|-------------------------------------------|---------------|
| 1      | Exercise Uploads     | Upload / Submission                | Accuracy, completeness, timeliness        | 60            |
| 2      | Testing              | Demonstration or practical testing | Functionality, correctness, performance   | 30            |
| 3      | Viva                 | Oral questioning                   | Concept understanding, application skills | 10            |



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| C Language Mastery – Self-Learning Program            |                                                                                              | 45                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-learning Course Objectives- Product base outcome |                                                                                              |                                                                                                                                                                                                                                                                       |
| 1                                                     | Master core C programming concepts to solve real-world problems.                             |                                                                                                                                                                                                                                                                       |
| 2                                                     | Gain proficiency in pointers and dynamic memory management.                                  |                                                                                                                                                                                                                                                                       |
| 3                                                     | Implement fundamental data structures using C for strong internal understanding.             |                                                                                                                                                                                                                                                                       |
| 4                                                     | Strengthen logical and algorithmic problem-solving skills through coding practice.           |                                                                                                                                                                                                                                                                       |
| 5                                                     | Build confidence to clear coding rounds and technical interviews in product-based companies. |                                                                                                                                                                                                                                                                       |
| Name of the Software – Turbo- C++, Dev C++            |                                                                                              |                                                                                                                                                                                                                                                                       |
| Module 1- Exercises                                   |                                                                                              | Learning Link                                                                                                                                                                                                                                                         |
| 1                                                     | Introduction to C                                                                            | <a href="https://www.nesoacademy.org/pl/02-c-programming">https://www.nesoacademy.org/pl/02-c-programming</a>                                                                                                                                                         |
| 2                                                     | Variables, Constant, Keywords                                                                | <a href="https://www.nesoacademy.org/pl/02-c-programming">https://www.nesoacademy.org/pl/02-c-programming</a>                                                                                                                                                         |
| 3                                                     | Basic Input Statements                                                                       | <a href="https://www.nesoacademy.org/pl/02-c-programming">https://www.nesoacademy.org/pl/02-c-programming</a>                                                                                                                                                         |
| Module 2-Exercises                                    |                                                                                              | Learning Link                                                                                                                                                                                                                                                         |
| 1                                                     | Basic Output Statements                                                                      | <a href="https://www.nesoacademy.org/pl/02-c-programming">https://www.nesoacademy.org/pl/02-c-programming</a>                                                                                                                                                         |
| 2                                                     | Operators                                                                                    | <a href="https://www.nesoacademy.org/pl/02-c-programming/02-operators-in-c/01-introduction-to-operators-in-c">https://www.nesoacademy.org/pl/02-c-programming/02-operators-in-c/01-introduction-to-operators-in-c</a>                                                 |
| 3                                                     | Decision Making                                                                              | <a href="https://www.nesoacademy.org/pl/02-c-programming/03-conditionals-and-loops-in-c/01-conditionals-ifelse-nested-if-and-else-if">https://www.nesoacademy.org/pl/02-c-programming/03-conditionals-and-loops-in-c/01-conditionals-ifelse-nested-if-and-else-if</a> |
| Module 3-Exercises                                    |                                                                                              | Learning Link                                                                                                                                                                                                                                                         |
| 1                                                     | Control Statements                                                                           | <a href="https://www.nesoacademy.org/pl/02-c-programming/03-conditionals-and-loops-in-c/01-conditionals-ifelse-nested-if-and-else-if">https://www.nesoacademy.org/pl/02-c-programming/03-conditionals-and-loops-in-c/01-conditionals-ifelse-nested-if-and-else-if</a> |
| 2                                                     | Array – 1D, 2D                                                                               | <a href="https://www.nesoacademy.org/pl/02-c-programming/08-arrays-in-c/01-definition-of-array">https://www.nesoacademy.org/pl/02-c-programming/08-arrays-in-c/01-definition-of-array</a>                                                                             |
| 3                                                     | String                                                                                       | <a href="https://www.nesoacademy.org/pl/02-c-programming/10-strings-in-c/01-basics-of-string-literals">https://www.nesoacademy.org/pl/02-c-programming/10-strings-in-c/01-basics-of-string-literals</a>                                                               |
| Module 4-Exercises                                    |                                                                                              | Learning Link                                                                                                                                                                                                                                                         |
| 1                                                     | Functions                                                                                    | <a href="https://www.nesoacademy.org/pl/02-c-programming/11-function-pointers/01-function-pointers">https://www.nesoacademy.org/pl/02-c-programming/11-function-pointers/01-function-pointers</a>                                                                     |
| 2                                                     | Pointers                                                                                     | <a href="https://www.nesoacademy.org/pl/02-c-programming/09-pointers-in-c/01-introduction-to-pointers-in-c">https://www.nesoacademy.org/pl/02-c-programming/09-pointers-in-c/01-introduction-to-pointers-in-c</a>                                                     |
| 3                                                     | Structure                                                                                    | <a href="https://www.nesoacademy.org/pl/02-c-programming/12-structures-in-c/01-introduction-to-structures-in-c">https://www.nesoacademy.org/pl/02-c-programming/12-structures-in-c/01-introduction-to-structures-in-c</a>                                             |
| Module 5-Exercises                                    |                                                                                              | Learning Link                                                                                                                                                                                                                                                         |
| 1                                                     | Union                                                                                        | <a href="https://www.nesoacademy.org/pl/02-c-programming/13-unions-in-c/01-introduction-to-unions-in-c">https://www.nesoacademy.org/pl/02-c-programming/13-unions-in-c/01-introduction-to-unions-in-c</a>                                                             |
| 2                                                     | File Handling                                                                                | <a href="https://www.nesoacademy.org/pl/02-c-programming/14-file-handling-in-c/01-file-handling-basics-and-motivation">https://www.nesoacademy.org/pl/02-c-programming/14-file-handling-in-c/01-file-handling-basics-and-motivation</a>                               |
| 3                                                     | Special Number patterns                                                                      | <a href="https://www.nesoacademy.org/pl/02-c-programming/04-special-programs-in-c/01-special-programs-in-c-pyramid">https://www.nesoacademy.org/pl/02-c-programming/04-special-programs-in-c/01-special-programs-in-c-pyramid</a>                                     |



