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

M.E. ENERGY ENGINEERING
CURRICULUM AND SYLLABUS
REGULATIONS 2024
CHOICE BASED CREDIT SYSTEM

Powered by

Meenakshi Sundararajan Career Development Cell

Achievers Excellence Program

Meenakshi Sundararajan Innovation and Incubation Centre

MSEC JAPANESE CLUB

Institutions' Innovation Council

Societal Beneficial Innovation

MATLAB Enabled Campus

363, Arcot Road, Kodambakkam, Chennai - 600 024.
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:

S.No	Course	Intake
	Undergraduate courses in B.E / B. Tech	
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
	Postgraduate courses in M.E / M. Tech	
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 & Guidnace 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.

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Vision of the department	Mission of the department
To equip the students with a strong foundation in Core mechanical principles, fostering innovation and producing well-rounded engineers capable of solving complex challenges to address the evolving needs of society and industry.	• Quality education and knowledge updates provide a strong foundation to meet the complex challenges. • Adopt world-class technology, through digital education for fostering innovations. • Imparting ethical principles to solve the evolving needs of the society and industry.

PROGRAM OUTCOMES (PO) and PROGRAM SPECIFIC OUTCOMES (PSO)

PO1	An ability to independently carry out research/investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PSO1	Versatile with modern tools, softwares and techniques for improving the efficiency of energy utilities/system/better management (technical and financial) of projects
PSO2	Proficiency to work autonomously and amongst a team towards designing energy products and processes with environment consciousness for sustainable development
PSO3	Development of competence and promoting lifelong learning for better interaction amongst industry peers, business conglomerates and society in a professional and ethical manner

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Curriculum for I to IV semesters

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
THEORY								
1	P24EY101	Energy Management and Environmental Benefits	PCC	45	3	0	0	3
2	P24EY102	Fluid Mechanics and Heat Transfer	PCC	60	3	1	0	4
3	P24EY103	Instrumentation for Energy Systems	PCC	45	3	0	0	3
4	P24EY104	Renewable Energy Systems	PCC	45	3	0	0	3
5	P24EY105	Thermodynamic Analysis of Energy Systems	PCC	60	3	1	0	4
6	P24RM101	Research Methodology and IPR	RMC	30	2	0	0	2
7		Audit Course - I (Optional)	AC[#]	30	2	0	0	0
PRACTICAL								
8	P24EY106	Renewable Energy Laboratory	PCC	60	0	0	4	2
9	P24EY107	Applied Thermal Engineering Laboratory	PCC	60	0	0	4	2
TOTAL				**435**	**19**	**2**	**8**	**23**

[#]Audit Course is a Non-Credit Course.

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M.E. Energy Engineering

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
THEORY								
1	P24EY201	Energy Conservation in Industrial Utilities	PCC	45	3	0	0	3
2	P24EY202	Computational Fluid Dynamics for Energy Systems	PCC	60	3	1	0	4
3	P24EY203	Energy Efficient Buildings Design	PCC	45	3	0	0	3
4		Professional Elective - I	PEC	45	3	0	0	3
5		Professional Elective - II	PEC	45	3	0	0	3
6		Audit Course - II (Optional)	AC[#]	30	2	0	0	0
PRACTICAL								
7	P24EY204	Energy Conservation Laboratory	PCC	60	0	0	4	2
8	P24EY205	Analysis and Simulation Laboratory for Energy Engineering	PCC	60	0	0	4	2
9	P24EY206	Mini Project with Seminar	EEC	60	0	0	4	2
TOTAL				**450**	**17**	**1**	**12**	**22**

[#]Audit Course is a Non-Credit Course.

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
THEORY								
1		Professional Elective - III	PEC	45	3	0	0	3
2		Professional Elective - IV	PEC	45	3	0	0	3
3		Professional Elective - V	PEC	45	3	0	0	3
4		Open Elective	OEC	45	3	0	0	3
PRACTICAL								
5	P24EY301	Project Work - I	EEC	180	0	0	12	6
TOTAL				**360**	**12**	**0**	**12**	**18**

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M.E. Energy Engineering

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
PRACTICAL								
1	P24EY401	Project Work - II	EEC	360	0	0	24	12
TOTAL				**360**	**0**	**0**	**24**	**12**
OVERALL TOTAL								**75**

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M.E. Energy Engineering

ELECTIVE COURSES

Semester II, Elective I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24EYP01	Design and Analysis of Turbomachines	PEC	45	3	0	0	3
2	P24EYP02	Fluidized Bed Systems	PEC	45	3	0	0	3
3	P24EYP03	Bio Energy Technologies	PEC	45	3	0	0	3
4	P24EYP04	Energy Forecasting, Modeling and Project Management	PEC	45	3	0	0	3

Semester II, Elective II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24EYP05	Modeling and Analysis of Energy Systems	PEC	45	3	0	0	3
2	P24EYP06	Power Generation, Transmission and Distribution	PEC	45	3	0	0	3
3	P24EYP07	Nuclear Engineering	PEC	45	3	0	0	3
4	P24EYP08	Solar Energy Technologies	PEC	45	3	0	0	3

Semester III, Elective III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24EYP09	Advanced Energy Storage Technologies	PEC	45	3	0	0	3
2	P24EYP10	Design of Heat Exchangers	PEC	45	3	0	0	3
3	P24EYP11	Hybrid and Electric Vehicles	PEC	45	3	0	0	3

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M.E. Energy Engineering

Semester III, Elective IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24EYP12	Power Electronics for Renewable Energy Systems	PEC	45	3	0	0	3
2	P24EYP13	Wind Energy Systems	PEC	45	3	0	0	3
3	P24EYP14	Advanced Power Plant Engineering	PEC	45	3	0	0	3

Semester III, Elective V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24EYP15	Hydrogen and Fuel Cell Terminologies	PEC	45	3	0	0	3
2	P24EYP16	Smart Grid	PEC	45	3	0	0	3
3	P24EYP17	Environmental Engineering and Pollution Control	PEC	45	3	0	0	3
4	P24EYP18	Human Industrial Safety and Hygiene	PEC	45	3	0	0	3

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M.E. Energy Engineering

LIST OF OPEN ELECTIVES FOR PG PROGRAMMES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	TCP	PERIODS PER WEEK			CREDITS
					L	T	P	
1	P24OT501	Sustainable Management	OEC	3	0	0	3	3
2	P24OT502	Micro and Small Business Management	OEC	3	0	0	3	3
3	P24OT503	Intellectual Property Rights	OEC	3	0	0	3	3
4	P24OT504	Ethical Management	OEC	3	0	0	3	3
5	P24OT505	Big Data Analytics	OEC	3	0	0	3	3
6	P24OT506	Internet of Things and Cloud	OEC	3	0	0	3	3
7	P24OT507	Medical Robotics	OEC	3	0	0	3	3
8	P24OT508	Embedded Automation	OEC	3	0	0	3	3
9	P24OT509	Environmental Sustainability	OEC	3	0	0	3	3
10	P24OT510	Textile Reinforced Composites	OEC	3	0	0	3	3
11	P24OT511	Nanocomposite Materials	OEC	3	0	0	3	3
12	P24OT512	IPR, Biosafety and Entrepreneurship	OEC	3	0	0	3	3
13	P24OE513	IoT for Smart Systems	OEC	3	0	0	3	3
14	P24OE514	Machine Learning and Deep Learning	OEC	3	0	0	3	3
15	P24OE515	Renewable Energy Technology	OEC	3	0	0	3	3
16	P24OE516	Smart Grid	OEC	3	0	0	3	3
17	P24OC517	Security Practices	OEC	3	0	0	3	3
18	P24OC518	Cloud Computing Technologies	OEC	3	0	0	3	3
19	P24OC519	Design Thinking	OEC	3	0	0	3	3
20	P24OC520	Principles of Multimedia	OEC	3	0	0	3	3
21	P24OC521	Blockchain Technologies	OEC	3	0	0	3	3
22	P24OC522	Deep Learning	OEC	3	0	0	3	3
23	P24OC528	Integrated Water Resources Management	OEC	3	0	0	3	3
24	P24ON529	Water, Sanitation and Health	OEC	3	0	0	3	3
25	P24ON530	Principles of Sustainable Development	OEC	3	0	0	3	3
26	P24ON531	Environmental Impact Assessment	OEC	3	0	0	3	3

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M.E. Energy Engineering

CATEGORY OF COURSES AND CREDIT DISTRIBUTION

S. No.	Subject Area	Credits per Semester				Total Credits
		1	2	3	4	
1	PCC	21	14	0	0	35
2	PEC	0	6	9	0	15
3	RMC	2	0	0	0	2
4	OEC	0	0	3	0	3
5	EEC	0	2	6	12	20
6	Non Credit / Audit Course	Y	Y	0	0	0
Total		**23**	**22**	**18**	**12**	**75**

PCC - Professional Core Courses

PEC - Professional Elective Courses

RMC - Research Methodology Courses

OEC - Open Elective Courses

EEC - Employability Enhancement Courses

AC - Audit Courses / Non-Credit Courses

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY101	ENERGY MANAGEMENT AND ENVIRONMENTAL BENEFITS	L	T	P	C
		3	0	0	3

Course Objectives

1	To create awareness on the energy scenario of India with respect to world
2	To learn the methodology adopted for an energy audit
3	To appreciate the concepts adopted in project management
4	To study the different techniques adopted for financial appraisal of a project
5	To Comprehend the impact of energy on environment

UNIT 1 ENERGY SCENARIO — **9**

Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing –energy security-energy conservation and its importance –Energy Conservation Act2001

UNIT 2 ENERGY MANAGEMENT — **9**

Energy audit - need – types – methodology – barriers - analysis on energy costing and sharing - bench marking - fuel and energy substitution – billing parameters in TANGEDCO – demand side management - instruments for energy audit – energy monitoring and targeting – CUSUM – energy labeling

UNIT 3 PROJECT MANAGEMENT — **9**

Four Basic Elements of Project Management - Project Management Life Cycle - Steps in Project Management Project Definition and Scope, Technical Design, Financing, Contracting, Implementation Techniques (Gantt Chart, CPM and PERT) and PerformanceMonitoring-EnMS5001

UNIT 4 FINANCIAL MANAGEMENT — **9**

Investment appraisal for energy conservation projects - Financial analysis techniques -Simple payback period, Return on investment, Net present value, Internal rate of return - Cash flows – Risk and sensitivity analysis: micro and macro factors- Financing options- energy performance contracts-ESCOs.

UNIT 5 ENERGY AND ENVIRONMENT — **9**

Greenhouse effect and the carbon cycle - current evidence and future effects of climate change - Global Environmental Concerns-United Nations Frame work Convention on Climate Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Emissions trading(ET), Joint implementation(JI), Clean Development Mechanism (CDM), Proto type Carbon Fund(PCF), Sustainable Development

TOTAL PERIODS — **45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Recognize the importance of energy conservation and suggest measures for improving per capita energy consumption
CO2	Analyse the energy sharing and cost sharing pattern of fuels used in industries
CO3	Apply Gantt Chart, CPM and PERT in energy conservation projects
CO4	Evaluate the techno-economics of a project adopting discounting and non-discounting Cash flow techniques
CO5	Assess the sources of additional revenue generation for energy conservation projects Adopting UNFCC

TEXT BOOKS

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE),a statutory body under Ministry of Power, Government of India.2004.

2. L.C. Witte, P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ,Washington,1988.

REFERENCES

1. W.C.turner, “Energy Management Hand book”Wiley,NewYork,1982

2. W.R.Murphy and G.McKay “Energy Management” Butter worths, London 1987

3. Eastop.T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.

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	PSO1	PSO2	PSO3
CO1	3	-	1	-	2	-
CO2	3	-	3	3	2	1
CO3	1	-	2	3	-	1
CO4	1	-	3	3	-	1
CO5	1	-	1	-	3	2
AVG	1.8	-	2	3	2.33	1.25

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY102	FLUID MECHANICS AND HEAT TRANSFER	L	T	P	C
		3	1	0	4

Course Objectives

1	To make students familiarize with the application of conservation equations
2	To explain the incompressible and compressible fluid flow concepts
3	To inculcate the analysis of conduction and gas radiation heat transfer
4	To provide the details of turbulent forced convective heat transfer
5	To impart the knowledge of design of single phase and multi-phase heat exchangers

UNIT 1 BASIC EQUATION, POTENTIAL FLOW AND BOUNDARY LAYER THEORY — **12**

Three dimensional forms of governing equations – Mass, Momentum and Energy equations and their engineering applications. Rotational and irrotational flows – vorticity – stream and potential functions. Boundary Layer–displacement, momentum and energy thickness–laminar and turbulent boundary layers in flat plates and circular pipes.

UNIT 2 INCOMPRESSIBLE AND COMPRESSIBLE FLOWS — **12**

Laminar flow between parallel plates– flow through circular pipe– friction factor– smooth and rough pipes – Moody diagram – losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes. One dimensional compressible flow analysis – flow through variable area passage–nozzles and diffusers.

UNIT 3 CONDUCTION AND RADIATION HEAT TRANSFER — **12**

Governing Equation and Boundary conditions, Extended surface heat transfer, Transient Conduction – Use of Heisler -Grober charts, Conduction with moving boundaries, Stefan and Neumann problem –Gas Radiation.

UNIT 4 TURBULENT FORCED CONVECTIVE HEAT TRANSFER — **12**

Turbulence theory–mixing length concept –turbulence model–k Є model–analogy between heat and momentum transfer–Reynolds, Colburn, Prandtl turbulent flow in a tube–high speed flows.

UNIT 5 PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER — **12**

Condensation on bank of tubes–boiling–pool and flow boiling, Heat exchanger–Є–NTU approach and design procedure–compact heat exchanger

TOTAL PERIODS — **60**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Identify, formulate and analyze the governing equations for various engineering Applications
CO2	Explain the flow concepts of incompressible and compressible flow.
CO3	Solve the conduction and radiation heat transfer problems.
CO4	Infer the turbulent forced convective heat transfer
CO5	Design a heat exchanger as per the industrial needs.

TEXT BOOKS

1. Yunus A Cengel and John M Cimbala, “Fluid Mechanics Fundamentals and Applications,”TMHLtd.,Second Edition,2006.

2. ShivKumar, “Fluid Mechanics Basic Concepts & Principles“ Ane Books Pvt. Ltd, Second Edition 2011

REFERENCES

1. Venkateshan SP., “Heat Transfer” Ane Books Pvt. Ltd, 2011

2. Holman JP, “Heat Transfer”, TMH Ltd., Ninth Edition, 2010.

3. Ozisik MN., “Heat Transfer–A Basic Approach”, McGraw Hill Co,1985.

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	PSO1	PSO2	PSO3
CO1	3	-	1	1	-	-
CO2	3	-	1	1	-	-
CO3	3	-	2	-	-	-
CO4	3	-	2	-	-	-
CO5	3	-	3	-	-	-
AVG	3	-	1.8	0.4	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY103	INSTRUMENTATION FOR ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1	To impart knowledge about characteristics of measurement system and statistical analysis of Measured data.
2	To make students conversant with the electrical measurements and signal conditioning circuits.
3	To provide insight into the digital measuring techniques of physical quantities and Solar instruments.
4	To make the students get acquainted with the measurement of thermo-physical properties and air pollutants.
5	To inculcate skills in the design and development of measurement and control systems.

UNIT 1 MEASUREMENT SYSTEM: CHARACTERISTICS AND STATISTICAL ANALYSIS	**9**
Introduction to measurement system, Errors in Measurement, Static and Dynamic characteristics of transducers, Statistical analysis of experimental data–Uncertainty analysis, Regression analysis, Design of experiments–Full and Half factorial design.	
UNIT 2 ELECTRICAL MEASUREMENTS AND SIGNAL CONDITIONING	**9**
Voltage, Current, Power, Energy, Time and Frequency measurement, Frequency Counter, Signal conditioning Circuits: Wheatstone bridge–Differential Amplifier–VtoI Converter, ItoV Converter, Integrator, Differentiator, Instrumentation Amplifier, Attenuators and Filters, DAC, ADC,PID Controller.	
UNIT 3 DIGITAL MEASUREMENT OF PHYSICAL QUANTITIES	**9**
Digital measuring techniques of Displacement, Temperature, Pressure, Force, Torque, Vibration, Acceleration, Velocity, Level, Flow, Thermal and Nuclear Radiation. Solar instruments: Pyrheliometers – Pyranometers – Pyrheliometers – Albedometers – Pyrradiometers – Pyrgeometers – Net Pyrradiometers – Sun photometers.	
UNIT 4 MEASUREMENT OF T HERMO-PHYSICAL PROPERTIES AND AIR POLLUTANTS	**9**
Measurement of Thermal Conductivity–Solids, Liquids and Gas, Viscosity, Gas Diffusion. Calorimetry – Bomb Calorimeter – Continuous flow Calorimeter. Measurement of Heat Transfer, Humidity, Heat flux, pH, Air pollution Sampling and Measurement–Particulate Sampling techniques –Measurement of Sulphur Dioxide, Combustion products, Opacity and Odour.	
UNIT 5 CONTROL SYSTEMS	**9**
Introduction to Controller – Interfacing with I/O devices of system: Sensors, Display devices, Stepper and Servomotors. Measurement by Data Acquisition System. Introduction to Internet of Things (IoT) – Application of IoT with Raspberry Pi for Process monitoring and control–Energy management. PID Controller in thermal systems-Application of Smart Sensors and Intelligent instrumentation and Control.	
TOTAL PERIODS	**45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Analyze and evaluate the uncertainties in measurement data.
CO2	Identify appropriate sensors for measuring electrical quantities and signal conditioning Circuits.
CO3	Explain the digital measurement techniques of physical quantities and solar instruments.
CO4	Compare the thermo-physical properties of air pollutants and identify air pollutant measurement techniques.
CO5	Design and develop the appropriate measurement and control system for an application.

TEXT BOOKS

1. Barney G.C., “Intelligent instrumentation: microprocessor applications in measurement and Control”, Prentice Hall,1988.1.

2. Bell C., “Beginning Sensor Networks with Arduino and Raspberry Pi”, Apress, 2013

REFERENCES

1. Doebelin E. and Manik D.N., “Doebelin's Measurement Systems”, Tata McGraw Hill, 2011.

2. George, B., Roy, J.K., Kumar, V.J., Mukhopadhyay, S.C., “Advanced Interfacing Techniques for Sensors”, Springer, 2017.

3. Holman J.P., “Experimental methods for Engineers”,Tata McGrawHill,2007.

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	PSO1	PSO2	PSO3
CO1	3	-	3	1	-	-
CO2	3	-	1	1	-	3
CO3	3	-	1	1	-	-
CO4	3	-	3	1	2	-
CO5	3	-	3	2	-	3
AVG	3	-	2.2	1.2	2	3

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY104	RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

1	To know the present status of Indian and global energy scenario.
2	To learn the various solar energy technologies and its applications.
3	To educate the various wind energy technologies.
4	To explore the various bio-energy technologies.
5	To study the ocean and geothermal technologies.

UNIT 1 ENERGY SCENARIO — **9**

Indian energy scenario in various sectors–domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption –Future energy plans

UNIT 2 SOLAR ENERGY — **9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems –Solar PV applications.

UNIT 3 WIND ENERGY — **9**

Wind data and energy estimation – Betz limit – Site selection for wind farms – characteristics – Wind resource assessment – Horizontal axis wind turbine – components – Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems–Environmental issues- Applications.

UNIT 4 BIO-ENERGY — **9**

Bio resources – Biomass direct combustion – thermochemical conversion – biochemical conversion-mechanical conversion – Biomass gasifier – Types of biomass gasifiers –Cogeneration – Carbonisation – Pyrolysis – Biogas plants – Digesters –Biodiesel production – Ethanol production –Applications.

UNIT 5 OCEAN AND GEOTHERMAL ENERGY — **9**

Small hydro –Tidal energy–Wave energy–Open and closed OTEC Cycles–Limitations –Geothermal energy–Geothermal energy sources – Types of geothermal power plants – Applications- Environmental impact.

TOTAL PERIODS — **45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Illustrate the Indian and global energy scenario
CO2	Compare various solar energy technologies and identify its applications.
CO3	Infer wind data and compare various wind energy systems.
CO4	Examine various bio-energy technologies and identify their application.
CO5	Interpret ocean and geothermal energy conversion technologies.

TEXT BOOKS

1. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press,U.K., 2012.

2. David M. Buchla., “Renewable Energy Systems”, pearson education publication, Hard cover/Paperback-2017.

REFERENCES

1. Sukhatme.S.P., “Solar Energy: Principles of Thermal Collection and Storage”,Tata McGraw Hill Publishing Company Ltd., New Delhi,2009.

2. TiwariG.N.,“Solar Energy–Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.

3. Mehmet Kanoglu “Fundamentals and Applications of Renewable Energy”, Indian edition McGraw Hill Publication, Hard cover/Paperback-2020.

4. Twidell,J.W.&WeirA.,“Renewable Energy Resources”, EFN Spon Ltd., UK, 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	PSO1	PSO2	PSO3
CO1	1	-	1	1	3	2
CO2	3	-	2	2	3	2
CO3	3	-	2	3	3	2
CO4	3	-	2	3	3	3
CO5	2	-	2	1	3	1
AVG	2.4	-	1.8	2	3	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY105	THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives

1	To understand, apply and analyze the concept of availability to the thermodynamic systems
2	To understand, study and analyze the behavior of real gas and gas mixtures
3	To understand the applications of first and second law to chemically reacting systems
4	To study, balance and analyze the various combustion aspects of hydrocarbon fuels
5	To apply the concepts of thermodynamics to IC Engines and Gas turbines energy systems

UNIT 1 AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS — **12**

Reversible work – availability – irreversibility. Second law efficiency for a closed system and steady – state, control volume. Availability analysis of simple cycles. Thermodynamic potentials. Maxwellrelations. Generalized relations for changes in entropy – internal energy and enthalpy – Cpand CV. Clausius Clayperon equation, Joule – Thomson coefficient. Bridgeman tables for thermodynamic relations.

UNIT 2 PROPERTIES OF REALGAS AND GAS MIXTURES — **12**

Different equations of state – fugacity – compressibility. Principle of corresponding States – Use of generalized charts for enthalpy and entropy departure. Fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Ideal and real gas mixtures.

UNIT 3 CHEMICAL THERMODYNAMICS AND EQUILIBRIUM — **12**

First and second law analysis of reacting systems – Adiabatic flame temperature – entropy change of reacting systems. Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures and evaluation of equilibrium composition.

UNIT 4 COMBUSTION CHEMISTRY — **12**

Combustion of Hydrocarbon Fuels. Heat of reaction, combustion and formation. Stoichiometric, fuel rich and oxygen rich reactions. Heating value of fuels. Explosion limits, flames and flammability limits. Diffusion and premixed flames.

UNIT 5 COMBUSTION PROCESSES AND COMBUSTION CHAMBERS — **12**

Combustion in IC Engines and Gas turbines. Knocking and Detonation and control. Design principles of combustion chambers for IC Engines and Gas turbine. Arrangements of gas turbine combustion – comparative analysis.

TOTAL PERIODS — **60**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Explain the availability and entropy of the thermodynamic systems and simple cycles, and apply various thermodynamic relations to arrive at the T-dS relations
CO2	Examine the behavior of real gas through empirical equations and thermodynamic tables, and calculate the various properties of gas mixtures
CO3	Apply first and second law to chemically reacting closed and open systems and arrive at the various thermodynamic parameters
CO4	Calculate the air fuel ratio, chemical composition of combustion products, understand the various levels of air supply to the hydrocarbon fuels and combustion limits
CO5	Make use of the knowledge of thermodynamics for analyzing the process of combustion and its related parameters in an IC Engine and study the various arrangements of Gas Turbine systems

TEXT BOOKS

1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
2. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw – Hill Inc., 1995.

REFERENCES

1. Kalyan Annamalai, Ishwar K. Puri, Milind A. Jog., Advanced thermodynamics engineering, CRC press, 2011.
2. Claus Borgnakke, Richard E. Sonntag., Fundamentals of Thermodynamics, John Wiley & Sons, 2009.
3. Ganesan, V., Thermodynamics: Basics and Applied, Tata McGraw Hill, 2018.
4. Natarajan, E., Engineering Thermodynamics – Fundamentals and Applications, Anuragam Publications, 2014.
5. Rao, Y. V. C., Chemical Engineering Thermodynamics, University Press, 1997.

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	PSO1	PSO2	PSO3
CO1	3	-	-	1	-	-
CO2	3	-	2	1	-	-
CO3	3	-	2	3	-	-
CO4	3	-	2	3	-	-
CO5	2	-	2	2	-	-
AVG	2.8	-	2	2.5	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24RM101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

UNIT 1 RESEARCH DESIGN	**6**
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.	
UNIT 2 DATA COLLECTION AND SOURCES	**6**
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.	
UNIT 3 DATA ANALYSIS AND REPORTING	**6**
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.	
UNIT 4 INTELLECTUAL PROPERTY RIGHTS	**6**
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.	
UNIT 5 PATENTS	**6**
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents	
TOTAL PERIODS	**30**

TEXT BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).

2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.

REFERENCES

1. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.

2. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY106	RENEWABLE ENERGY LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives

1	To learn the working of different renewable energy devices.
2	To understand the methodology adopted for performance evaluation of various renewable energy systems.
3	To understand the emission from biodiesel engines and biofuel analysis.

LIST OF EXPERIMENTS

1. Study on solar radiation measurement devices
2. Performance testing of solar water heater
3. Determining the characteristics of solar photovoltaic materials and estimation of MPP(I-V curve)
4. Performance evaluation of solar cookers (box type and concentrating type)
5. Evaluating and comparing the efficiency of conventional stove and improved (energy efficient) cook stoves.
6. Testing of biomass Gasifier in up draught / down draught mode. Study of biogas plant–fixed dome and floating drum model
7. Proximate analysis of a given biofuel
8. Estimation of calorific value of any solid fuels using bomb calorimeter
9. Computation of calorific value of liquid fuels using Junkers gas calorimeter
10. Synthesis of biodiesel –energy and mass balancing
11. Performance evaluation of engine on biodiesel
12. Comparison of combustion and emissions of B0 and B100

TOTAL PERIODS **60**

Course Outcomes

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

CO1	Evaluate the performance of renewable energy devices.
CO2	Analyze the factors influencing the efficiency and suggest methods for improving the Adaptability and efficiency of renewable energy devices.
CO3	Appraise testing methods and evaluate emissions from renewable energy systems

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	PSO1	PSO2	PSO3
CO1	3	-	3	2	-	2
CO2	3	-	3	2	-	2
CO3	2	-	3	2	-	3
AVG	2.66	-	3	2	-	2.33

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY107	APPLIED THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives

1	To educate the students on the realities of thermal engineering.
2	To educate the students about calibration and its essentiality in thermal systems.
3	To Educate the students on thermal engineering concepts

LIST OF EXPERIMENTS

1. Experimental Studies on Thermal Boundary Layer for different geometries.
2. Calibration of Temperature Transducers (Thermocouple, RTD & Thermistors).
3. Calibration of Pressure Transducers.
4. Experimental Analysis of Organic Rankine Cycle.
5. Fluid and Thermal Transfer Properties of Liquid Fuels/Heat Transfer Fluids.
6. Experimental Studies on Pool Boiling of Water using Flow Visualization Technique.
7. Flow Characteristic occurrence between Bodies in Wind Tunnel.
8. Experimental Studies on Fluidization of Solid Fuels.
9. Studies on Absorption Refrigeration System.
10. Experimental Studies on Drying of Agro Products.
11. Determining the Actual p-v Diagram of an IC Engine.

	TOTAL	**60**

Course Outcomes

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

CO1	Construct the error curve and correction curve for different measuring instruments.
CO2	Analyze the critical/influential properties of thermal systems.
CO3	Interpret the heat transfer and mass transfer in thermal devices

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	PSO1	PSO2	PSO3
CO1	3	-	2	2	-	2
CO2	3	-	3	2	-	2
CO3	2	-	3	3	-	2
AVG	2.66	-	2.66	2.33	-	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY201	ENERGY CONSERVATION IN INDUSTRIAL UTILITIES	L	T	P	C
		3	0	0	3

Course Objectives

1	To understand the types of fuels used in Industries and their characteristics
2	To Know the techniques adopted for performance evaluation of thermal utilities
3	To Learn and appreciate the working principle employed in VCRS and VAM systems
4	To list the parameters considered in electricity billing and the losses associated with a motor
5	To Comprehend the techniques available for energy conservation in electrical utilities

UNIT 1 BOILERS — **9**

Types-Performances evaluation via direct and indirect method–energy conservation avenues. Properties of steam – Assessment of steam distribution losses – Steam trapping –Condensate and flash steam recovery system – Opportunities for energy saving in steam consumption systems

UNIT 2 FURNACES AND THERMIC FLUID HEATERS — **9**

Furnaces and Thermic Fluid Heaters: Types-Performances evaluation via direct and indirect method–energy conservation avenues. Insulation and Refractory: types and application

UNIT 3 HVAC AND WASTE HEAT RECOVERY — **9**

VCRS – performance assessment – energy savings opportunities – VAM: working, types, benefits, comparison with vapor compression system. WHR systems: Classification–Benefits- Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate,Shell & Tube),heat pumps, thermo compressor.CHP– Poly generation

UNIT 4 ELECTRICAL SYSTEMS AND INDUCTION MOTORS — **9**

Electricity billing – Demand side management – Power factor improvement transformer losses – Harmonics induction Motors : Types – Losses – performance assessment adopting direct and indirect method-Factors affecting motor performance-energy efficient motors

UNIT 5 ENERGY CONSERVATION IN ELECTRICAL UTILITIES — **9**

Performance assessment and energy conservation avenues in: fans-blowers–pumps–air compressors-illumination systems –cooling towers

TOTAL — **45**

Course Outcomes

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

CO1	Estimate the stoichiometric air for fuel and suggest measures for efficient combustion
CO2	Discover the cause for underperformance of thermal utilities and suggest suitable remedial measures there of
CO3	Analyse the factors affecting the COP of a VCR and VAR system
CO4	Evaluate the performance of induction motors and transformers
CO5	Assess energy conservation avenues of thermal and electrical utilities

TEXT BOOKS

1. Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp,a website administered by Bureau of Energy Efficiency
(BEE), a statutory body under Ministry of Power, Government of India. 2004.