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|                                                                                                                                                                  |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------|-----|-----|-------------------------------------------|-----|-----|-----|------|-------|---------------|------|------|
|                                                                                                                                                                  |                                                                                      | <a href="#">of-stars</a> |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| Total Periods                                                                                                                                                    |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       | 45 Periods    |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| At the end of the course, students will be able to                                                                                                               |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 1                                                                                                                                                                | Ability to write efficient and error-free C programs using core concepts.            |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 2                                                                                                                                                                | Improved understanding of pointers, memory management, and system-level programming. |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 3                                                                                                                                                                | Skill to implement basic data structures and algorithms in C.                        |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 4                                                                                                                                                                | Enhanced logical reasoning and problem-solving ability for coding tests.             |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 5                                                                                                                                                                | Confidence to crack technical interviews and product-based placement rounds.         |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 1                                                                                                                                                                | Let Us C – Yashavant Kanetkar                                                        |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 2                                                                                                                                                                | Programming in ANSI C – E. Balagurusamy                                              |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 1                                                                                                                                                                | Expert C Programming: Deep C Secrets – Peter van der Linden                          |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| 2                                                                                                                                                                | C Traps and Pitfalls – Andrew Koenig                                                 |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
|                                                                                                                                                                  | PO1                                                                                  | PO2                      | PO3                                                                                                                           | PO4 | PO5 | PO6                                       | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1          | PSO2 | PSO3 |
| CO1                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| CO2                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| CO3                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| CO4                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| CO5                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| AVG                                                                                                                                                              |                                                                                      |                          | 2                                                                                                                             |     |     |                                           |     |     |     |      | 3     |               |      |      |
| Assessment Plan-100marks                                                                                                                                         |                                                                                      |                          |                                                                                                                               |     |     |                                           |     |     |     |      |       |               |      |      |
| Sr. No.                                                                                                                                                          | Evaluation Component                                                                 |                          | Mode of Evaluation                                                                                                            |     |     | Criteria                                  |     |     |     |      |       | Weightage (%) |      |      |
| 1                                                                                                                                                                | Exercise Uploads                                                                     |                          | Upload / Submission in GIT HUB LINK                                                                                           |     |     | Accuracy, completeness, timeliness        |     |     |     |      |       | 60            |      |      |
| 2                                                                                                                                                                | Testing                                                                              |                          | Demonstration or practical testing in <a href="https://www.hackerrank.com/domains/c">https://www.hackerrank.com/domains/c</a> |     |     | Functionality, correctness, performance   |     |     |     |      |       | 30            |      |      |
| 3                                                                                                                                                                | Viva                                                                                 |                          | Oral questioning                                                                                                              |     |     | Concept understanding, application skills |     |     |     |      |       | 10            |      |      |



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| Independent Study Module (ISM) in Python Programming                                                |                                                                                            | 45                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-learning Course Objectives- Product base outcome                                               |                                                                                            |                                                                                                                                                                                                                                                                                                                               |
| 1                                                                                                   | Master core Python concepts to write clean, efficient, and scalable programs.              |                                                                                                                                                                                                                                                                                                                               |
| 2                                                                                                   | Develop strong logical and problem-solving skills using Python for coding challenges.      |                                                                                                                                                                                                                                                                                                                               |
| 3                                                                                                   | Build proficiency in data structures and algorithms using Python for technical interviews. |                                                                                                                                                                                                                                                                                                                               |
| 4                                                                                                   | Apply Python to real-world tasks such as automation, data handling, and simple projects.   |                                                                                                                                                                                                                                                                                                                               |
| 5                                                                                                   | Gain confidence to clear coding assessments and develop placement-ready Python projects.   |                                                                                                                                                                                                                                                                                                                               |
| Name of the Software – IDLE (built-in Python IDE), Visual Studio Code (VS Code) + Python Extension. |                                                                                            |                                                                                                                                                                                                                                                                                                                               |
| Module 1- Exercises                                                                                 |                                                                                            | Learning Link                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                   | Introduction to Python                                                                     | <a href="https://www.nesoacademy.org/pl/04-python-programming/01-introduction-to-python/01-introduction-to-python-programming">https://www.nesoacademy.org/pl/04-python-programming/01-introduction-to-python/01-introduction-to-python-programming</a>                                                                       |
| 2                                                                                                   | Data Types & Variables                                                                     | <a href="https://www.nesoacademy.org/pl/04-python-programming/02-data-types-and-variables-in-python/01-understanding-arithmetic-operators-through-repl-in-python">https://www.nesoacademy.org/pl/04-python-programming/02-data-types-and-variables-in-python/01-understanding-arithmetic-operators-through-repl-in-python</a> |
| 3                                                                                                   | Operators                                                                                  | <a href="https://www.nesoacademy.org/pl/04-python-programming/04-operators-in-python/01-arithmetic-operators-in-python">https://www.nesoacademy.org/pl/04-python-programming/04-operators-in-python/01-arithmetic-operators-in-python</a>                                                                                     |
| Module 2-Exercises                                                                                  |                                                                                            | Learning Link                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                   | Decision Statement                                                                         | <a href="https://www.nesoacademy.org/pl/04-python-programming/06-conditionals-and-loops-in-python/01-the-if-statement-in-python">https://www.nesoacademy.org/pl/04-python-programming/06-conditionals-and-loops-in-python/01-the-if-statement-in-python</a>                                                                   |
| 2                                                                                                   | Control Statement                                                                          | <a href="https://www.nesoacademy.org/pl/04-python-programming/06-conditionals-and-loops-in-python/01-the-if-statement-in-python">https://www.nesoacademy.org/pl/04-python-programming/06-conditionals-and-loops-in-python/01-the-if-statement-in-python</a>                                                                   |
| 3                                                                                                   | String                                                                                     | <a href="https://www.nesoacademy.org/pl/04-python-programming/03-strings-in-python/01-strings-in-python">https://www.nesoacademy.org/pl/04-python-programming/03-strings-in-python/01-strings-in-python</a>                                                                                                                   |
| Module 3-Exercises                                                                                  |                                                                                            | Learning Link                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                   | Function                                                                                   | <a href="https://www.nesoacademy.org/pl/04-python-programming/08-functions-in-python/01-introduction-to-functions-in-python">https://www.nesoacademy.org/pl/04-python-programming/08-functions-in-python/01-introduction-to-functions-in-python</a>                                                                           |
| 2                                                                                                   | List                                                                                       | <a href="https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python">https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python</a>                                           |
| 3                                                                                                   | Tuples                                                                                     | <a href="https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python">https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python</a>                                           |
| Module 4-Exercises                                                                                  |                                                                                            | Learning Link                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                   | Dictionary                                                                                 | <a href="https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python">https://www.nesoacademy.org/pl/04-python-programming/05-lists-dictionaries-and-tuples-in-python/01-introduction-to-lists-in-python</a>                                           |
| 2                                                                                                   | Sets                                                                                       | <a href="https://www.geeksforgeeks.org/python/python-sets/">https://www.geeksforgeeks.org/python/python-sets/</a>                                                                                                                                                                                                             |
| 3                                                                                                   | Built in Function                                                                          | <a href="https://www.nesoacademy.org/pl/04-python-programming/09-builtin-functions-in-python/01-python-builtin-functions-type">https://www.nesoacademy.org/pl/04-python-programming/09-builtin-functions-in-python/01-python-builtin-functions-type</a>                                                                       |
| Module 5-Exercises                                                                                  |                                                                                            | Learning Link                                                                                                                                                                                                                                                                                                                 |
| 1                                                                                                   | File handling                                                                              | <a href="https://www.nesoacademy.org/pl/04-python-programming/11-file-handling-in-python/01-introduction-to-file-handling">https://www.nesoacademy.org/pl/04-python-programming/11-file-handling-in-python/01-introduction-to-file-handling</a>                                                                               |
| 2                                                                                                   | Numpy, Matplotlib                                                                          | <a href="https://www.geeksforgeeks.org/python/introduction-to-numpy/">https://www.geeksforgeeks.org/python/introduction-to-numpy/</a><br><a href="https://www.geeksforgeeks.org/python/python-introduction-matplotlib/">https://www.geeksforgeeks.org/python/python-introduction-matplotlib/</a>                              |



|                                                                                                                                                                  |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-------------------------------------------|-----|-----|-----|-----|------|---------------|------|------|------|
| 3                                                                                                                                                                | Special Program in Python                                                                 | <a href="https://www.nesoacademy.org/pl/04-python-programming/07-python-special-programs/01-python-special-programs-separating-even-and-odd-numbers">https://www.nesoacademy.org/pl/04-python-programming/07-python-special-programs/01-python-special-programs-separating-even-and-odd-numbers</a> |     |     |                                           |     |     |     |     |      |               |      |      |      |
| Total Periods                                                                                                                                                    |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      | 45 Periods    |      |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| At the end of the course, students will be able to                                                                                                               |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 1                                                                                                                                                                | Ability to write efficient Python programs using core programming concepts.               |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 2                                                                                                                                                                | Improved logical thinking and problem-solving skills for coding challenges.               |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 3                                                                                                                                                                | Proficiency in implementing data structures and algorithms using Python.                  |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 4                                                                                                                                                                | Skill to apply Python for real-world tasks, automation, and mini-projects.                |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 5                                                                                                                                                                | Confidence to perform well in coding assessments and technical interviews.                |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 1                                                                                                                                                                | Core Python Programming – R. Nageswara Rao                                                |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 2                                                                                                                                                                | Programming and Problem Solving with Python – Ashok Namdev Kamthane & Amit Ashok Kamthane |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 1                                                                                                                                                                | Python Programming Using Problem Solving Approach – Reema Thareja                         |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| 2                                                                                                                                                                | Fundamentals of Python Programming – Mohit Kumar                                          |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
|                                                                                                                                                                  | PO1                                                                                       | PO2                                                                                                                                                                                                                                                                                                 | PO3 | PO4 | PO5                                       | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11         | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| CO2                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| CO3                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| CO4                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| CO5                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| AVG                                                                                                                                                              |                                                                                           |                                                                                                                                                                                                                                                                                                     | 2   |     |                                           |     |     |     |     |      | 3             |      |      |      |
| Assessment Plan-100marks                                                                                                                                         |                                                                                           |                                                                                                                                                                                                                                                                                                     |     |     |                                           |     |     |     |     |      |               |      |      |      |
| Sr. No.                                                                                                                                                          | Evaluation Component                                                                      | Mode of Evaluation                                                                                                                                                                                                                                                                                  |     |     | Criteria                                  |     |     |     |     |      | Weightage (%) |      |      |      |
| 1                                                                                                                                                                | Exercise Uploads                                                                          | Upload / Submission in GIT HUB LINK                                                                                                                                                                                                                                                                 |     |     | Accuracy, completeness, timeliness        |     |     |     |     |      | 60            |      |      |      |
| 2                                                                                                                                                                | Testing                                                                                   | Demonstration or practical testing in <a href="https://www.hackerrank.com/domains/python">https://www.hackerrank.com/domains/python</a>                                                                                                                                                             |     |     | Functionality, correctness, performance   |     |     |     |     |      | 30            |      |      |      |
| 3                                                                                                                                                                | Viva                                                                                      | Oral questioning                                                                                                                                                                                                                                                                                    |     |     | Concept understanding, application skills |     |     |     |     |      | 10            |      |      |      |





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| Java Essentials: Academic Independent Study                                     |                                                                                                        | 45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-learning Course Objectives- Product base outcome                           |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 1                                                                               | Master core Java programming concepts to write efficient, industry-standard code.                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 2                                                                               | Develop strong understanding of Object-Oriented Programming (OOP) for designing scalable applications. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 3                                                                               | Gain proficiency in Java-based data structures and algorithms used in coding interviews.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4                                                                               | Strengthen logical thinking and problem-solving skills through hands-on Java coding practice.          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5                                                                               | Build confidence to clear coding assessments, technical interviews, and Java-based placement tasks.    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Name of the Software – JDK + Command Prompt/Terminal, Eclipse IDE, NetBeans IDE |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Module 1- Exercises                                                             |                                                                                                        | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                                                                               | Introduction to Java, data types, variables                                                            | <a href="https://www.geeksforgeeks.org/introduction-to-java/">https://www.geeksforgeeks.org/introduction-to-java/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 2                                                                               | Operators and Expressions                                                                              | <a href="https://www.geeksforgeeks.org/operators-in- java/?ref=lbp">https://www.geeksforgeeks.org/operators-in- java/?ref=lbp</a><br><a href="https://www.programiz.com/java- programming/expressions-statements-blocks">https://www.programiz.com/java- programming/expressions-statements-blocks</a>                                                                                                                                                                                                                                                                                           |
| 3                                                                               | Control Flow Statements                                                                                | <a href="https://www.geeksforgeeks.org/decision-making- javaif-else-switch-break-continue-jump/">https://www.geeksforgeeks.org/decision-making- javaif-else-switch-break-continue-jump/</a><br><a href="https://www.geeksforgeeks.org/loops-in- java/?ref=lbp">https://www.geeksforgeeks.org/loops-in- java/?ref=lbp</a>                                                                                                                                                                                                                                                                         |
| Module 2-Exercises                                                              |                                                                                                        | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                                                                               | Methods                                                                                                | <a href="https://www.geeksforgeeks.org/methods-in-java/">https://www.geeksforgeeks.org/methods-in-java/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2                                                                               | Arrays and Strings                                                                                     | <a href="https://www.w3schools.com/java/java_arrays.asp">https://www.w3schools.com/java/java_arrays.asp</a><br><a href="https://www.w3schools.com/java/java_strings.asp">https://www.w3schools.com/java/java_strings.asp</a>                                                                                                                                                                                                                                                                                                                                                                     |
| 3                                                                               | Object- Oriented Programming in Java                                                                   | <a href="https://www.geeksforgeeks.org/object-oriented-programming-oops-concept-in-java">https://www.geeksforgeeks.org/object-oriented-programming-oops-concept-in-java</a>                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Module 3-Exercises                                                              |                                                                                                        | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                                                                               | Exception Handling                                                                                     | <a href="https://www.geeksforgeeks.org/exceptions-in-java/">https://www.geeksforgeeks.org/exceptions-in-java/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2                                                                               | Java Collections Framework                                                                             | <a href="https://www.geeksforgeeks.org/collections-in-java-2/">https://www.geeksforgeeks.org/collections-in-java-2/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3                                                                               | Functional Programming in Java                                                                         | <a href="https://www.geeksforgeeks.org/functional-programming- in-java-with-examples/">https://www.geeksforgeeks.org/functional-programming- in-java-with-examples/</a>                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Module 4-Exercises                                                              |                                                                                                        | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 1                                                                               | Java I/O and File Handling                                                                             | <a href="https://www.geeksforgeeks.org/file-handling-in-java/">https://www.geeksforgeeks.org/file-handling-in-java/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2                                                                               | Multithreading and Concurrency                                                                         | <a href="https://www.geeksforgeeks.org/decision-making- javaif-else-switch-break-continue-jump/">https://www.geeksforgeeks.org/decision-making- javaif-else-switch-break-continue-jump/</a><br><a href="https://www.geeksforgeeks.org/loops-in- java/?ref=lbp">https://www.geeksforgeeks.org/loops-in- java/?ref=lbp</a><br><a href="https://www.geeksforgeeks.org/multithreading-in-java/">https://www.geeksforgeeks.org/multithreading-in-java/</a><br><a href="https://www.geeksforgeeks.org/java-util-concurrent- package/">https://www.geeksforgeeks.org/java-util-concurrent- package/</a> |
| 3                                                                               | Introduction to Reactive                                                                               | <a href="https://www.baeldung.com/cs/reactive-programming">https://www.baeldung.com/cs/reactive-programming</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |





|                                                                                                                                                                  |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|-----|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|------|------------|------|------|------|
|                                                                                                                                                                  | Programming                                                                                 |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| Module 5-Exercises                                                                                                                                               |                                                                                             |     |     |     | Learning Link                                                                                                                                                 |     |     |     |     |      |            |      |      |      |
| 1                                                                                                                                                                | Working with Java Modules                                                                   |     |     |     | <a href="https://www.geeksforgeeks.org/java-modules/">https://www.geeksforgeeks.org/java-modules/</a>                                                         |     |     |     |     |      |            |      |      |      |
| 2                                                                                                                                                                | Java Networking                                                                             |     |     |     | <a href="https://www.geeksforgeeks.org/java-networking/">https://www.geeksforgeeks.org/java-networking/</a>                                                   |     |     |     |     |      |            |      |      |      |
| 3                                                                                                                                                                | Reverse Engineering Concepts                                                                |     |     |     | <a href="https://www.geeksforgeeks.org/software-engineering-reverse-engineering/">https://www.geeksforgeeks.org/software-engineering-reverse-engineering/</a> |     |     |     |     |      |            |      |      |      |
| 4                                                                                                                                                                | Introduction to Java Database Connectivity (JDBC)                                           |     |     |     | <a href="https://www.geeksforgeeks.org/introduction-to-jdbc/">https://www.geeksforgeeks.org/introduction-to-jdbc/</a>                                         |     |     |     |     |      |            |      |      |      |
| Total Periods                                                                                                                                                    |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      | 45 Periods |      |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| At the end of the course, students will be able to                                                                                                               |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 1                                                                                                                                                                | Ability to write efficient Java programs using core programming concepts.                   |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 2                                                                                                                                                                | Strong understanding of Object-Oriented Programming principles for real-world applications. |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 3                                                                                                                                                                | Proficiency in implementing data structures and algorithms using Java.                      |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 4                                                                                                                                                                | Enhanced problem-solving and logical thinking skills for coding assessments.                |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 5                                                                                                                                                                | Confidence to perform well in technical interviews and Java-based placement rounds.         |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 1                                                                                                                                                                | Programming with Java – E. Balagurusamy                                                     |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 2                                                                                                                                                                | Java: The Complete Reference (Indian Edition) – Herbert Schildt                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 3                                                                                                                                                                | Core Java for Beginners – R. Nageswara Rao                                                  |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 1                                                                                                                                                                | Effective Java – Joshua Bloch                                                               |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| 2                                                                                                                                                                | Core Java Volume I & II – Cay S. Horstmann                                                  |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |
|                                                                                                                                                                  | PO1                                                                                         | PO2 | PO3 | PO4 | PO5                                                                                                                                                           | PO6 | PO7 | PO8 | PO9 | PO10 | PO11       | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| CO2                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| CO3                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| CO4                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| CO5                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| AVG                                                                                                                                                              |                                                                                             |     | 2   |     |                                                                                                                                                               |     |     |     |     |      | 3          |      |      |      |
| Assessment Plan-100marks                                                                                                                                         |                                                                                             |     |     |     |                                                                                                                                                               |     |     |     |     |      |            |      |      |      |



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| Sr. No. | Evaluation Component | Mode of Evaluation                                                                                                                  | Criteria                                  | Weightage (%) |
|---------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------|
| 1       | Exercise Uploads     | Upload / Submission in GIT HUB                                                                                                      | Accuracy, completeness, timeliness        | 60            |
| 2       | Testing              | Demonstration or practical testing in <a href="https://www.hackerrank.com/domains/java">https://www.hackerrank.com/domains/java</a> | Functionality, correctness, performance   | 30            |
| 3       | Viva                 | Oral questioning                                                                                                                    | Concept understanding, application skills | 10            |