2. L.C.Witte, P.S.Schmidt, D.R.Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ,Washington,1988.

REFERENCES

1. W.C.turner, “Energy Management Handbook”Wiley,NewYork,1982

2. W.R. Murphy and G. McKay “Energy Management” Butter worths, London1987

3. Eastop.T.D & Croft D.R, Energy Efficiency for Engineers and Technologists,. Logman Scientific &Technical, ISBN-0-582-03184,1990.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	2	2	-	-
CO2	3	-	2	2	-	-
CO3	3	-	3	2	-	-
CO4	3	-	2	2	-	-
CO5	3	-	2	3	-	-
AVG	3	-	2.2	2.2	-	-

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY202	COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives

1	To make students familiarize with the computational analysis.
2	To understand, apply and analyze to numerically solve the steady and unsteady diffusion problems by various schemes.
3	To understand, apply and analyze to numerically solve the convection-diffusion problems by various discretization techniques.
4	To study and understand the discretization of incompressible flow governing equations by various pressure velocity decoupling algorithms.
5	To impart and make students familiarize with the knowledge of various turbulence models

UNIT 1 GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES	**12**
Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species – Classification of partial differential equations – Initial and Boundary Conditions – Discretization techniques using finite difference methods – Taylor's Series – Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	
UNIT 2 DIFFUSION PROCESSES: FINITE VOLUME METHOD	**12**
Steady one-dimensional diffusion, two and three dimensional steady state diffusion problems, Discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.	
UNIT 3 CONVECTION-DIFFUSION PROCESSES: FINITEV OLUME METHOD	**12**
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme –Hybrid and power law discretization techniques – QUICK scheme. – Assessment of discretization scheme properties.	
UNIT 4 INCOMPRESSIBLE FLOW PROCESSES: FINITE VOLUME METHOD	**12**
Discretization of incompressible flow equations – Stream Function – Vorticity methods – Pressure based algorithms, SIMPLE, SIMPLER, SIMPLEC & PISO algorithms.	
UNIT 5 TURBULENCE MODELLING	**12**
Kolmogorov's Theory – Turbulence – Algebraic Models, One equation model & k – , k – models – Standard and High and Low Reynolds number models.	
	TOTAL **60**

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Infer the fundamental governing equations and apply the boundary conditions to arrive at the unknown variables.
CO2	Solve the diffusion heat transfer problems by finite volume method.
CO3	Formulate the convection-diffusion heat transfer problems by finite volume method.
CO4	Interpret the incompressible flow governing equations by applying various pressure velocity decoupling algorithms.
CO5	Construct various turbulence models available.

TEXT BOOKS

1. Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics The Finite Volume Method,” Pearson Education, Ltd., Second Edition,2014.

2. Anderson,D.A., Tannehill,J.I., and Pletcher,R.H., “Computational fluid Mechanics and Heat Transfer“ Hemisphere Publishing Corporation,NewYork,USA,1984

REFERENCES

1. Suhas, V. Patankar, “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation,1980.

2. TapanK.Sengupta,“FundamentalsofComputationalFluidDynamics”UniversitiesPress, 2011.

3. Muralidhar,K., and Sundararajan,T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi,1995.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	2	3	-	-
CO2	3	-	3	3	-	-
CO3	3	-	3	3	-	-
CO4	2	-	2	3	-	-
CO5	2	-	2	3	-	-
AVG	2.4	-	2.4	3	-	-

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY203	ENERGY EFFICIENT BUILDING DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

1	To learn the green buildings concepts applicable to alternate design
2	To be familiar with basic terminologies related to buildings
3	To learn the building(air)conditioning techniques
4	To know the methods to evaluate the performance of buildings
5	To incorporate Renewable energy systems in buildings

UNIT 1 INTRODUCTION — **9**

Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards

UNIT 2 LAND SCAPE AND BUILDING ENVELOPES — **9**

Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity(DHC),ThermalLag, Decrement Factor, Effect of Solar Radiation –Sol-air Temperature, Processes of heat exchange of building with environment, Insulation

UNIT 3 PASSIVE HEATING AND COOLING — **9**

HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Day lighting, Passive Cooling–Natural Ventilation(Stack and Wind),Evaporative Cooling and Radiative Cooling

UNIT 4 THERMAL PERFORMANCE OF BUILDINGS — **9**

Heat transfer due to fenestration / infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

UNIT 5 RENEWABLE ENERGY IN BUILDINGS — **9**

ntroduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, stand-alone PV systems, Hybrid system–Economics.

TOTAL — **45**

Course Outcomes

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

CO1	Design climate responsive building
CO2	Discover various physical properties influencing passive building design
CO3	Apply the passive(air)conditioning techniques in energy efficient building
CO4	Interpret the energy performance of buildings
CO5	Appraise the adaptation of renewable energy systems in buildings

TEXT BOOKS

1. ASHRAEHandbook-2009-Fundamentals.

2. Baruch Givoni: Climate considerationsinbuildingandUrbanDesign,JohnWiley&Sons,1998

REFERENCES

1. Baruch Givoni: Passive Low Energy Cooling of Buildings by,John Wiley & Sons,15-Jul-1994

2. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley& Sons, 2006.

3. Jan F. Kreider, Peter S.Curtiss, Ari Rabl, Heating and cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press,28-Dec-2009.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	3	-	1	1
CO2	3	-	2	2	3	-
CO3	3	-	3	3	3	2
CO4	3	-	3	3	3	1
CO5	3	-	3	3	3	3
AVG	2.8	-	2.8	2.75	2.6	1.75

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY204	ENERGY CONSERVATION LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives

1	To Understand the working and usage of instruments employed in energy audits
2	To Learn the methodology adopted for performance evaluation of industrial equipments
3	To compare the performance parameters of equipments with benchmark standards to explore the avenue for performance improvement.

LIST OF EXPERIMENTS

1. Study of energy audit instruments (flue gas analyser, calorimeter, pitottube, digital pressure indicator, differential manometer, anemometer – vane type and thermal type, digital tachometer – contact/non-contact, stroboscope, hygrometer, temperature indicator – contact type and non-contact type, ultrasonic leak detector, ultrasonic flow meter, lux meter, energy manager, harmonic analyzer, KVA demand analyser)
2. Performance evaluation of boiler adopting direct and indirect method
3. Determining the efficiency of a simple impulse steam turbine
4. Assessment of performance of steam condensers
5. Performance evaluation of air compressors and computing its specific energy consumption and cost of compressed air
6. Determining the characteristics of an induction motor and computing its efficiency adopting direct and indirect method
7. Determination of pump & pumping system characteristics (pump curve, system curve and BEP)
8. Comparison on the effect of different discharge control techniques in pumps (VFD, throttling and bypass mode) with respect to specific energy consumption
9. Analysis of various luminaries and evaluation of their efficacy
10. Determination of characteristic curves of blowers and comparison of its characteristic supon subjecting it to damper control at inlet and discharge.
11. Performance evaluation of cooling tower
12. Comparison on the performance of shell and tube, pipe-in-pipe and plate heat exchangers

	TOTAL	**60**

Course Outcomes

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

CO1	Evaluate the specific energy consumption of industrial utilities
CO2	Estimate the cost of energy for process essentials like steam, compressed air
CO3	Examine the performance parameters of various energy equipments

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

CO, PO Mapping						
CO / PO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	2	-	-	2
CO2	3	-	2	-	-	2
CO3	3	-	3	-	-	2
AVG	3	-	2.33	-	-	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EY205	ANALYSIS AND SIMULATION LABORATORY FOR ENERGY ENGINEERING	L	T	P	C
		0	0	4	2

Course Objectives

1	To provide a platform to learn and get familiar with computational analysis
2	To learn the simulation and analysis of software for solving of flow with heat transfer related problems
3	To predict the heat transfer equipment performance using models.

LIST OF EXPERIMENTS

1. Heat exchanger analysis–NTU method
2. Heat exchanger analysis–LMTD method
3. Convection heat transfer analysis–Velocity boundary layer
4. Convection heat transfer analysis –Internal flow
5. Radiation heat transfer analysis –Emissivity
6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis
10. Analysis on flow through pipe
11. Nozzle/Diffuser Analysis
12. Boiling heat transfer analysis

TOTAL	**60**

Course Outcomes

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

CO1	Use modern engineering software is to analyze the flow with heat transfer related problems
CO2	Analyse the various parameters influencing the performance of thermodynamic systems
CO3	Predict the thermal and flow performance of different models of various thermal and fluid systems.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	3	3	-	-
CO2	3	-	3	3	-	-
CO3	3	-	3	2	-	-
AVG	3	-	3	2.66	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP01	DESIGN AND ANALYSIS OF TURBOMACHINES	L	T	P	C
		3	0	0	3

Course Objectives

1	To understand the basics of isentropic flow and energy transfer process in turbo machines and to derive the governing equations.
2	To under stand the functional aspects and performance of compressors.
3	To learn about the components of combustion chamber and their functions
4	To understand the working and performance of axial & radial turbines
5	To calculate the performance of gas turbines and jet engine cycles.

UNIT 1 INTRODUCTION	**9**
Basics of isentropic flow–static and stagnation properties–diffuser and nozzle configurations– area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbo machines – velocity diagrams. Euler's equation for turbo machines and its different forms. Degree of reaction in turbo-machines–various efficiencies – isentropic, mechanical, thermal, overall and polytropic.	
UNIT 2 CENTRIFUGAL AND AXIAL FLOW COMPRESSORS	**9**
Centrifugal compressor – configuration and working – slip factor – work input factor – ideal and actual work – pressure coefficient - pressure ratio. Axial flow compressor – geometry and working–velocity diagrams–ideal and actual work–stage pressure ratio–free vortex theory–performance curves and losses.	
UNIT 3 COMBUSTION CHAMBER	**9**
Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements–flame stability–fuel injection nozzles. Flame stabilization–cooling of combustion chamber.	
UNIT 4 AXIAL AND RADIAL FLOW TURBINES	**9**
Elementary theory of axial flow turbines– stage parameters – multi-staging– stage loading and flow coefficients. Degree of reaction – stage temperature and pressure ratios – single and twin spool arrangements – performance. Matching of components. Blade Cooling. Radial flow turbines.	
UNIT 5 GAS TURBINE AND JET ENGINE CYCLES	**9**
Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulse jet Engines and cycle analysis – thrust, specific impulse, and specific fuel consumption, thermal and propulsive efficiencies.	
TOTAL	**45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Analyze the energy transfer process in thermodynamic systems
CO2	Appraise the performance of centrifugal flow and axial flow combustion systems
CO3	Design and develop the combustion chamber for turbo machines
CO4	Compare and analyze the performance of axial and radial flow turbines
CO5	Predict the performance of gas turbines and thermodynamic energy systems

TEXT BOOKS

1. Ganesan,V.,GasTurbines,TataMcGrawHill,2011.

2. Cohen H, Rogers G.F.C, Saravan motto H.I.H, Straznicky P.V, Nix A.C, Gas Turbine Theory, Pearson, 7th Edition 2018.

REFERENCES

1. Khajuria P.R and DubeyS.P., GasTurbines and Propulsive Systems, Dhanpat Rai Publications, 2011

2. HillPG and Peterson CR, Mechanics and Thermodynamics of Propulsion, Pearson Education, 2nd edition, 2009.

3. Mattingly JD, Elements of Gas turbine Propulsion, McGraw Hill, Edition.2005

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	2	2	-	-
CO2	3	-	2	3	-	-
CO3	2	-	2	2	-	-
CO4	1	-	2	1	-	-
CO5	2	-	2	2	-	-
AVG	2	-	2	2	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP02	FLUIDIZED BED SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

1	To understand the behavior of fluidized beds
2	To learn about the heat transfer process
3	To differentiate the combustion and gasification, and appreciate the relative merits
4	To design components of fluidized bed systems
5	To understand the industrial applications of fluidized bed systems

UNIT 1 FLUIDIZED BED BEHAVIOUR — **9**

Characterization of bed particles–comparison of different methods of gas–solid contacts. Fluidization phenomena – regimes of fluidization – bed pressure drop curve. Two phase and well-mixed theory of fluidization. Particle entrainment and elutriation – unique features of circulating fluidized beds.

UNIT 2 HEAT TRANSFER — **9**

Different modes of heat transfer in fluidized bed– bed to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces. Methods for improvement –external heat exchangers– heat transfer and part load operations.

UNIT 3 COMBUSTION AND GASIFICATION — **9**

Fluidized bed combustion and gasification–stages of combustion of particles–performance–start – up methods. Pressurized fluidized beds.

UNIT 4 DESIGN CONSIDERATIONS — **9**

Design of distributors–stoichiometric calculations–heat and mass balance–furnace design–design of heating surfaces–gas solid separators.

UNIT 5 INDUSTRIAL APPLICATIONS — **9**

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing. Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

TOTAL — **45**

Course Outcomes

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

CO1	Illustrate the behavior of fluidized bed particles and explain the theory of fluidization.
CO2	Analyze the heat transfer process in fluidized beds
CO3	Apply concepts of combustion and gasification in fluidized beds
CO4	Interpret the design consideration for components of fluidized bed system.
CO5	Evaluate fluidized bed systems for various industrial applications.

TEXT BOOKS

1. Howard,J.R.,Fluidized Bed Technology:Principles and Applications, Adam Hilger,New York,1983.

2. Geldart, D., Gas Fluidization Technology, John Willey and Sons, 1986.

REFERENCES

1. Kunii,D and Levespiel,O., Fluidization Engineering, John Wiley and Son Inc, New York,1969.

2. Howard,J.R.(Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, New York, 1983.

3. Botteril,J.S.M., Fluid Bed Heat Transfer, Academic Press, London,1975.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	2	3	-	-
CO2	3	-	3	3	-	-
CO3	3	-	2	3	2	2
CO4	3	-	3	3	2	2
CO5	3	-	2	3	2	2
AVG	3	-	2.4	3	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP03	BIO ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

1	To learn availability of biomass, methods of biomass analysis and study of characteristics.
2	To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3	To impart knowledge on stoichiometry and combustion of biofuels and costing of biomass technologies
4	To elucidate the thermochemical conversion methods of biomass and its use in engines
5	To provide insight to the possibilities of producing liquid fuels form biomass

UNIT 1 INTRODUCTION — **9**

Biomass: types–advantages and drawbacks–Indian scenario–characteristics–carbon neutrality–conversion mechanisms–fuel assessment studies–densification technologies Comparison with coal – Proximate & Ultimate Analysis – Thermo Gravimetric Analysis –Differential Thermal Analysis–Differential Scanning Calorimetry

UNIT 2 BIOMETHANATION — **9**

Microbial systems – phases in biogas production – parameters affecting gas production – effect of additives on biogas yield – possible feed stocks. Biogas plants – types – design –constructional details and comparison – biogas appliances – burner, luminaries and power generation – effect on engine performance.

UNIT 3 COMBUSTION — **9**

Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems –steam cost comparison with conventional fuels.

UNIT 4 GASIFICATION, PYROLYSIS AND CARBONISATION — **9**

Chemistry of gasification- types–comparison–application–performance evaluation–economics– dual fuelling in IC engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning systems – Pyrolysis – Classification – process governing parameters – Typical yield rates. Carbonization Techniques–merits of carbonized fuels

UNIT 5 LIQUIFIED BIOFUELS — **9**

History of usage of Straight Vegetable Oil (SVO) as fuel – Biodiesel production from oil seeds, waste oils and algae – Process and chemistry – Biodiesel health effects / emissions /performance. Production of alcoholic fuels (methanol and ethanol) from biomass –engine modifications

TOTAL — **45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Estimate the availability of surplus biomass and study the characteristics
CO2	Design a biogas plant for different bioenergy sources
CO3	Determine and compare the cost of steam generation from biofuels with conventional fuels.
CO4	Analyze the influence of process governing parameters in thermo chemical conversion of biomass and in internal combustion engines
CO5	Evaluate the production of liquid biofuels for power generation from biomass

TEXT BOOKS

1. David Boyles,Bio Energy Technology Thermodynamics and costs, Ellis Horwood Chichester,1984.

2. Iyer PV Retal, Thermo chemical Characterization of Biomass, MNES

REFERENCES

1. KhandelwalKC, Mahdi SS, Biogas Technology–A Practical Handbook,Tata McGraw Hill,1986

2. Maheswari,R.C. BioEnergy for Rural Energisation, Concepts Publication,1997

3. Tom B Reed, Biomass Gasification–Principles and Technology, Noyce Data Corporation,1981.

4. Bioenergy: Biomass to Biofuels and Waste to Energy, Academic Press,2020

5. David C. Dayton , Thomas D. Foust ,Analytical Methods for Biomass Characterization and Conversion (Emerging Issues in Analytical Chemistry), Elsevier,2019

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	-	1	-	3	-
CO2	2	-	2	-	2	-
CO3	2	-	2	-	1	-
CO4	2	-	2	-	1	-
CO5	2	-	2	-	1	-
AVG	1.8	-	1.8	-	1.6	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP04	ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

1	To impart knowledge about the present status of energy scenario in India.
2	To predict the energy demand using various forecasting models.
3	To develop an optimization model for the effective utilization of energy sources.
4	To understand and learn the procedure to the write the project proposal.
5	To learn the present status of energy policies in the country.

UNIT 1 ENERGY SCENARIO — **9**

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics – Energy Sources and Overall Energy demand and Availability – Energy Consumption in various sectors and its changing pattern –Status of Nuclear and Renewable Energy: Present Status and future promise.

UNIT 2 FORECASTING MODEL — **9**

Forecasting Techniques – Regression Analysis – Double Moving Average – Double Experimental Smoothing – Triple Exponential Smoothing – ARIMA model- Validation techniques – Qualitative forecasting–Delphi technique-Concept of Neural Net Works.

UNIT 3 OPTIMIZATION MODEL — **9**

Principles of Optimization – Formulation of Objective Function – Constraints – Multi Objective Optimization–Mathematical Optimization Software–Development of Energy Optimization Model-Development of Scenarios– Sensitivity Analysis-Concept of Fuzzy Logic.

UNIT 4 PROJECT MANAGEMENT — **9**

Project Preparation – Feasibility Study – Detailed Project Report – Project Appraisal – Social-cost benefit Analysis – Project Cost Estimation – Project Risk Analysis – Project Financing – Financial Evaluation.

UNIT 5 ENERGY POLICY — **9**

National & State Level Energy Issues – National & State Energy Policy – Energy Security –National solar mission – state solar energy policy – Framework of Central Electricity Authority(CEA),Central & States Electricity Regulatory Commissions (CERC & ERCs)- Costing.

TOTAL — **45**

Course Outcomes

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

CO1	Illustrate the energy scenario and appraise energy availability
CO2	Predict energy demand using various forecasting models.
CO3	Develop different optimization model for energy planning.
CO4	Formulate project proposal and financial evaluation.
CO5	Interpret the national and state energy policies.

TEXT BOOKS

1. ArmstrongJ.Scott (ed.), Principles of forecasting: a handbook for researchers and practitioners,Norwell, Massachusetts:Kluwer Academic Publishers.2001.

2. Dhandapani Alagiri, Energy Security in India Current Scenario, the ICFAI University Press,2006.

REFERENCES

1. Fred Luthans, BrettC. Luthan, KyleW.Luthans, Organisational Behaviour: An Evidence-Based Approach, Information Age Publishing edition,2015

2. Spyros G. Makridakis, Steven C.Wheelwright, Rob J.Hyndman, Forecasting:Methods and Applications, 4th Edition,ISBN:978-0-471-53233-0,2003

3. YangX.S.,Introduction to mathematical optimization:From linear programming to Metaheuristics,Cambridge, Int. Science Publishing,2008.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	3	1	1	2	1
CO2	3	3	2	3	2	2
CO3	3	2	2	3	3	2
CO4	2	3	3	3	-	2
CO5	1	3	2	-	-	2
AVG	2	2.8	2	2.5	2.33	1.8

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP05	MODELING AND ANALYSIS OF ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives	
1	To learn to apply mass and energy balances for the energy systems
2	To impart knowledge about the modeling and simulation techniques for energy systems.
3	To provide insight into optimization techniques to optimize the energy system.
4	To learn to use the energy-economy models.
5	To explore the various application and case studies.

UNIT 1 INTRODUCTION	**9**
Primary energy analysis- energy balance for closed and control volume systems – applications of energy analysis for selected energy system design – modeling overview – levels and steps in model development –Examples of models–curve fitting and regression analysis	
UNIT 2 MODELLING AND SYSTEMS SIMULATION	**9**
Modeling of energy systems – heat exchanger – solar collectors – distillation –rectification turbo machinery components – refrigeration systems – information flow diagram – solution of set of non- linear algebraic equations – successive substitution – Newton Raphson method- examples of energy systems simulation	
UNIT 3 OPTIMISATION TECHNIQUES	**9**
Objectives-constraints, problem formulation-unconstrained problems-necessary and sufficiency conditions. Constrained optimization – Lagrange multipliers, constrained variations, Linear Programming- Simplex tableau, pivoting, sensitivity analysis-New generation optimization techniques–Genetic algorithm and simulated annealing–examples.	
UNIT 4 ENERGY-ECONOMY MODELS	**9**
Multiplier Analysis – Energy and Environmental Input / Output Analysis – Energy Aggregation – Econometric Energy Demand Modeling-Overview of Econometric Methods-Dynamic programming-Search Techniques –Univariate/Multivariate	
UNIT 5 APPLICATIONS AND CASE STUDIES	**9**
Case studies of optimization in Energy systems problems- Dealing with uncertainty- probabilistic techniques –Trade-offs between capital and energy using Pinch analysis	
TOTAL	**45**

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Apply mass and energy balances for the energy systems
CO2	Propose simulation and modeling of typical energy system
CO3	Identify optimization techniques for energy systems.
CO4	Appraise Energy-Economic Analysis for the typical applications
CO5	Examine the application of optimization for energy systems and its economics

TEXT BOOKS

1. Bejan,A,Tsatsaronis,GandMoran,M.,ThermalDesignandOptimization,JohnWiley&Sons,1996

2. BalajiC., Essentials of Thermal System Design and Optimization, CRC Press, 2011.

REFERENCES

1. Chang, Ni-Bin, Systems analysis for sustainable engineering: theory and applications, New York :McGraw-Hill,c2011.

2. Stoecker W.F., Design of Thermal Systems, McGrawHill,2011

3. Yogesh Jaluria, Design and Optimization of Thermal Systems, CRCPress,2007

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	3	2	-	-
CO2	3	-	3	2	-	-
CO3	2	-	2	1	-	-
CO4	2	-	2	3	-	-
CO5	2	-	2	2	-	-
AVG	2.4	-	2.4	2	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP06	POWER GENERATION, TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

Course Objectives

1	To learn knowledge on Conventional Power Plants (Steam, Hydro, Nuclear and Gas Turbine plants)
2	To impart knowledge on Non-Conventional Power Plants(Renewable Energy)
3	To understand various components and factors affecting power transmission
4	To learn & understand the major electrical energy components and its Utilization of Electrical energy for various applications.
5	To understand the Economics of Power generation and transmissions.

UNIT 1 CONVENTIONAL POWER GENERATION — **9**

Steam power plant-Selection of site- Generated Layout-coal and Ash Handling-Steam Generating Plants – Feed Make Circuit – Cooling Towers – Turbine Governing –Hydro Power Plant-Selection of Site-Classification Layout Governing of Turbines-Nuclear Power Plants-Selection of Site – Classification Layout Governing of Turbines – Nuclear Power Plants – Gas Turbine Plants.

UNIT 2 NON CONVENTIONAL POWER GENERATION — **9**

Wind power generation-characteristics of wind power-design of wind mills-Tidal power generation – Single and two-basin systems –Turbines for tidal power – Solar power generation –Energy from biomass, biogas and waste

UNIT 3 ELECTRICAL POWER TRANSMISSION — **9**

Online diagram of transmission – substation and distribution systems – comparison of systems (DC and AC) – EHVAC and HVDC transmission – layout of substations and bus bar arrangements –Equivalents circuit of short, medium and long lines –Transmission efficiency regulation-reactive power – compensation-transmission –loss minimization.

UNIT 4 UTILISATION OF ELECTRICAL ENERGY — **9**

Selection of Electrical Drives-Electrical characteristics and mechanical considerations-size, rating and cost, Transformer characteristics – illumination – laws of illumination-polar curve –incandescent – fluorescent and vapour lamps – Design of OLTC lighting Scheme of industry-electrical welding-energy efficient aspects of devices

UNIT 5 ECONOMICS OF POWER GENERATION & TRANSMISSION — **9**

Daily load curves – load factor – diversity factor – load deviation curve – load management – number and size of generating unit, distribution losses, cost of electrical energy – tariff – power factor improvement

TOTAL — **45**

Course Outcomes

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

CO1	Explain the selection and operation of c onventional power plants.
CO2	Appraise the operation of renewable energy power generation
CO3	Explain about the functioning of major electrical energy component
CO4	Elucidate about power transmission and various factors involved affecting it
CO5	Assess the economics of power generation and utilization of electrical energy

TEXT BOOKS
1. Singh.S.N., Electrical Power generation, Transmission and Distribution 2nd Edition, PHI Learning Private Limited, 2010
2. Wadhwa.C.L., Generation Distribution and utilization of Electrical Energy, New Age International, 2012
REFERENCES
1. Twidell. J.W. and Weir. A.D., Renewable Energy Sources, Taylor and Francis, 2006.
2. Mohammed E. EI Hawary, Introduction to Electrical Power Systems, John Wiley&Sons,2008.
3. R. Krishnan, Electric Motor Drives, Prentice hall, 2001.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	1	-	-	-
CO2	3	-	1	-	3	-
CO3	2	-	2	1	-	-
CO4	2	-	2	2	-	-
CO5	2	-	1	1	-	-
AVG	2.4	-	1.4	1.33	3	-

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP07	NUCLEAR ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

1	To elucidate on the physics involved in nuclear reaction and radiation detection
2	To understand the reactor theory and classification of nuclear fuels
3	To comprehend the working of nuclear power plants and economic analysis
4	To understand the application of radioactivity
5	To acquire knowledge on nuclear waste management, storage and regulatory issues.

UNIT 1 NUCLEAR PHYSICS, RADIATION SOURCES AND DETECTION — **9**

Basic properties of nucleus and nuclear radiations, Nuclear Stability, Binding energy and nuclear stability, Radioactive Decay, Determination of mass of neutrino, Sources of Alpha, beta, gamma radiations, neutron sources, spontaneous fission source Detection techniques – Gas filled ionization detectors – Ionization chambers, proportional counters and GM counters. Pulse height spectra and energy resolution.

UNIT 2 NUCLEAR REACTOR THEORY, NUCLEAR REACTOR MATERIALS AND FUELS — **9**

Fissile and fertile atoms, conversion of fertile into fissile atoms, Fission power, fission chain, control of fission chain, Effective multiplication factor, concept of criticality, sub criticality and super criticality. Conversion / breeding ratio, fuel burn-up. Selection of reactor materials – fuel and cladding, corrosion, pressure vessel materials. Nuclear fuels – Properties of Uranium metal, UO2 and UC. Fuel elements- Thermal properties, Stress analysis of fuel elements, Fuel Chemistry, Solid fission products, corrosion in nuclear reactors, primary failure modes of fuel elements. Radio Isotopes

UNIT 3 NUCLEAR POWER ENGINEERING AND ECONOMICS — **9**

Principles of conversion – Types of nuclear power plants – Fast breeder reactors- Breeding requirements and fast reactors, Fast reactor system features Economics of nuclear power plants- capital costs, fuel costs and O&M (operations and maintenance) costs, Economics of nuclear vs. other types of power plants.

UNIT 4 APPLICATION OF RADIATION TECHNOLOGY — **9**

Applications using gamma ray attenuation & scattering, Borehole logging, Radio gauging principles. Beta transmission gauges for measurements of sheets thickness, density and composition analysis. X- ray fluorescence principles. Neutron gauges. Gamma and neutron radiography, radiation processing, food irradiation and power packs.

Material analysis – Basic principles, nuclear techniques for elemental analysis, Rutherford back scattering (RBS) and elastic recoil detection analysis (ERDA).Medical applications – Projection imaging, positron emission tomography, magnetic resonance imaging, radiation therapy. Sterilization plants

UNIT 5 NUCLEAR WASTE STORAGE AND MANAGEMENT — **9**

Classification of nuclear waste, environmental impacts of nuclear waste, nuclear decay law, nuclear fuel cycle. Treatment of liquid and solid radioactive wastes, hydraulic cements in waste immobilization and cementation technology.

Storage and disposal – Deep geologic disposal – Design principles and evaluation methods – Repository

requirements and site selection – multi-barrier concept – Regulatory environment and community Issues, International scenarios for permanent disposal.		
	TOTAL	**45**

Course Outcomes

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

CO1	Detail the principle of nuclear physics and various radiation detection methods
CO2	Recognize the significance on proper selection of nuclear reactor materials / fuels
CO3	Describe the working of various nuclear power plants and evaluate the economics of nuclear power plant
CO4	Interpret the application of nuclear radiation in diverse fields and devise strategies for application in other diverse fields
CO5	Explain the challenges involved in treatment and disposal of nuclear waste.

TEXT BOOKS

1. Kenneth S. Krane, Introductory Nuclear Physics. Hoboken: John Wiley & Sons, Inc. (1987).

2. G.F.Knoll, Radiation Detection and Measurement, 3rd Edition, John Wiley and Sons (2000)

REFERENCES

1. S.Garg, F. Ahmed and L.S.Kothari, Physics of Nuclear Reactors, Tata McGraw Hill, New Delhi (1986).

2. S. E. Liverhant Elementary Introduction to Nuclear Reactor Theory ,Publisher: John Wiley and sons, INC, second print (1966)

3. Was and Gary S,Fundamentals of Radiation Materials Science Metals and Alloys,Springer,2017.

4. John Lilley, Nuclear Physics, Principles and Application, John Wiley (2002).

5. James H. Saling, Audeen W. Fentiman, Yu S. Tang, Radioactive Waste Management, Taylor & Francis, 2001.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	-	1	1	2	-
CO2	2	-	1	1	2	1
CO3	2	-	1	2	2	1
CO4	2	-	2	1	2	1
CO5	2	-	1	1	3	2
AVG	1.8	-	1.2	1.2	2.2	1.25

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP08	SOLAR ENERGY TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

1	To learn and study the solar radiation and various solar collectors
2	To study the various solar thermal energy technologies and their applications
3	To learn about various solar PV cell materials and conversion techniques
4	To learn various Solar SPV systems designs and their applications
5	To know about various solar passive building techniques for cooling and heating applications

UNIT 1 SOLAR RADIATION AND MEASUREMENT — **9**

Energy from Sun – Solar Constant –Sun earth relationship – Spectral distribution of Extraterrestrial Radiation – Variation of Extraterrestrial Radiation – Solar angles–Sun path diagrams– Solar Time and its equation –Air mass ratio – Radiation reaching Earth's surface – Measurement and estimation on horizontal and tilted surfaces –Measurement devices for Solar Radiation.

UNIT 2 SOLAR COLLECTORS — **9**

Flat plate collector thermal analysis – Testing methods-Evacuated tubular collectors –Concentrating collectors – Classification- Design and performance parameters-Tracking systems- Compound parabolic concentrators – Parabolictrough concentrators-Concentrators with point focus-Heliostats–performance of the collectors.

UNIT 3 SOLAR PV FUNDAMENTALS — **9**

Semiconductor – properties – energy levels – basic equations of semiconductor devices physics. Solar cells – p-n junction: homo and hetro junctions – metal-semiconductor interface – dark and illumination characteristics – figure of merits of solar cell – efficiency limits – variation of efficiency with b and-gap and temperature-efficiency measurements-high efficiency cells–Solar thermo-Photovoltaic.

UNIT 4 SPV SYSTEM DESIGN AND APPLICATIONS — **9**

Solar cell array system analysis and performance prediction- Shadow analysis: reliability – solar cell array design concepts – PV system design – design process and optimization – detailed array design-storage autonomy-voltage regulation-maximum tracking-centralized and decentralized SPV systems-standalone-hybrid and grid connected system-System installation - Operation and maintenances – field experience – PV market analysis and economics of SPV systems.

UNIT 5 SOLAR PASSIVE ARCHITECTURE — **9**

Thermal comfort – bioclimatic classification – passive heating concepts: direct heat gain – indirect heat gain – isolated gain and sun spaces- passive cooling concepts: evaporative cooling-Radiative cooling-application of wind, water and earth for cooling; shading-paints and cavity Walls for cooling – roof radiation traps – earth air-tunnel – energy efficient landscape design –thermal comfort.

TOTAL — **45**

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Illustrate solar radiation and its measurement
CO2	Identify various solar thermal energy technologies and their applications
CO3	Compare various solar PV cell materials and interpret factors influencing of conversion efficiency
CO4	Infer various SPV systems designs and their applications
CO5	Evaluate various solar passive building techniques for cooling and heating applications

TEXT BOOKS

1. Chetan Singh Solanki, Solar Photo voltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011.

2. John A.Duffie, William A.Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013.

REFERENCES

1. Lovegrove K.,Stein W., Concentrating Solar Power Technology, Wood head Publishing Series in Energy, Elsevier, 1stEdition,2012.

2. Solar Energy International, Photovoltaic–Design and Installation Manual, New Society Publishers, 2006.

3. Sukhatme SP, Naya kJK, Solar Energy–Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.

4. Garg H P, Prakash J, Solar Energy – Fundamentals and Applications, Tata McGraw Hill,2013.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	1	1	3	-
CO2	2	-	1	2	3	1
CO3	2	-	1	2	3	-
CO4	3	-	1	-	3	2
CO5	2	-	2	2	3	2
AVG	2.2	-	1.2	1.75	3	1.66

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP09	ADVANCED ENERGY STORAGE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems using TRNSYS.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT– I INTRODUCTION — **9**

Necessity of energy storage–types of energy storage–comparison of energy storage technologies–Applications.

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.

UNIT–III ELECTRICAL ENERGY STORAGE — **9**

Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.

UNIT– IV HYDROGEN AND BIOGAS STORAGE — **9**

Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage - Applications.

UNIT– V ALTERNATE ENERGY STORAGE TECHNOLOGIES — **9**

Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

TOTAL — **45**

Course Outcomes

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

CO1	1. Identify the energy storage technologies for suitable applications.
CO2	2. Analyze the energy storage systems using TRNSYS.
CO3	3. Summarise the concepts and types of batteries.
CO4	4. Examine the principle of operation of Hydrogen and Biogas storage systems.
CO5	5. Explain the working of super capacitor, Flywheel and compressed energy storage systems

REFERENCES

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010.

2. Viswanathan, Fuel cell principle and applications university press,2006.

3. Luisa F.Cabeza, Advances in Thermal Energy Storage Sy stems: Methods and Applications, Rlsevier Wood head Publishing, 2015

4. Robert Huggins, Energy Storage: Fundamentals, Materials andApplications,2ndedition, Springer,2015.

5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion,,Wileypublications,2012.

6. National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition).

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	1	2	-	-
CO2	2	-	3	3	-	-
CO3	2	-	1	2	-	-
CO4	2	-	1	2	-	-
CO5	2	-	1	2	-	-
AVG	2	-	1	2	-	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP10	DESIGN OF HEAT EXCHANGERS	L	T	P	C
		3	0	0	3

Course Objectives

1 To make students familiarize with the various types of heat exchangers

2 To explain the importance of thermal and stress analysis of heat exchangers

3 To inculcate the thermal design aspects of tubular heat exchangers

4 To provide the details of design aspects of compact heat exchangers

5 To explain the function and design aspects of condensers and cooling towers

UNIT- I FUNDAMENTALS OF HEAT EXCHANGER	**9**
Temperature distribution and its implications types–shell and tube heat exchangers–regenerators and recuperators – analysis of heat exchangers–LMTD and effectiveness method	
UNIT- II STRESS ANALYSIS	**9**
Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses –types of failures.	
UNIT- III DESIGN ASPECTS	**9**
Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe – finned tube – shell and tube heat exchangers – simulation of heat exchangers	
UNIT- IV COMPACT AND PLATE HEAT EXCHANGERS	**9**
Types–merits and demerits–design of compact heat exchangers, plate heat exchangers–performance influencing parameters– limitations.	
UNIT- V CONDENSERS AND COOLING TOWERS	**9**
Design of surface and evaporative condensers–cooling tower –performance characteristics	
TOTAL	**45**

Course Outcomes

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

CO1	1. Classify heat exchangers and illustrate the applications of various types of heat exchangers
CO2	2. Interpret the significance of stress analysis of heat exchangers
CO3	3. Analyse the design of tubular heat exchangers for various applications
CO4	4. Appraise the design of compact heat exchangers for industrial requirements
CO5	5. Evaluate the performance calculation of condensers and cooling towers

REFERENCES

1. SadikKakac, Hongtan Liu, Anchasa Pramuanjaroenkij, “Heat Exchangers Selection, Rating and Thermal Design”, CRC Press,Third Edition,2012.

2. Ramesh K.Shah, Dušan P.Sekulić, ”Fundamentals of heat exchanger design”, John Wiley & Sons, 2003.

3. Robert W. Serth, “Process heat transfer principles and applications”, Academic press, Elsevier, 2010.

4. T. Kuppan, “Heat exchanger design hand book”,New York: Marcel Dekker,2009.

5. Arthur.P Frass, “Heat Exchanger Design”, John Wiley & Sons,1989

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	1	3	1	-
CO2	3	-	1	3	1	-
CO3	3	-	3	2	1	-
CO4	3	-	2	2	1	-
CO5	3	-	3	1	1	-
AVG	3	-	2	2	1	-

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP11	HYBRID AND ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the concept of hybrid and electric drive trains.
2. To elaborate on the types and utilisation of hybrid and electric drive trains
3. To expose on different types of AC and DC drives for electric vehicles.
4. To understand and utilise different types of energy storage systems
5. To introduce concept of energy management strategies and drive sizing

UNIT I INTRODUCTION — **9**

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS — **9**

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III CONTROL OF AC & DC DRIVES — **9**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE — **9**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES — **9**

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.

TOTAL — **45**

Course Outcomes

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

CO1	1. Characterise and configure hybrid drivetrains requirement for a vehicle
CO2	2. Design and apply appropriate hybrid and electric drive trains in a vehicle
CO3	3. Design and install suitable AC and DC drives for electric vehicles.
CO4	4. Arrive at a suitable energy storage system for a hybrid / electric vehicle
CO5	5. Apply energy management strategies to ensure better economy and efficiency

REFERENCES

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	-	2	3	-	2	-
CO2	3	2	3	-	2	2
CO3	3	2	3	-	2	2
CO4	2	2	3	-	2	3
CO5	2	2	3	-	2	3
AVG	2	2	3	-	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP12	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

1. To impart knowledge on conversion techniques and renewable energy technologies.
2. To study the mechanisms of machines for the conversion of renewable energy sources.
3. To learn the power converters and its applications in renewable energy systems.
4. To understand the different conversion mechanisms of wind and solar systems.
5. To understand the various hybrid systems of renewable energy conversion techniques.

UNIT- I INTRODUCTION	**9**
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) – Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems	
UNIT- II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION	**9**
Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG	
UNIT- III POWER CONVERTERS	**9**
Solar: Block diagram of solar photovoltaic system-Principle of operation: line commutated converters (inversion-mode) – Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. Power Quality Measurements – Maximum power point tracking (MPPT)	
UNIT- IV ANALYSIS OF WIND AND PV SYSTEMS	**9**
Stand-alone operation of fixed and variable speed wind energy conversion systems and solar systemGrid connection Issues –Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system	
UNIT- V HYBRID RENEWABLE ENERGY SYSTEMS	**9**
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind and PV in microgrid	
TOTAL	**45**

Course Outcomes

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

CO1	1. Analyze the various conversion techniques in renewable energy technologies.
CO2	2. Apply the various mechanisms for the conversion of renewable energy sources.
CO3	3. Evaluate the appropriate power converters for renewable energy systems.
CO4	4. Examine the different conversion mechanisms for wind and solar systems.
CO5	5. Interpret the importance of various hybrid renewable energy systems.

REFERENCES
1. Leon Freris, David Infield, “Renewable energy in power systems”, John Wiley & Sons,2008.
2. Rashid.M.H “power electronics Handbook”, Academic press, 2007.
3. Rai.G.D, “Non conventional energy sources”, Khanna publishes, 2010.
4. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 2011.
5. Wind Electric Systems: S.N.Bhadra, D.Kastha, OXFORD university press, 2005.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	1	2	2	1
CO2	2	-	1	2	2	1
CO3	3	-	3	3	-	1
CO4	1	-	1	2	2	1
CO5	1	-	1	-	1	1
AVG	2	-	1	2	2	1

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP13	WIND ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the fundamentals of wind energy and its conversion system
2. To impart knowledge on air foil design and braking system
3. To learn gear coupled generator wind turbine components
4. To brief on the working of different generators and power conditioning system used in grid tied wind systems
5. To impart knowledge on modern wind turbine control & monitoring

UNIT- I WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS — **9**

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis

UNIT- II AERODYNAMICS THEORY & WIND TURBINE TYPES — **9**

Airfoil terminology, Blade design, Rotor performance and dynamics, Balancing technique (Rotor &Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control ,Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator

UNIT- III GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION — **9**

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/Super Capacitor for Pitch System, Transient Suppressor/Lightning Arrestors, Oscillation & Vibration sensing

UNIT- IV DIRECT ROTOR COUPLED GENERATOR (MULTI POLE) [VARIABLE SPEED VARIABLE FREQ.] — **9**

Excited Rotor Synch. Generator/PMG Generator, Control Rectifier, Capacitor Banks, Step Up /Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit(Voltage and Current),Transformer, Safety Chain Circuits

UNIT- V MODERN WINDTURBINE CONTROL & MONITORING SYSTEM — **9**

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA& Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, FACTS control & LVRT & New trends for new Grid Codes.

TOTAL — **45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	1. Determine energy available in wind and limitations in wind turbine design
CO2	2. Analyze the wind turbine aerodynamics and breaking system
CO3	3. Explain about various components of wind turbine and its working
CO4	4. Explain about different types of generators and power condition used in wind systems
CO5	5. Assess modern wind turbine control, monitoring and maintenance and report generation.

REFERENCES

1. C-WET: Wind Energy Resources Survey in India.
2. John D Sorensen and Jens N Sorensen, Wind Energy Systems, Wood head Publishing Ltd, 2011
3. Kaldellis. J.K, Stand–alone and Hybrid Wind Energy Systems, CRC Press, 2010
4. Mario Garcia–Sanz, Constantine H. Houpis, Wind Energy Systems, CRC Press, 2012
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CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	3	3	2	-
CO2	3	-	3	3	-	-
CO3	3	-	3	2	-	-
CO4	3	-	3	2	-	-
CO5	3	-	3	3	2	-
AVG	3	-	3	3	2	-

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP15	ADVANCED POWER PLANT ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives

1. Understand the thermodynamics associated with power plants
2. Detail on the role of various utilities in coal based thermal power plants
3. Acquire know-how on the working of gas turbine and diesel power plants
4. Appreciate the concept of Poly generation for total energy recovery from a system
5. Brief on the working of hydro electric and nuclear power plants

UNIT– I INTRODUCTION

Energy scenario: India Vs. World – Load curves and–thermodynamic analysis of Conventional Power Plants (Coal, Gas Turbine and Diesel)-Advanced Power Cycles-Kalina Cycle, IGCC.

UNIT– II COAL BASED THERMAL POWER PLANTS **9**

Basics of typical power plant utilities – Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system – steam rate and heat rate – mean temperature of heat addition-Rankine cycle improvements–Superheat, Reheat, Regeneration, Supercritical, AFBC/PFBC – computation of per unit cost of power generation from coal/biomass

UNIT–III GAS TURBINE AND DIESEL POWER PLANTS **9**

Brayton cycle – Open and Closed – Improvements – Intercooler, Reheating and Regeneration. Diesel power plant – Layout – Performance analysis and improvement – Techniques for starting, cooling and lubrication of diesel engines-computation of per unit cost of power generation

UNIT– IV CHP AND MHD POWER PLANTS **9**

Cogeneration systems–types-heat to power ratio-Thermodynamic performance of steam turbine gas turbine and IC engine-based cogeneration systems–Poly Generation-Binary Cycle-Combined cycle. MHD –Open cycle and closed cycle-Hybrid MHD & steam power plants

UNIT– V HYDRO ELECTRIC & NUCLEAR POWER PLANTS **9**

Hydroelectric Power plants – classifications – essential elements – pumped storage systems – micro and mini hydel power plants. General aspects of Nuclear Engineering – Components of nuclear power plants – Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor-nuclear safety–Environmental Issues-Computation of per Unit cost of power generation

TOTAL **45**

Course Outcomes

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

CO1	1. Evaluate appropriate power generation technologies for mitigating the energy gap
CO2	2. Appraise the steam rate, heat rate and cost for generating electricity from coal based thermal power plants
CO3	3. Analyse and suggest measures for improving the performance of gas turbine and diesel power plants
CO4	4. Assess the applicability and performance of a cogeneration system
CO5	5. Decide a suitable type of hydroelectric/nuclear power plant commensurate with the prevailing conditions

REFERENCES
1. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi,1998.
2. Haywood, R.W., Analysis of Engineering Cycles,4th Edition, Pergamon Press,Oxford,1991.
3. Wood, A.J., Wollen berg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
4. Gill, A.B., Power Plant Performance, Butter worths,1984.
5. Lamarsh, J.R., Introduction to Nuclear Engg. 2nd edition, Addison-Wesley, 1983.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	-	2	-	-	-
CO2	2	-	2	2	-	1
CO3	2	-	2	2	-	1
CO4	2	-	2	2	-	1
CO5	2	-	2	1	2	-
AVG	2	-	2	2	2	1

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP15	HYDROGEN AND FUEL CELL TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

1. To study in detail on the hydrogen production methodologies, possible applications and various storage options.
2. To understand the working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
3. To study the cost effectiveness and eco-friendliness of Fuel Cells.

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES — **9**

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II HYDROGEN STORAGE AND APPLICATIONS — **9**

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen. Applications of Hydrogen.

UNIT III FUEL CELLS — **9**

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell.

UNIT IV FUEL CELL – TYPES — **9**

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS — **9**

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL — **45**

Course Outcomes

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

Know the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies.

REFERENCES

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK 2005.
4. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
5. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA 2002.
7. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	3	1	1	2
CO2	3	-	3	1	1	2
CO3	2	-	2	2	-	1
CO4	2	-	2	1	-	2
CO5	2	-	2	1	3	2
AVG	2	-	2	1	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP16	SMART GRID	L	T	P	C
		3	0	0	3

Course Objectives

1. To Study about Smart Grid technologies with its benefits and challenges
2. To study about smart grid transmission technologies
3. To study about smart grid distribution technologies
4. To familiarize about smart metering and need for Advanced metering infrastructure
5. To familiarize the high performance computing for Smart Grid applications

UNIT- I INTRODUCTION TO SMART GRID — **9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT- II SMARTGRID TECHNOLOGIES (Transmission) — **9**

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation , Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT- III SMARTGRID TECHNOLOGIES (Distribution) — **9**

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles(PHEV).

UNIT- IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE — **9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT- V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS — **9**

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broad band over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL — **45**

Course Outcomes

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

CO1	1. Demonstrate concepts of smart grid and its present developments.
CO2	2. Interpret different smart grid technologies.
CO3	3. Infer different smart meters and advanced metering infrastructure.
CO4	4. Appraise power quality management in smart grids
CO5	5. Recommend LAN, WAN and cloud computing for smart grid applications.

REFERENCES

1. Vehbi C. Güngör, DilanSahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics,Vol.7, No.4, November 2011.

2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grids.

3. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press, 2012.

4. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “SmartGrid: Technology and Applications”, Wiley, 2012.

5. FabioToledo “Smart Metering Handbook”, Penn Well Corporation, 2013

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	-	1	1	1	1
CO2	1	-	1	1	1	-
CO3	2	-	2	1	2	-
CO4	1	-	1	1	2	-
CO5	2	-	2	3	-	-
AVG	1	-	1	1	2	1

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP17	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objectives

1. To impart knowledge on the atmosphere and its present condition and, global warming.
2. To detail on the sources of water pollution and possible solutions for mitigating their degradation.
3. To detail on the sources of air pollution and possible solutions for mitigating their degradation.
4. To detail on the sources of solid waste and possible ways to dispose them safely.
5. To impart knowledge on hazardous waste management.

UNIT– I INTRODUCTION **9**

Man & Environment– Types of Pollution– Global Environmental issues–Environmental Impact Assessment – Global Warming Issues – CO2Mitigation – Basic definition of Pollution Indicators – Noise Pollution

UNIT– II WATER POLLUTION **9**

Pollutants in Water & Waste water – Physical and Chemical Treatment Methods–(An Overview) Neutralization – Aeration –Colour / Odour Removal - Sludge dewatering – Biological Treatment including Aerobic & Anaerobic Treatment

UNIT–III AIR POLLUTION **9**

Sources – Ambient Air Quality Standards – Emission Limits – Equipment for Ambient Air & Stack Monitoring – Principles of operation of Particulate Control Equipments-ESPs, Bag Filters, Cyclone Separators–Vehicular Pollution and its Control–BS standards

UNIT– IV SOLID WASTE MANAGEMENT **9**

Types & Sources–Types–Waste Generation–Composition–Physical, Chemical and Biological Properties–Transformation Technologies for Waste Treatment–Land fill Management–Layout, Closure & Post Closure Operation–Reclamation Leachate Generation
– E Waste Disposal

UNIT– V HAZARDOUS WASTE MANAGEMENT **9**

Sources – Classification – Characterization of waste - health effects - Incineration– Radio active Waste from nuclear power plants and disposal options -RDF- Mass Firing–Material Recycling

TOTAL **45**

Course Outcomes

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

CO1	1. Classify types and effects of each type of pollution.
CO2	2. Assess technical aspects of global warming and their impact on climate change
CO3	3. Choose technologies that are available for reduction of pollutants dumped into the atmosphere
CO4	4. Appraise waste management and hazardous waste disposal.
CO5	5. Comprehend the different techniques available for safe disposal of hazardous waste

REFERENCES

1. Peavy, H.S. and D.R. Rowe,G. Tchobanoglous: Environmental Engineering-McGraw-Hill Book Company, New York,1985.

2. Ludwig,H. W.Evans: Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands, N.J,1991.

3. Arcadio P Sincero and G.A. Sincero, Environmental Engineering–A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.

4. G. Masters: Introduction to Environmental Engineering and Science, Prentice Hall of India Pvt Ltd,NewDelhi,2003.

5. Richard J.Watts, Hazardous Wastes-Sources, Pathways, Receptors John Wiley and Sons, New York,1997

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	-	1	1	3	1
CO2	1	-	1	1	3	3
CO3	2	-	1	1	3	3
CO4	1	-	1	1	3	3
CO5	2	-	1	3	3	3
AVG	1	-	1	1	3	3

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EYP18	HUMAN INDUSTRIAL SAFETY AND HYGIENE	L	T	P	C
		3	0	0	3

Course Objectives

1. Identify and prevent operational hazard
2. Categorize, analyze and interpret the accidents data based on various safety techniques.
3. Use proper safety techniques on safety engineering and management.
4. Design the system with environmental consciousness by implementing safety regulation
5. Use safety management practices in Industries.

UNIT I OPERATIONAL SAFETY — **9**

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes- metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II SAFETY APPRAISAL AND ANALYSIS — **9**

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III OCCUPATIONAL HEALTH — **9**

Concept and spectrum of health functional units and activities of operational health service –occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS — **9**

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V SAFETY MANAGEMENT — **9**

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL — **45**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Ability to Identify and prevent operational hazard
CO2	Ability to collect, analyze and interpret the accidents data based on various safety techniques.
CO3	Ability to apply proper safety techniques on safety engineering and management.
CO4	Ability to design the system with environmental consciousness by implementing safety regulation
CO5	Ability to apply safety management practices in Industries.

REFERENCES

1. John. V. Grimaldi and Rollin. H Simonds, “Safety Management”, All India traveler Book seller, New Delhi – 1989.

2. John V Grimaldi, Safety Management. AITB publishers, 2003.

3. Krishnan N.V, “Safety in Industry”, Jaico Publisher House, 1996.

4. Singh, U.K and Dewan, J.M., “Safety, Security and Risk Management”, APH publishing company, New Delhi, 1996

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	-	-	-	1	-	-
CO2	1	-	-	-	1	-
CO3	2	-	-	1	1	-
CO4	-	-	2	-	-	1
CO5	-	-	-	-	1	1
AVG	2	-	2	1	1	1

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24AC01	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

Course Objectives

1	Teach how to improve writing skills and level of readability
2	Tell about what to write in each section
3	Summarize the skills needed when writing a Title
4	Infer the skills needed when writing the Conclusion
5	Ensure the quality of paper at very first-time submission

UNIT 1 INTRODUCTION TO RESEARCH PAPER WRITING	**6**
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	
UNIT 2 PRESENTATION SKILLS	**6**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction	
UNIT 3 TITLE WRITING SKILLS	**6**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	
UNIT 4 RESULT WRITING SKILLS	**6**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	
UNIT 5 VERIFICATION SKILLS	**6**
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission	
TOTAL PERIODS	**30**

Course Outcomes

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

CO1	Understand that how to improve your writing skills and level of readability
CO2	Learn about what to write in each section
CO3	Understand the skills needed when writing a Title
CO4	Understand the skills needed when writing the Conclusion
CO5	Ensure the good quality of paper at very first-time submission

TEXT BOOKS

1. Adrian Wallwork , English for Writing Research Papers, Springer New York D, Heidelberg London, 2011

2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006

REFERENCES

1. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006

2. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman’s book 1998.

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24AC02	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

Course Objectives

1	Summarize basics of disaster
2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3	Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4	Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5	Develop the strengths and weaknesses of disaster management approaches

UNIT 1 INTRODUCTION	**6**
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	
UNIT 2 REPERCUSSIONS OF DISASTERS AND HAZARDS	**6**
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	
UNIT 3 DISASTER PRONE AREAS IN INDIA	**6**
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics	
UNIT 4 DISASTER PREPAREDNESS AND MANAGEMENT	**6**
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.	
UNIT 5 RISK ASSESSMENT	**6**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival	
TOTAL PERIODS	**30**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	summarize basics of disaster
CO2	explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3	illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4	describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5	develop the strengths and weaknesses of disaster management approaches
TEXT BOOKS	
1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.	
REFERENCES	
1. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.	
2. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.	

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24AC003	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

Course Objectives	
1	Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2	To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
3	To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT 1 HISTORY OF MAKING OF THE INDIAN CONSTITUTION	**3**
History, Drafting Committee, (Composition & Working)	
UNIT 2 PHILOSOPHY OF THE INDIAN CONSTITUTION	**3**
Preamble, Salient Features	
UNIT 3 CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES	**6**
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.	
UNIT 4 ORGANS OF GOVERNANCE	**6**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.	
UNIT 5 LOCAL ADMINISTRATION	**6**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.	
UNIT 6 ELECTION COMMISSION	**6**
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.	
TOTAL PERIODS	**30**

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO4	Discuss the passage of the Hindu Code Bill of 1956.
TEXT BOOKS	
1. The Constitution of India,1950(Bare Act),Government Publication.	
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.	
REFERENCES	
1. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.	
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.	

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24EMA04	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

Course Objectives

1	சங்க இலக்கியம் பற்றி மாணவர்களுக்கு எடுத்துரைத்தல்.
2	நீதி நூல்கள் வாயிலாக அறக்கருத்துகளை எடுத்து கூறுதல்.
3	சிலப்பதிகாரம், மணிமேகலை காப்பியங்களை எடுத்துரைத்தல்.
4	இலக்கியங்களில் காணப்படும் அருள்நெறிக் கதைகளைப் பற்றி விளக்குதல்.
5	தற்காலத் தமிழ் இலக்கியங்களை மாணவர்களுக்கு தெரியப்படுத்துதல்.

UNIT 1 சங்க இலக்கியம் — **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள்.
2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம்.
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி.
4. புறநானூறு (95, 195) – போரை நிறுத்திய ஔவையார்.

UNIT 2 அறநெறித்தமிழ் — **6**

1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்.
2. பிற அறநூல்கள் – இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்).

UNIT 3 இரட்டைக்காப்பியங்கள் — **6**

1. கண்ணகியின் புரட்சி- சிலப்பதிகார வழக்குரை காதை.
2. சமூக சேலை இலக்கியம் மணிமேகலை – சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை.

UNIT 4 அருள்நெறித்தமிழ் — **6**

1. சிறுபாணாற்றுப்படை – பாரி முல்லைக்கு தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்.
2. நற்றிணை – அன்னைக்குரிய புன்னை சிறப்பு.
3. திருமந்திரம் (617,618) இயமம் நியமம் விதிகள்.
4. தர்மசாலையை நிறுவிய வள்ளலார்.
5. புறநானூறு – சிறுவனே வள்ளலானான்.
6. அகநானூறு (4) – வண்டு.
7. நற்றிணை (11) – நண்டு.
8. கலித்தொகை (11) – யானை, புறா.
9. ஐந்திணை ஐம்பது (27) – மான்.

ஆகியவை பற்றிய செய்திக

UNIT 5 நவீன தமிழ் இலக்கியம் — **6**

1. உரைநடைத்தமிழ்
   – தமிழின் முதல் புதினம்.
   – தமிழின் முதல் சிறுகதை.

– கட்டுரை இலக்கியம். – பயண இலக்கியம். – நாடகம். 2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும். 3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும். 4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும். 5. அறிவியல் தமிழ். 6. இணையத்தில் தமிழ். 7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL PERIODS	**30**

Course Outcomes

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

CO1	சங்க இலக்கியம் மாணவர்கள் முழுமையாக அறிந்து பயன்பெறுதல்.
CO2	அறநெறி இலக்கியம் வாயிலாக வாழ்வியலுக்குத் தேவையான தூய்மைப் பணிகளை மேற்கொள்ளுதல்.
CO3	சிலப்பதிகாரம், மணிமேகலை காப்பியங்களில் உள்ள நீதிக்கருத்துகளை மாணவர்கள் தெரிந்துகொள்ளுதல்.
CO4	இலக்கியங்களில் காணப்படும் அருள்நெறிக் கதைகளைப் பற்றி விளக்குதல்.
CO5	தற்காலத் தமிழ் இலக்கியங்களை மாணவர்கள் தெரிந்து அவற்றின் வாயிலாக பயன் அடைதல்.

TEXT BOOKS: தமிழ் இலக்கிய வெளியீடுகள் புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org.
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org.
3. தர்மபுர ஆதீன வெளியீடு.
4. வாழ்வியல் களஞ்சியம் – தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.
5. தமிழ்க்கலைக்களஞ்சியம் - தமிழ் வளர்ச்சித்துறை (thamilvalarchithurai.com).
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT501	SUSTAINABLE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

1. To provide students with fundamental knowledge of the notion of corporate sustainability.

2. To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I MANAGEMENT OF SUSTAINABILITY — **9**

Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II CORPORATE SUSTAINABILITY AND RESPONSIBILITY — **9**

Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES — **9**

Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption
and Green Marketing strategies, Environmental regulation and strategic postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION — **9**

Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS — **9**

Energy management, Water management, Waste management, Wild Life Conservation, Emerging trends in sustainable management, Case Studies.

TOTAL — **45**

Course Outcomes

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

CO1	An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2	An understanding of corporate sustainability and responsible Business Practices
CO3	Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4	Knowledge of innovative practices in sustainable business and community management
CO5	Deep understanding of sustainable management of resources and commodities

REFERENCES

1. Daddi, T., Iraldo, F., Testa, Environmental Certification for Organizations and Products: Management, 2015
2. Christian N. Madu, Handbook of Sustainability Management 2012
3. Petra Molthan-Hill, The Business Student's Guide to Sustainable Management: Principles and Practice, 2014
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	2
CO2	3	2	2	2	1	2
CO3	3	3	1	2	1	3
CO4	3	3	2	1	1	2
CO5	3	3	2	1	2	2
AVG	3	3	2	1	2	3

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT502	MICRO AND SMALL BUSINESS MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

1. To familiarize students with the theory and practice of small business management.
2. To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS — **9**

Creation, Innovation, entrepreneurship and small business - Defining Small Business –Role of Owner – Manager – government policy towards small business sector –elements of entrepreneurship –evolution of entrepreneurship –Types of Entrepreneurship – social, civic, corporate - Business life cycle - barriers and triggers to new venture creation – process to assist start ups – small business and family business.

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN — **9**

Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.

UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY — **9**

Management and Leadership – employee assessments – Tuckman's stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model.
Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS — **9**

Main sources of entrepreneurial capital; Nature of 'bootstrap' financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working
capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy
issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT — **9**

Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

TOTAL — **45**

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Familiarise the students with the concept of small business
CO2	In depth knowledge on small business opportunities and challenges
CO3	Ability to devise plans for small business by building the right skills and marketing strategies
CO4	Identify the funding source for small start ups
CO5	Business evaluation for buying and selling of small firms

REFERENCES

1. Hankinson,A.(2000). “The key factors in the profile of small firm owner-managers that influence business
performance. The South Coast Small Firms Survey, 1997-2000.” Industrial and Commercial Training 32(3):94-98.

2. Parker,R.(2000). “Small is not necessarily beautiful: An evaluation of policy support for small and medium-sized enterprise in Australia.” Australian Journal of Political Science 35(2):239-253.

3. Journal articles on SME’s.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	2	1	1	-	-
CO2	3	3	3	3	2	3
CO3	3	3	2	2	3	3
CO4	3	2	2	2	1	1
CO5	3	2	2	3	2	1
AVG	3	3	2	2	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT503	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

Course Objectives

To understand intellectual property rights and its valuation.

UNIT I INTRODUCTION **9**

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS **9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

UNIT III STATUTES **9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh-Dole Act and Issues of Academic Entrepreneurship.

UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY **9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V MODELS **9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL **45**

Course Outcomes

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

CO1	Understanding of intellectual property and appreciation of the need to protect it
CO2	Awareness about the process of patenting
CO3	Understanding of the statutes related to IPR
CO4	Ability to apply strategies to protect intellectual property
CO5	Ability to apply models for making strategic decisions related to IPR

REFERENCES

1. V. Sople Vinod, Managing Intellectual Property by (Prentice hall of India Pvt.Ltd), 2006.
2. Intellectual Property rights and copyrights, EssEss Publications.
3. Primer, R. Anita Rao and Bhanoji Rao, Intellectual Property Rights, Lastain Book company.
4. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2006.
5. WIPO Intellectual Property Hand book.

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

CO, PO Mapping						
CO / PO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	2	3
CO2	3	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3
AVG	3	3	3	3	2	3

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT504	ETHICAL MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I ETHICS AND SOCIETY — **9**

Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society's expectations-Individual and organizational responsibility to society and the community.

UNIT II ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS — **9**

Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.

UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT — **9**

Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANJAGEMENT — **9**

Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS — **9**

Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL — **45**

Course Outcomes

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

CO1	Role modelling and influencing the ethical and cultural context.
CO2	Respond to ethical crises and proactively address potential crises situations.
CO3	Understand and implement stakeholder management decisions.
CO4	Develop the ability, knowledge, and skills for ethical management
CO5	Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

1. Brad Agle, Aaron Miller, Bill O' Rourke, The Business Ethics Field Guide: the essential companion to leading your career and your company, 2016.

2. Steiner & Steiner, Business, Government & Society: A managerial Perspective, 2011.

3. Lawrence & Weber, Business and Society: Stakeholders, Ethics, Public Policy, 2020.

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

CO, PO Mapping						
CO / PO	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	2	3
CO2	-	3	2	3	1	3
CO3	3	3	3	3	2	3
CO4	3	3	3	2	1	3
CO5	3	3	3	2	2	3
AVG	3	3	3	3	2	3

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT505	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand the basics of big data analytics
2. To understand the search methods and visualization
3. To learn mining data streams
4. To learn frameworks
5. To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA — **9**

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis –Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION — **9**

Search by simulated Annealing – Stochastic, Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques – Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS — **9**

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing -Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS — **9**

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE — **9**

Overview, Programming structures: Control statements -Operators -Functions -Environment and scope issues -Recursion -Replacement functions, R data structures: Vectors -Matrices and arrays -Lists -Data frames - Classes, Input/output, String manipulations

TOTAL — **45**

Course Outcomes

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

CO1	understand the basics of big data analytics
CO2	Ability to use Hadoop, Map Reduce Framework.
CO3	Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4	gain knowledge on R language
CO5	Contextually integrate and correlate large amounts of information to gain faster insights

REFERENCES

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1
CO2	3	3	3	3	2	1
CO3	3	3	3	3	2	1
CO4	3	3	3	3	2	1
CO5	3	3	3	3	2	1
AVG	3	3	3	3	2	1

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT506	INTERNET OF THINGS AND CLOUD	L	T	P	C
		3	0	0	3

Course Objectives

1. To understand Smart Objects and IoT Architectures
2. To learn about various IOT-related protocols
3. To build simple IoT Systems using Arduino and Raspberry Pi.
4. To understand data analytics and cloud in the context of IoT
5. To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT — **9**

ntroduction to IoT – IoT definition – Characteristics – IoT Complete Architectural Stack – IoT enabling Technologies – IoT Challenges. Sensors and Hardware for IoT – Hardware Platforms – Arduino, Raspberry Pi, Node MCU. A Case study with any one of the boards and data acquisition from sensors

UNIT II PROTOCOLS FOR IoT — **9**

Infrastructure protocol (IPV4/V6/RPL), Identification (URIs), Transport (Wifi, Lifi, BLE), Discovery, Data Protocols, Device Management Protocols. – A Case Study with MQTT/CoAP usage-IoT privacy, security and vulnerability solutions.

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS — **9**

Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION — **9**

Introduction to Cloud Computing - Service Model – Deployment Model- Virtualization Concepts – Cloud Platforms – Amazon AWS – Microsoft Azure – Google APIs.

UNIT V IoT AND CLOUD — **9**

IoT and the Cloud - Role of Cloud Computing in IoT - AWS Components - S3 – Lambda - AWS IoT Core - Connecting a web application to AWS IoT using MQTT- AWS IoT Examples. Security Concerns, Risk Issues, and Legal Aspects of Cloud Computing- Cloud Data Security

TOTAL — **45**

Course Outcomes

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

CO1	Understand the various concept of the IoT and their technologies..
CO2	Develop IoT application using different hardware platforms
CO3	Implement the various IoT Protocols
CO4	Understand the basic principles of cloud computing.
CO5	Develop and deploy the IoT application into cloud environment

REFERENCES
1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman ,CRC Press, 2017
2. Adrian McEwen, Designing the Internet of Things, Wiley,2013.
3. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley publishers, 2015.
4. Simon Walkowiak, “Big Data Analytics with R” PackT Publishers, 2016
5. Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.

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M.E. Energy Engineering

P24OT507	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

Course Objectives

1. To explain the basic concepts of robots and types of robots
2. To discuss the designing procedure of manipulators, actuators and grippers
3. To impart knowledge on various types of sensors and power sources
4. To explore various applications of Robots in Medicine
5. To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS — **9**

Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS — **9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning

Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS — **9**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS — **9**

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS — **9**

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL — **45**

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Describe the configuration, applications of robots and the concept of grippers and actuators
CO2	Explain the functions of manipulators and basic kinematics
CO3	Describe the application of robots in various surgeries
CO4	Design and analyze the robotic systems for rehabilitation
CO5	Design the wearable robots

REFERENCES

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw Hill, First edition, 2003
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008
3. Fu.K.S, Gonzalez. R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008
4. Bruno Siciliano, Oussama Khatib, Springer Handbook of Robotics, 1st Edition, Springer, 2008
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6. Sashi S Kommu, Rehabilitation Robotics, I-Tech Education and Publishing, 2007
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8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005
9. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw Hill, First Edition, 1983
10. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011
11. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
12. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	-	-	-	1	-	-
CO2	-	-	-	2	-	-
CO3	2	-	2	2	2	2
CO4	2	-	2	2	3	2
CO5	2	-	2	2	3	3
AVG	2	-	2	2	3	2

Meenakshi Sundararajan Engineering College

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M.E. Energy Engineering

P24OT508	EMBEDDED AUTOMATION	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn about the process involved in the design and development of real-time embedded system
2. To develop the embedded C programming skills on 8-bit microcontroller
3. To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
4. To learn about the tools, firmware related to microcontroller programming
5. To build a home automation system

UNIT - I INTRODUCTION TO EMBEDDED C PROGRAMMING — **9**

C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II AVR MICROCONTROLLER — **9**

ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS — **9**

Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV VISION SYSTEM — **9**

Fundamentals of Image Processing - Filtering - Morphological Operations - Feature Detection and Matching - Blurring and Sharpening - Segmentation - Thresholding - Contours - Advanced Contour Properties - Gradient - Canny Edge Detector - Object Detection - Background Subtraction

UNIT – V HOME AUTOMATION — **9**

Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor -Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL — **45**

Course Outcomes

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

CO1	analyze the 8-bit series microcontroller architecture, features and pin details
CO2	write embedded C programs for embedded system application
CO3	design and develop real time systems using AVR microcontrollers
CO4	design and develop the systems based on vision mechanism
CO5	design and develop a real time home automation system

REFERENCES

1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", McGraw-Hill, 2001.

2. Joe Pardue, "C Programming for Microcontrollers ", Smiley Micros, 2005.

3. Steven F. Barrett, Daniel J. Pack, "ATMEL AVR Microcontroller Primer : Programming and Interfacing", Morgan & Claypool Publishers, 2012

4. Mike Riley, "Programming Your Home - Automate With Arduino, Android and Your Computer", the Pragmatic Programmers, Llc, 2012.

5. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2011.

6. Kevin P. Murphy, "Machine Learning - a Probabilistic Perspective", the MIT Press Cambridge, Massachusetts, London, 2012.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	-	1	1	1	-
CO2	1	3	1	1	1	3
CO3	1	3	1	1	1	3
CO4	1	3	1	1	1	3
CO5	1	3	1	1	1	3
AVG	1	3	1	1	1	3

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M.E. Energy Engineering

P24OT509	ENVIRONMENTAL SUSTAINABILITY	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION	**9**
Valuing the Environment: Concepts, Valuing the Environment: Methods, Property Rights, Externalities, and Environmental Problems	
UNIT II CONCEPT OF SUSTAINABILITY	**9**
Sustainable Development: Defining the Concept, the Population Problem, Natural Resource Economics: An Overview, Energy, Water, Agriculture	
UNIT III SIGNIFICANCE OF BIODIVERSITY	**9**
Biodiversity, Forest Habitat, Commercially Valuable Species, Stationary - Source Local Air Pollution, Acid Rain and Atmospheric Modification, Transportation	
UNIT IV POLLUTION IMPACTS	**9**
Water Pollution, Solid Waste and Recycling, Toxic Substances and Hazardous Wastes, Global Warming.	
UNIT V ENVIRONMENTAL ECONOMICS	**9**
Poverty, and the Environment, Visions of the Future, Environmental economics and policy by Tom Tietenberg, Environmental Economics	
TOTAL	**45**

REFERENCES

1. Andrew Hoffman, Competitive Environmental Strategy - A Guide for the Changing Business Landscape, Island Press.
2. Stephen Doven, Environment and Sustainability Policy: Creation, Implementation, Evaluation, the Federation Press, 2005
3. Robert Brinkmann., Introduction to Sustainability, Wiley-Blackwell., 2016
4. Niko Roorda., Fundamentals of Sustainable Development, 3rd Edn, Routledge, 2020
5. Bhavik R Bakshi., Sustainable Engineering: Principles and Practice, Cambridge University Press, 2019

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT510	TEXTILE REINFORCED COMPOSITES	L	T	P	C
		3	0	0	3

UNIT I REINFORCEMENTS	**9**
Introduction – composites –classification and application; reinforcements- fibres and its properties; preparation of reinforced materials and quality evaluation; preforms for various composites	
UNIT II MATRICES	**9**
Preparation, chemistry, properties and applications of thermoplastic and thermoset resins; mechanism of interaction of matrices and reinforcements; optimization of matrices	
UNIT III COMPOSITE MANUFACTURING	**9**
Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites and composite design requirements	
UNIT IV TESTING	**9**
Fibre volume and weight fraction, specif ic gravity of composites, tensile, f lexural, impact, compression, inter laminar shear stress and fatigue properties of thermoset and thermoplastic composites.	
UNIT V MECHANICS	**9**
Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory, failure theories and prediction of inter laminar stresses using at ware	
TOTAL	**45**

REFERENCES

1. Bor Z. Jang,“Advanced Polymer composites”, ASM International,USA,1994.
2. Carlsson L.A. and Pipes R.B., “Experimental Characterization of advanced composite Materials”, Second Edition, CRC Press, New Jersey, 1996.
3. George Lubinand Stanley T. Peters, “Handbook of Composites”, Springer Publications,1998.
4. Mel. M. Schwartz, “Composite Materials”, Vol. 1 &2, Prentice Hall PTR, New Jersey,1997.
5. Richard M. Christensen, “Mechanics of composite materials”, Dover Publications, 2005.
6. Sanjay K. Mazumdar, “Composites Manufacturing: Materials, Product, and Process Engineering”,CRCPress,2001

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M.E. Energy Engineering

P24OT511	NANOCOMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

UNIT I BASICS OF NANOCOMPOSITES | **9**

Nomenclature, Properties, features and processing of nanocomposites. Sample Preparation and Characterization of Structure and Physical properties. Designing, stability and mechanical properties and applications of super hard nanocomposites.