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|                                                              |                                                                                                                           |                                                                                                                                                                                         |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data Structures: Learner-Centred Self-Instructional Module   |                                                                                                                           | 45                                                                                                                                                                                      |
| Self-learning Course Objectives- Product base outcome        |                                                                                                                           |                                                                                                                                                                                         |
| 1                                                            | Ability to understand and implement core data structures such as arrays, linked lists, stacks, queues, trees, and graphs. |                                                                                                                                                                                         |
| 2                                                            | Improved problem-solving skills through analysis and application of efficient algorithms.                                 |                                                                                                                                                                                         |
| 3                                                            | Proficiency in evaluating time and space complexity to write optimal code.                                                |                                                                                                                                                                                         |
| 4                                                            | Enhanced capability to solve coding challenges and competitive programming problems.                                      |                                                                                                                                                                                         |
| 5                                                            | Confidence to crack technical interviews and coding rounds in product-based companies.                                    |                                                                                                                                                                                         |
| Name of the Software – Visual Studio Code (VS Code), Dev-C++ |                                                                                                                           |                                                                                                                                                                                         |
| Module 1- Exercises                                          |                                                                                                                           | Learning Link                                                                                                                                                                           |
| 1                                                            | Introduction to Data Structure                                                                                            | <a href="https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/">https://www.geeksforgeeks.org/dsa/dsa-tutorial-learn-data-structures-and-algorithms/</a> |
| 2                                                            | Array Data Structure                                                                                                      | <a href="https://www.geeksforgeeks.org/dsa/array-data-structure-guide/">https://www.geeksforgeeks.org/dsa/array-data-structure-guide/</a>                                               |
| 3                                                            | String in Data Structure                                                                                                  | <a href="https://www.geeksforgeeks.org/dsa/string-data-structure/">https://www.geeksforgeeks.org/dsa/string-data-structure/</a>                                                         |
| Module 2-Exercises                                           |                                                                                                                           | Learning Link                                                                                                                                                                           |
| 1                                                            | Hashing in Data Structure                                                                                                 | <a href="https://www.geeksforgeeks.org/dsa/hashing-data-structure/">https://www.geeksforgeeks.org/dsa/hashing-data-structure/</a>                                                       |
| 2                                                            | Linked List Data Structure                                                                                                | <a href="https://www.geeksforgeeks.org/dsa/linked-list-data-structure/">https://www.geeksforgeeks.org/dsa/linked-list-data-structure/</a>                                               |
| 3                                                            | Stack Data Structure                                                                                                      | <a href="https://www.geeksforgeeks.org/dsa/stack-data-structure/">https://www.geeksforgeeks.org/dsa/stack-data-structure/</a>                                                           |
| Module 3-Exercises                                           |                                                                                                                           | Learning Link                                                                                                                                                                           |
| 1                                                            | Queue Data Structure                                                                                                      | <a href="https://www.geeksforgeeks.org/dsa/queue-data-structure/">https://www.geeksforgeeks.org/dsa/queue-data-structure/</a>                                                           |
| 2                                                            | Tree Data Structure                                                                                                       | <a href="https://www.geeksforgeeks.org/dsa/tree-data-structure/">https://www.geeksforgeeks.org/dsa/tree-data-structure/</a>                                                             |
| 3                                                            | Graph Data Structure                                                                                                      | <a href="https://www.geeksforgeeks.org/dsa/graph-data-structure/">https://www.geeksforgeeks.org/dsa/graph-data-structure/</a>                                                           |
| Module 4-Exercises                                           |                                                                                                                           | Learning Link                                                                                                                                                                           |
| 1                                                            | Trie Data Structure                                                                                                       | <a href="https://www.geeksforgeeks.org/dsa/trie-insert-and-search/">https://www.geeksforgeeks.org/dsa/trie-insert-and-search/</a>                                                       |
| 2                                                            | Searching Algorithms                                                                                                      | <a href="https://www.geeksforgeeks.org/dsa/searching-algorithms/">https://www.geeksforgeeks.org/dsa/searching-algorithms/</a>                                                           |
| 3                                                            | Sorting Algorithm                                                                                                         | <a href="https://www.geeksforgeeks.org/dsa/sorting-algorithms/">https://www.geeksforgeeks.org/dsa/sorting-algorithms/</a>                                                               |
| Module 5-Exercises                                           |                                                                                                                           | Learning Link                                                                                                                                                                           |
| 1                                                            | Greedy Algorithm                                                                                                          | <a href="https://www.geeksforgeeks.org/dsa/greedy-algorithms/">https://www.geeksforgeeks.org/dsa/greedy-algorithms/</a>                                                                 |
| 2                                                            | Dynamic Programming                                                                                                       | <a href="https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/">https://www.geeksforgeeks.org/competitive-programming/dynamic-programming/</a>                     |
| 3                                                            | Recursion Data Structure                                                                                                  | <a href="https://www.geeksforgeeks.org/dsa/introduction-to-recursion-2/">https://www.geeksforgeeks.org/dsa/introduction-to-recursion-2/</a>                                             |
| Total Periods                                                |                                                                                                                           | 45 Periods                                                                                                                                                                              |
| Course Outcomes                                              |                                                                                                                           |                                                                                                                                                                                         |
| At the end of the course, students will be able to           |                                                                                                                           |                                                                                                                                                                                         |
| 1                                                            | Ability to implement fundamental data structures and apply them to solve complex problems.                                |                                                                                                                                                                                         |



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|   |                                                                                      |
|---|--------------------------------------------------------------------------------------|
| 2 | Improved logical reasoning and algorithmic thinking for writing efficient code.      |
| 3 | Proficiency in analyzing time and space complexities for optimal solutions.          |
| 4 | Enhanced capability to solve coding challenges on competitive programming platforms. |
| 5 | Confidence to clear technical interviews, coding rounds, and placement assessments.  |

**TEXTBOOKS**

|   |                                                                                            |
|---|--------------------------------------------------------------------------------------------|
| 1 | Data Structures Using C – Reema Thareja                                                    |
| 2 | Fundamentals of Data Structures in C – Ellis Horowitz, Sartaj Sahni & Susan Anderson-Freed |
| 3 | Data Structures and Algorithms Made Easy – Narasimha Karumanchi                            |

**REFERENCE BOOKS**

|   |                                                                       |
|---|-----------------------------------------------------------------------|
| 1 | Introduction to Algorithms (CLRS) – Cormen, Leiserson, Rivest & Stein |
| 2 | Algorithms – Robert Sedgewick & Kevin Wayne                           |

**CO/PO, PSO Mapping**

(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak  
 Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

|     | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-------|------|------|------|
| CO1 |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO2 |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO3 |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO4 |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO5 |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| AVG |     |     | 2   |     |     |     |     |     |     |      | 3     |      |      |      |

**Assessment Plan-100marks**

| Sr. No. | Evaluation Component | Mode of Evaluation                                                                                                                                           | Criteria                                  | Weightage (%) |
|---------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------|
| 1       | Exercise Uploads     | Upload / Submission in GIT HUB                                                                                                                               | Accuracy, completeness, timeliness        | 60            |
| 2       | Testing              | Demonstration or practical testing in -<br><a href="https://www.hackerrank.com/domains/datastructures">https://www.hackerrank.com/domains/datastructures</a> | Functionality, correctness, performance   | 30            |
| 3       | Viva                 | Oral questioning                                                                                                                                             | Concept understanding, application skills | 10            |



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| Essentials of SQL: Self-Paced Academic Unit           |                                                                                                                               | 45 Periods                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self learning Course Objectives- Product base outcome |                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 1                                                     | Understand and apply core SQL concepts to efficiently create, manage, and query relational databases.                         |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 2                                                     | Develop the ability to write optimized SQL queries for real-world data handling and analysis tasks.                           |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 3                                                     | Gain proficiency in using SQL functions, joins, subqueries, and constraints for backend and data operations.                  |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 4                                                     | Strengthen problem-solving skills through hands-on SQL exercises used in coding assessments and interviews.                   |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5                                                     | Build confidence to perform well in placement tests and job roles involving database management and data-driven applications. |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Name of the Software –                                |                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Module 1- Exercises                                   |                                                                                                                               | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                     | Introduction to DBMS                                                                                                          | <a href="https://www.nesoacademy.org/cs/14-database-management-systems-dbms/01-introduction-to-dbms/01-introduction-to-database-management-systems-dbms">https://www.nesoacademy.org/cs/14-database-management-systems-dbms/01-introduction-to-dbms/01-introduction-to-database-management-systems-dbms</a>                                                                                                                            |
| 2                                                     | Relational Database                                                                                                           | <a href="https://www.nesoacademy.org/cs/14-database-management-systems-dbms/02-relational-databases-/01-introduction-to-relational-databases">https://www.nesoacademy.org/cs/14-database-management-systems-dbms/02-relational-databases-/01-introduction-to-relational-databases</a>                                                                                                                                                  |
| 3                                                     | Entity Relationship Database                                                                                                  | <a href="https://www.nesoacademy.org/cs/14-database-management-systems-dbms/03-entityrelationship-er-model/01-database-design">https://www.nesoacademy.org/cs/14-database-management-systems-dbms/03-entityrelationship-er-model/01-database-design</a>                                                                                                                                                                                |
| Module 2-Exercises                                    |                                                                                                                               | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                     | Introduction to SQL                                                                                                           | <a href="https://www.geeksforgeeks.org/sql/what-is-sql/">https://www.geeksforgeeks.org/sql/what-is-sql/</a><br><a href="https://www.nesoacademy.org/cs/14-database-management-systems-dbms/04-structured-query-language-sql/01-introduction-to-structured-query-language-sql">https://www.nesoacademy.org/cs/14-database-management-systems-dbms/04-structured-query-language-sql/01-introduction-to-structured-query-language-sql</a> |
| 2                                                     | SQL operators                                                                                                                 | <a href="https://www.geeksforgeeks.org/sql/sql-operators/">https://www.geeksforgeeks.org/sql/sql-operators/</a>                                                                                                                                                                                                                                                                                                                        |
| 3                                                     | SQL DATABASE operation                                                                                                        | <a href="https://www.geeksforgeeks.org/sql/sql-database/">https://www.geeksforgeeks.org/sql/sql-database/</a>                                                                                                                                                                                                                                                                                                                          |
| Module 3-Exercises                                    |                                                                                                                               | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                     | SQL String function                                                                                                           | <a href="https://www.geeksforgeeks.org/sql/sql-string-functions/">https://www.geeksforgeeks.org/sql/sql-string-functions/</a>                                                                                                                                                                                                                                                                                                          |
| 2                                                     | Introduction to ANSI SQL and MySQL                                                                                            | <a href="https://www.dwbi.org/pages/30/introduction-to-ansi-sql">https://www.dwbi.org/pages/30/introduction-to-ansi-sql</a><br><a href="https://www.w3schools.com/mysql/mysql_intro.asp">https://www.w3schools.com/mysql/mysql_intro.asp</a>                                                                                                                                                                                           |
| 3                                                     | Data Retrieval with SELECT Statement                                                                                          | <a href="https://www.geeksforgeeks.org/mysql-select-statement/">https://www.geeksforgeeks.org/mysql-select-statement/</a>                                                                                                                                                                                                                                                                                                              |
| Module 4-Exercises                                    |                                                                                                                               | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 1                                                     | Filtering and Sorting Data                                                                                                    | <a href="https://www.sqlshack.com/learn-mysql-sorting-and-filtering-data-in-a-table/">https://www.sqlshack.com/learn-mysql-sorting-and-filtering-data-in-a-table/</a>                                                                                                                                                                                                                                                                  |
| 2                                                     | Aggregate Functions and Grouping                                                                                              | <a href="https://www.geeksforgeeks.org/mysql-aggregate-function/">https://www.geeksforgeeks.org/mysql-aggregate-function/</a><br><a href="https://www.w3schools.com/mysql/mysql_groupby.asp">https://www.w3schools.com/mysql/mysql_groupby.asp</a>                                                                                                                                                                                     |
| 3                                                     | Joins and Subqueries                                                                                                          | <a href="https://www.geeksforgeeks.org/mysql-join-1/">https://www.geeksforgeeks.org/mysql-join-1/</a><br><a href="https://www.geeksforgeeks.org/mysql-subquery/">https://www.geeksforgeeks.org/mysql-subquery/</a>                                                                                                                                                                                                                     |
| Module 5-Exercises                                    |                                                                                                                               | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                          |



|                                                                                                                                                                  |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------------------------------------|-----|-----|---------------|-----|------|------|------|------|------|
| 1                                                                                                                                                                | Data Modification with INSERT, UPDATE, DELETE                                                       | <a href="https://www.geeksforgeeks.org/sql-ddl-dql-dml-dcl-tcl-commands/">https://www.geeksforgeeks.org/sql-ddl-dql-dml-dcl-tcl-commands/</a>                                                                                                                                    |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 2                                                                                                                                                                | Creating and Modifying Tables                                                                       | <a href="https://www.geeksforgeeks.org/sql-create-table/?ref=lbp">https://www.geeksforgeeks.org/sql-create-table/?ref=lbp</a><br><a href="https://www.geeksforgeeks.org/sql-alter-add-drop-modify/?ref=lbp">https://www.geeksforgeeks.org/sql-alter-add-drop-modify/?ref=lbp</a> |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 3                                                                                                                                                                | Indexes and Constraint s                                                                            | <a href="https://www.w3schools.com/mysql/mysql_constraints.asp">https://www.w3schools.com/mysql/mysql_constraints.asp</a><br><a href="https://www.w3schools.com/mysql/mysql_create_index.asp">https://www.w3schools.com/mysql/mysql_create_index.asp</a>                         |     |     |                                    |     |     |               |     |      |      |      |      |      |
| Total Periods                                                                                                                                                    |                                                                                                     | 45 Periods                                                                                                                                                                                                                                                                       |     |     |                                    |     |     |               |     |      |      |      |      |      |
| Course Outcomes                                                                                                                                                  |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| At the end of the course, students will be able to                                                                                                               |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 1                                                                                                                                                                | Ability to write efficient SQL queries for data retrieval, manipulation, and analysis.              |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 2                                                                                                                                                                | Skill to design and manage relational databases using SQL commands.                                 |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 3                                                                                                                                                                | Proficiency in using joins, subqueries, functions, and constraints for solving real-world problems. |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 4                                                                                                                                                                | Improved problem-solving skills for SQL-based coding assessments and technical interviews.          |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 5                                                                                                                                                                | Confidence to work with databases in backend development, data analysis, and industry projects.     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| TEXTBOOKS                                                                                                                                                        |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 1                                                                                                                                                                | SQL, PL/SQL: The Programming Language of Oracle – Ivan Bayross                                      |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 2                                                                                                                                                                | Database System Concepts – Abraham Silberschatz, Henry F. Korth, S. Sudarshan (Indian co-author)    |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 3                                                                                                                                                                | Fundamentals of Database Management Systems – Mark L. Gillenson (India Edition)                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| REFERENCE BOOKS                                                                                                                                                  |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 1                                                                                                                                                                | Learning SQL – Alan Beaulieu                                                                        |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| 2                                                                                                                                                                | SQL for Data Analysis – Cathy Tanimura                                                              |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| CO/PO, PSO Mapping<br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
|                                                                                                                                                                  | PO1                                                                                                 | PO2                                                                                                                                                                                                                                                                              | PO3 | PO4 | PO5                                | PO6 | PO7 | PO8           | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| CO2                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| CO3                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| CO4                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| CO5                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| AVG                                                                                                                                                              |                                                                                                     |                                                                                                                                                                                                                                                                                  | 2   |     |                                    |     |     |               |     |      | 3    |      |      |      |
| Assessment Plan-100marks                                                                                                                                         |                                                                                                     |                                                                                                                                                                                                                                                                                  |     |     |                                    |     |     |               |     |      |      |      |      |      |
| Sr. No.                                                                                                                                                          | Evaluation Component                                                                                | Mode of Evaluation                                                                                                                                                                                                                                                               |     |     | Criteria                           |     |     | Weightage (%) |     |      |      |      |      |      |
| 1                                                                                                                                                                | Exercise Uploads                                                                                    | Upload / Submission in GIT HUB                                                                                                                                                                                                                                                   |     |     | Accuracy, completeness, timeliness |     |     | 60            |     |      |      |      |      |      |
|                                                                                                                                                                  | Testing                                                                                             | Demonstration or                                                                                                                                                                                                                                                                 |     |     | Functionality,                     |     |     | 30            |     |      |      |      |      |      |