UNIT II METAL BASED NANOCOMPOSITES | **9**

Metal-metal nanocomposites, some simple preparation techniques and their properties. Metal- Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Core-Shell structured nanocomposites

UNIT III POLYMER BASED NANOCOMPOSITES | **9**

Preparation and characterization of diblock Copolymer based nanocomposites; Polymer Carbon nanotubes
based composites, their mechanical properties, and industrial possibilities.

UNIT IV NANOCOMPOSITE FROM BIOMATERIALS | **9**

Natural nanocomposite systems - spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Biomimetic synthesis of nanocomposites material; Use of synthetic nanocomposites for bone, teeth replacement.

UNIT V NANOCOMPOSITE TECHNOLOGY | **9**

Nanocomposite membrane structures- Preparation and applications. Nanotechnology in Textiles and Cosmetics-Nano-fillers embedded polypropylene fibers – Soil repellence, Lotus effect - Nano finishing in textiles (UV resistant, anti-bacterial, hydrophilic, self-cleaning, flame retardant finishes), Sun-screen dispersions for UV protection using titanium oxide – Colour cosmetics. Nanotechnology in Food Technology - Nanopackaging for enhanced shelf life - Smart/Intelligent packaging.

TOTAL | **45**

REFERENCES

1. Introduction to Nanocomposite Materials. Properties, Processing, Characterization- Thomas E. Twardowski. 2007. DEStech Publications. USA.
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V.Braun 2006.
3. Physical Properties of Carbon Nanotubes- R. Saito 1998.
4. Carbon Nanotubes (Carbon , Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus 1997.
5. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
6. Nanometer versus micrometer-sized particles-Christian Brosseau, Jamal BeN Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003
7. Diblock Copolymer, - Aviram (Review Article), Nature, 2002
8. Bikramjit Basu, Kantesh Balani Advanced Structural Ceramics, A John Wiley & Sons, Inc.,
9. P. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead publication, London, 2006

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OT512	IPR, BIOSAFETY AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

UNIT I IPR — **9**

Intellectual property rights – Origin of the patent regime – Early patents act & Indian pharmaceutical industry – Types of patents – Patent Requirements – Application preparation filing and prosecution – Patentable
subject matter – Industrial design, Protection of GMO's IP as a factor in R&D,IP's of relevance to biotechnology and few case studies.

UNIT II AGREEMENTS, TREATIES AND PATENT FILING PROCEDURES — **9**

History of GATT Agreement – Madrid Agreement – Hague Agreement – WIPO Treaties – Budapest Treaty – PCT – Ordinary – PCT – Conventional – Divisional and Patent of Addition – Specifications – Provisional and complete – Forms and fees Invention in context of "prior art" – Patent databases – Searching International Databases – Country-wise patent searches (USPTO,espacenet(EPO) – PATENT Scope (WIPO) – IPO, etc National & PCT filing procedure – Time frame and cost – Status of the patent applications filed – Precautions while patenting – disclosure/non-disclosure – Financial assistance for patenting – Introduction to existing schemes Patent licensing and agreement Patent infringement – Meaning, scope, litigation, case studies

UNIT III BIOSAFETY — **9**

Introduction – Historical Backround – Introduction to Biological Safety Cabinets – Primary Containment for Biohazards – Biosafety Levels – Biosafety Levels of Specific Microorganisms – Recommended Biosafety Levels for Infectious Agents and Infected Animals – Biosafety guidelines – Government of India.

UNIT IV GENETICALLY MODIFIED ORGANISMS — **9**

Definition of GMOs & LMOs – Roles of Institutional Biosafety Committee – RCGM – GEAC etc. for GMO applications in food and agriculture – Environmental release of GMOs – Risk Analysis – Risk Assessment – Risk management and communication – Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

UNIT V ENTREPRENEURSHIP DEVELOPMENT — **9**

Introduction – Entrepreneurship Concept – Entrepreneurship as a career – Entrepreneurial personality – Characteristics of successful Entrepreneur – Factors affecting entrepreneurial growth – Entrepreneurial Motivation – Competencies – Mobility – Entrepreneurship Development Programmes (EDP) -
Launching Of Small Enterprise - Definition, Characteristics – Relationship between small and large units – Opportunities for an Entrepreneurial career – Role of small enterprise in economic development – Problems of small scale industries – Institutional finance to entrepreneurs - Institutional support to entrepreneurs.

TOTAL — **45**

REFERENCES
1. Bouchoux, D.E., “Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets for the Paralegal”, 3rd Edition, Delmar Cengage Learning, 2008.
2. Fleming, D.O. and Hunt, D.L., “Biological Safety: Principles and Practices”, 4th Edition, American Society for Microbiology, 2006.
3. Irish, V., “Intellectual Property Rights for Engineers”, 2nd Edition, The Institution of Engineering and Technology, 2005.
4. Mueller, M.J., “Patent Law”, 3rd Edition, Wolters Kluwer Law & Business, 2009.
5. Young, T., “Genetically Modified Organisms and Biosafety: A Background Paper for Decision- Makers and Others to Assist in Consideration of GMO Issues” 1st Edition, World Conservation Union, 2004.
6. S.S Khanka, “Entrepreneurial Development”, S.Chand & Company LTD, New Delhi, 2007.

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OE513	IoT FOR SMART SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

1. To study about Internet of Things technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT
5. To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS — **9**

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE — **9**

IoT reference model and architecture -Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture, IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT — **9**

PROTOCOLS:
NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.
Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV IOT PROCESSORS — **9**

Services/Attributes: Big-Data Analytics for IOT, Dependability,Interoperability, Security, Maintainability.
Embedded processors for IOT : Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES — **9**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL — **45**

Course Outcomes

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

CO1	Analyze the concepts of IoT and its present developments.
CO2	Compare and contrast different platforms and infrastructures available for IoT
CO3	Explain different protocols and communication technologies used in IoT
CO4	Analyze the big data analytic and programming of IoT
CO5	Implement IoT solutions for smart applications

REFERENCES

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	2	1	-	-	-
CO2	-	2	-	-	-	-
CO3	1	2	-	1	3	-
CO4	2	-	3	3	3	3
CO5	3	2	3	3	3	3
AVG	2	2	2	2	3	2

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OE514	MACHINE LEARNING AND DEEP LEARNING	L	T	P	C
		3	0	0	3

Course Objectives

1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS — **9**

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithm

UNIT II NEURAL NETWORKS — **9**

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, Auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS — **9**

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS — **9**

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS — **9**

Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL — **45**

Course Outcomes

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

CO1	Illustrate the categorization of machine learning algorithms.
CO2	Compare and contrast the types of neural network architectures, activation functions
CO3	Acquaint with the pattern association using neural networks
CO4	Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5	Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs

REFERENCES

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning

2. Deep Learning, Ian Good fellow, YoshuaBengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.

3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.

4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.

5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	3	1	-	-	-
CO2	2	-	2	-	-	-
CO3	3	3	3	-	3	-
CO4	2	3	3	-	-	-
CO5	3	3	3	-	3	-
AVG	3	3	3	-	3	-

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OE515	RENEWABLE ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. Different types of renewable energy technologies
2. Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION — **9**

Classification of energy sources – Co2 Emission - Features of Renewable energy – Renewable energy scenario in India -Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO2 Emission - importance of renewable energy sources, Potentials – Achievements– Applications.

UNIT II SOLAR PHOTOVOLTAICS — **9**

Solar Energy: Sun and Earth-Basic Characteristics of solar radiation- angle of sunrays on solar collector-Estimating Solar Radiation Empirically - Equivalent circuit of PV Cell- Photovoltaic cell- characteristics: P-V and I-V curve of cell-Impact of Temperature and Insolation on I-V characteristics-Shading Impacts on I-V characteristics-Bypass diode -Blocking diode.

UNIT III PHOTOVOLTAIC SYSTEM DESIGN — **9**

Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification-standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS — **9**

Origin of Winds: Global and Local Winds- Aerodynamics of Wind turbine-Derivation of Betz's limit-Power available in wind-Classification of wind turbine: Horizontal Axis wind turbine and Vertical axis wind turbine-Aerodynamic Efficiency-Tip Speed-Tip Speed Ratio-Solidity-Blade Count-Power curve of wind turbine - Configurations of wind energy conversion systems: Type A, Type B, Type C and Type D Configurations-Grid connection Issues - Grid integrated SCIG and PMSG based WECS.

UNIT V OTHER RENEWABLE ENERGY SOURCES — **9**

Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL — **45**

Course Outcomes

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

CO1	Demonstrate the need for renewable energy sources.
CO2	Develop a stand-alone photo voltaic system and implement a maximum power point tracking in the PV system.
CO3	Design a stand-alone and Grid connected PV system.
CO4	Analyze the different configurations of the wind energy conversion systems.
CO5	Realize the basic of various available renewable energy sources

REFERENCES
1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford UniversityPress, 2009.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Chetan Singh Solanki, “Solar Photovoltaics: Fundamentals, Technologies and Applications”, PHI Learning Private Limited, 2012.
5. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006
6. Gray, L. Johnson, “Wind energy system”, prentice hall of India, 1995.
7. B.H.Khan, " Non-conventional Energy sources", , McGraw-hill, 2nd Edition, 2009.
8. Fang Lin Luo Hong Ye, " Renewable Energy systems", Taylor & Francis Group,2013.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	-	2	2	2	1
CO2	3	-	2	3	3	3
CO3	3	-	2	3	3	3
CO4	3	-	2	3	3	2
CO5	3	-	2	2	2	2
AVG	3	-	2	2	2	2

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OE516	SMART GRID	L	T	P	C
		3	0	0	3

Course Objectives

1. To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
2. To know about the function of smart grid.
3. To familiarize the power quality management issues in Smart Grid.
4. To familiarize the high performance computing for Smart Grid applications
5. To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID — **9**

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between con entional & Smart Grid, Comparison of Micro
grid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES — **9**

Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE — **9**

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID — **9**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS — **9**

Architecture and Standards -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL — **45**

Course Outcomes

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

CO1	Relate with the smart resources, smart meters and other smart devices.
CO2	Explain the function of Smart Grid.
CO3	CO3: Experiment the issues of Power Quality in Smart Grid.
CO4	Analyze the performance of Smart Grid.
CO5	Recommend suitable communication networks for smart grid applications

REFERENCES

1. Stuart Borlase ‘Smart Grid: Infrastructure, Technology and Solutions’, CRC Press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, ‘Smart Grid: Technology and Applications’, Wiley, 2012.
3. Mini S. Thomas, John D McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, 2015
4. Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, ‘Communication Networks for Smart Grids’, Springer, 2014
5. SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	3	2	-	2	2	2
CO2	3	-	2	2	-	2
CO3	2	-	1	-	-	-
CO4	1	-	-	3	3	1
CO5	-	2	2	2	2	3
AVG	2	2	2	2	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OC517	SECURITY PRACTICES	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn the core fundamentals of system and web security concepts
2. To have through understanding in the security concepts related to networks
3. To deploy the security essentials in IT Sector
4. To be exposed to the concepts of Cyber Security and cloud security
5. To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY — **9**

Model of network security – Security attacks, services and mechanisms – OSI security architecture –A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT II NETWORK SECURITY — **9**

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security – Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT III SECURITY MANAGEMENT — **9**

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT IV CYBER SECURITY AND CLOUD SECURITY — **9**

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA

UNIT V PRIVACY AND STORAGE SECURITY — **9**

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL — **45**

Course Outcomes

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

CO1	Understand the core fundamentals of system security
CO2	Apply the security concepts to wired and wireless networks
CO3	Implement and Manage the security essentials in IT Sector
CO4	Explain the concepts of Cyber Security and Cyber forensics
CO5	Be aware of Privacy and Storage security Issues

REFERENCES

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017

2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022

3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019

4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007.

5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012

6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.

7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	2	1	1	2	1
CO2	2	1	3	1	1	2
CO3	-	-	2	3	3	3
CO4	2	2	1	2	1	3
CO5	1	-	1	1	2	3
AVG	2	2	2	2	2	2

Meenakshi Sundararajan Engineering College

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24OC518	CLOUD COMPUTING TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

1. To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
2. To understand the architecture, infrastructure and delivery models of cloud computing.
3. To explore the roster of AWS services and illustrate the way to make applications in AWS
4. To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
5. To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE — **6**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization — Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation

UNIT II CLOUD PLATFORM ARCHITECTURE — **12**

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS — **9**

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager

UNIT IV PAAS CLOUD PLATFORM — **9**

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows
Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services-REST API- Blops

UNIT V PROGRAMMING MODEL — **9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input
and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming,
Task Programming and Map-Reduce Programming in Aneka

TOTAL — **45**

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Employ the concepts of virtualization in the cloud computing
CO2	Identify the architecture, infrastructure and delivery models of cloud computing
CO3	Develop the Cloud Application in AWS platform
CO4	Apply the concepts of Windows Azure to design Cloud Application
CO5	Develop services using various Cloud computing programming models.

REFERENCES

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.

2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.

3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.

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6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.

7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.

8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.

9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

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M.E. Energy Engineering

P24OC519	DESIGN THINKING	L	T	P	C
		3	0	0	3

Course Objectives

1. To provide a sound knowledge in UI & UX
2. To understand the need for UI and UX
3. Research Methods used in Design
4. Tools used in UI & UX
5. Creating a wireframe and prototype

UNIT I UX LIFECYCLE TEMPLATE — **8**

Introduction. A UX process lifecycle template. Choosing a process instance for your project. The system complexity space. Meet the user interface team. Scope of UX presence within the team. More about UX lifecycles. Business Strategy. Value Innovation. Validated User Research. Killer UX Design. The Blockbuster
Value Proposition. What Is a Value Proposition?

UNIT II CONTEXTUAL INQUIRY — **10**

The system concept statement. User work activity data gathering. Look for emotional aspects of work practice. Abridged contextual inquiry process. Data-driven vs. model-driven inquiry. Organizing concepts: work roles and flow model. Creating and managing work activity notes. Constructing your work activity affinity diagram (WAAD). Abridged contextual analysis process. History of affinity diagrams.

UNIT III DESIGN THINKING, IDEATION, AND SKETCHING — **9**

Design-informing models: second span of the bridge . Some general “how to” suggestions. A New example
domain: slideshow presentations. User models. Usage models. Work environment models. Barrier summaries. Model consolidation. Protecting your sources. Abridged methods for design-informing models extraction. Design paradigms. Design thinking. Design perspectives. User personas. Ideation. Sketching

UNIT IV UX GOALS, METRICS, AND TARGETS — **9**

Introduction. UX goals. UX target tables. Work roles, user classes, and UX goals. UX measures. Measuring
instruments. UX metrics. Baseline level. Target level. Setting levels. Observed results. Practical tips and cautions for creating UX targets. How UX targets help manage the user experience engineering process.

UNIT V ANALYSING USER EXPERIENCE — **9**

Sharpening Your Thinking Tools. UX Research and Strength of Evidence. Agile Personas. How to Prioritize
Usability Problems. Creating Insights, Hypotheses and Testable Design