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|   |      |                                                                                                                    |                                                 |    |
|---|------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|----|
| 2 |      | practical testing -<br><a href="https://www.hackerrank.com/domains/sql">https://www.hackerrank.com/domains/sql</a> | correctness,<br>performance                     |    |
| 3 | Viva | Oral questioning                                                                                                   | Concept<br>understanding,<br>application skills | 10 |



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| Web Design and Scripting: Independent Study Curriculum (HTML, CSS, JavaScript) |                                                                                                                              | 45 Periods                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self learning Course Objectives- Product base outcome                          |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 1                                                                              | Develop a strong foundation in HTML, CSS, and JavaScript to build responsive and user-friendly web pages.                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 2                                                                              | Gain the ability to create dynamic, interactive, and real-world web applications using core front-end technologies.          |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 3                                                                              | Strengthen logical thinking and problem-solving skills through JavaScript-based coding challenges.                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4                                                                              | Build proficiency in front-end development concepts required for coding assessments and technical interviews.                |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 5                                                                              | Create portfolio-ready web projects that demonstrate practical front-end skills for campus placements and job opportunities. |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Name of the Software –                                                         |                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Module 1- Exercises                                                            |                                                                                                                              | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1                                                                              | JavaScript Basics                                                                                                            | <a href="https://www.geeksforgeeks.org/javascript-basic-syntax/?ref=lbq">https://www.geeksforgeeks.org/javascript-basic-syntax/?ref=lbq</a>                                                                                                                                                                                                                                                                                                       |
| 2                                                                              | Control Flow                                                                                                                 | <a href="https://www.geeksforgeeks.org/control-statements-in-javascript/">https://www.geeksforgeeks.org/control-statements-in-javascript/</a>                                                                                                                                                                                                                                                                                                     |
| 3                                                                              | Functions and Scope                                                                                                          | <a href="https://www.w3schools.com/js/js_functions.asp">https://www.w3schools.com/js/js_functions.asp</a><br><a href="https://www.geeksforgeeks.org/difference-between-scope-and-closures-in-javascript/">https://www.geeksforgeeks.org/difference-between-scope-and-closures-in-javascript/</a><br><a href="https://www.geeksforgeeks.org/javascript-higher-order-functions">https://www.geeksforgeeks.org/javascript-higher-order-functions</a> |
| Module 2-Exercises                                                             |                                                                                                                              | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1                                                                              | Objects and the Document Object Model (DOM)                                                                                  | <a href="https://www.geeksforgeeks.org/dom-document-object-model/">https://www.geeksforgeeks.org/dom-document-object-model/</a><br><a href="https://www.w3schools.com/js/js_events.asp">https://www.w3schools.com/js/js_events.asp</a>                                                                                                                                                                                                            |
| 2                                                                              | Arrays and Array Methods                                                                                                     | <a href="https://w3schools.com/js/js_arrays.asp">https://w3schools.com/js/js_arrays.asp</a><br><a href="https://www.w3schools.com/js/js_array_methods.asp">https://www.w3schools.com/js/js_array_methods.asp</a>                                                                                                                                                                                                                                  |
| 3                                                                              | Babel and Webpack                                                                                                            | <a href="https://www.geeksforgeeks.org/what-is-babel/">https://www.geeksforgeeks.org/what-is-babel/</a><br><a href="https://webpack.js.org/guides/typescript/">https://webpack.js.org/guides/typescript/</a>                                                                                                                                                                                                                                      |
| Module 3-Exercises                                                             |                                                                                                                              | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1                                                                              | Introduction to HTML                                                                                                         | <a href="https://www.w3schools.com/html/html_intro.asp">https://www.w3schools.com/html/html_intro.asp</a>                                                                                                                                                                                                                                                                                                                                         |
| 2                                                                              | Elements & Attributes                                                                                                        | <a href="https://www.geeksforgeeks.org/html-forms/">https://www.geeksforgeeks.org/html-forms/</a><br><a href="https://www.geeksforgeeks.org/difference-between-id-and-class-attributes-in-html">https://www.geeksforgeeks.org/difference-between-id-and-class-attributes-in-html</a><br><a href="https://www.w3schools.com/html/html_blocks.asp">https://www.w3schools.com/html/html_blocks.asp</a>                                               |
| 3                                                                              | Navigation                                                                                                                   | <a href="https://www.w3schools.com/tags/tag_nav.asp">https://www.w3schools.com/tags/tag_nav.asp</a><br><a href="https://www.html5dog.com/guides/html/intermediate/sectioning/">https://www.html5dog.com/guides/html/intermediate/sectioning/</a>                                                                                                                                                                                                  |
| Module 4-Exercises                                                             |                                                                                                                              | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1                                                                              | Events and Web Forms 2.0                                                                                                     | <a href="https://www.w3schools.com/jsref/dom_obj_event.asp">https://www.w3schools.com/jsref/dom_obj_event.asp</a><br><a href="https://www.tutorialspoint.com/html5/html5_web_forms2.htm">https://www.tutorialspoint.com/html5/html5_web_forms2.htm</a>                                                                                                                                                                                            |
| 2                                                                              | Web Storage and Web SQL Database                                                                                             | <a href="https://www.w3schools.com/html/html5_webstorage.asp">https://www.w3schools.com/html/html5_webstorage.asp</a><br><a href="https://www.geeksforgeeks.org/what-is-web-sql/">https://www.geeksforgeeks.org/what-is-web-sql/</a>                                                                                                                                                                                                              |
| 3                                                                              | Geo location                                                                                                                 | <a href="https://www.geeksforgeeks.org/html-geolocation/">https://www.geeksforgeeks.org/html-geolocation/</a>                                                                                                                                                                                                                                                                                                                                     |





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| Module 5-Exercises                                                                                                                                                      |                                                                                                          | Learning Link                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |     |     |     |     |     |     |     |      |       |      |      |      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-------|------|------|------|
| 1                                                                                                                                                                       | Introduction to CSS                                                                                      | <a href="https://www.w3schools.com/html/html_css.asp">https://www.w3schools.com/html/html_css.asp</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                       | Selectors                                                                                                | <a href="https://www.geeksforgeeks.org/css-selectors/">https://www.geeksforgeeks.org/css-selectors/</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                       | Styling                                                                                                  | <a href="https://www.w3schools.com/css/css_colors.asp">https://www.w3schools.com/css/css_colors.asp</a><br><a href="https://www.w3schools.com/css/css_background.asp">https://www.w3schools.com/css/css_background.asp</a><br><a href="https://www.w3schools.com/css/css_font.asp">https://www.w3schools.com/css/css_font.asp</a><br><a href="https://www.w3schools.com/css/css_link.asp">https://www.w3schools.com/css/css_link.asp</a><br><a href="https://www.w3schools.com/css/css_list.asp">https://www.w3schools.com/css/css_list.asp</a><br><a href="https://www.w3schools.com/css/css_table.asp">https://www.w3schools.com/css/css_table.asp</a><br><a href="https://www.w3schools.com/css/css_boxmodel.asp">https://www.w3schools.com/css/css_boxmodel.asp</a><br><a href="https://www.geeksforgeeks.org/what-is-the-difference-between-visibilityhidden-and-displaynone/">https://www.geeksforgeeks.org/what-is-the-difference-between-visibilityhidden-and-displaynone/</a><br><a href="https://www.w3schools.com/css/css3_mediaqueries.asp">https://www.w3schools.com/css/css3_mediaqueries.asp</a><br><a href="https://www.w3schools.com/css/css_rwd_intro.asp">https://www.w3schools.com/css/css_rwd_intro.asp</a> |     |     |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                                                         |                                                                                                          | <b>Total Periods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |     |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                                                         |                                                                                                          | <b>45 Periods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |     |     |     |     |     |     |      |       |      |      |      |
| <b>Course Outcomes</b>                                                                                                                                                  |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| <b>At the end of the course, students will be able to</b>                                                                                                               |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                       | Ability to design and develop responsive, structured, and visually appealing web pages.                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                       | Skill to create interactive and dynamic web functionalities using core JavaScript.                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                       | Improved logical thinking and problem-solving abilities through front-end coding practice.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 4                                                                                                                                                                       | Proficiency in building real-world front-end projects suitable for interviews and portfolio development. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 5                                                                                                                                                                       | Confidence to clear front-end coding assessments, technical interviews, and placement rounds.            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| <b>TEXTBOOKS</b>                                                                                                                                                        |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                       | <b>Web Technologies — HTML, CSS, JavaScript – Ramesh Bangia</b>                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                       | <b>Web Programming and Design – Kogent Learning Solutions</b>                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 3                                                                                                                                                                       | <b>HTML &amp; CSS: Design and Build Websites – Jon Duckett</b>                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| <b>REFERENCE BOOKS</b>                                                                                                                                                  |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 1                                                                                                                                                                       | <b>Beginning HTML, CSS &amp; JavaScript – Jon Duckett</b>                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| 2                                                                                                                                                                       | <b>Mastering HTML, CSS &amp; JavaScript Web Publishing – Rick Darnell</b>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
| <b>CO/PO, PSO Mapping</b><br>(3/2/1 indicates the strength of correlation) 3-Strong 2-Medium, 1-Weak<br>Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |     |     |     |     |     |     |      |       |      |      |      |
|                                                                                                                                                                         | PO1                                                                                                      | PO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO 11 | PSO1 | PSO2 | PSO3 |
| CO1                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO2                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO3                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO4                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| CO5                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |
| AVG                                                                                                                                                                     |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 2   |     |     |     |     |     |     |      | 3     |      |      |      |



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| Assessment Plan-100marks |                      |                                                                                                                                                                                                                                                           |                                           |               |
|--------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|---------------|
| Sr. No.                  | Evaluation Component | Mode of Evaluation                                                                                                                                                                                                                                        | Criteria                                  | Weightage (%) |
| 1                        | Exercise Uploads     | Upload / Submission in GIT HUB                                                                                                                                                                                                                            | Accuracy, completeness, timeliness        | 60            |
| 2                        | Testing              | Demonstration or practical testing in <a href="https://www.hackerrank.com/contests/javascript-challenges/challenges">https://www.hackerrank.com/contests/javascript-challenges/challenges</a> & <a href="https://leetcode.com/">https://leetcode.com/</a> | Functionality, correctness, performance   | 30            |
| 3                        | Viva                 | Oral questioning                                                                                                                                                                                                                                          | Concept understanding, application skills | 10            |



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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

**Board of Studies Meeting -4 Remuneration details**

Meeting no: MSEC/Autonomous/EEE/BoSM/04-2026

Date & Time: 12-01-2026, 10.00 am

Venue: Main Block- ECE Seminar Hall - II Floor

| S.No. | Name of Member          | Mode of Attendance | Remuneration | Travelling Allowance | Total | Account Holder Name  | Account number   | Bank Name            | Branch Name               | IFSC Code   | Signature |
|-------|-------------------------|--------------------|--------------|----------------------|-------|----------------------|------------------|----------------------|---------------------------|-------------|-----------|
| 1     | Dr.P.Somasundaram       | Online             | 3000         | -                    | 3000  | P.Somasundaram       | 845610 1100012   | Canara Bank          | Anna university extn cour | CNRB0008456 |           |
| 2     | Dr.R.Sarathi            | Online             | 3000         | -                    | 3000  |                      |                  |                      |                           |             |           |
| 3     | Dr.V.S.Sriraja balaguru | -                  | -            | -                    | -     | V.S.Sriraja balaguru | 911118 000004    | Canara Bank          | Mount Road                | CNRB0000911 |           |
| 4     | Mr.P Boniface           | Offline            | 3000         | 1500                 | 4500  | Boniface P           | 873053 000001076 | South Indian Bank    | VADAPERUMBAKKAM           | SIBL0000873 |           |
| 5     | Mr.Mayukh Kapoor        | Offline            | 3000         | 1500                 | 4500  | R. Mayukh Kapoor     | 912010026621369  | Axis Bank            | Ramapuram branch          | UTIB0000074 |           |
| 6     | Dr.C.Umayal             | Offline            | 3000         | 1500                 | 4500  | Umayal C             | 117001 000102924 | City Union Bank Ltd. | Tambaram(west)            | CIUB0000117 |           |
| 7     | Mr. Meenakshi Sundaram  | Offline            | 3000         | 1500                 | 4500  | Meenakshi Sundaram   | 536482804        | ETH Bank             | MG Road, Bangalore        | CITI0000004 |           |
| 8     | Dr.Ramani Kannan        | -                  | -            | -                    | -     | Ramani K             | 231801 000000948 | Indian Overseas Bank | T. Goundampalayam         | IOBA0002318 |           |
| 9     | Dr.P.S. Pandian         | -                  | -            | -                    | -     |                      |                  |                      |                           |             |           |
| 10    | Mr.V.Dinesh Kumar       | -                  | -            | -                    | -     | Dinesh Kumar V       | 602201538682     | ICICI                | Ashok Nagar               | ICIC0001684 |           |
| 11    | Dr. Selvi Radhakrishnan | -                  | -            | -                    | -     |                      |                  |                      |                           |             |           |

prepared by  
[Dr. R. MAHA LAKSHMI]  
prof-EEE

Prof-EEE  
(1-10-2026)

V.S. Sriraja  
Dean ECE  
Principal



# MEENAKSHI SUNDARARAJAN ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION



RECOGNIZED AS  
RESEARCH INSTITUTE  
BY ANNA UNIVERSITY

POWERED BY



Meenakshi  
Sundararajan Career  
Development Centre



Sri Sankara Meenakshi  
Sundararajan research  
Centre



Meenakshi Sundararajan  
Innovation & incubation  
center



Meenakshi Sundararajan  
Centre for Industrial &  
Institute Collaboration



Institutions'  
Innovation Council



Enabled  
Campus



Enrichment -  
Enhancement -  
Empowerment



Out of The  
Box



Achieve Excellence  
Program



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**Meenakshi College for Women**

<https://www.meenakshicollege.com/>



**Meenakshi Sundararajan Engineering College**

<https://msec.edu.in/>



**Meenakshi Sundararajan School of Management**

<https://www.mssm.edu.in/>



**The NEST School**

<https://thenest.school/>

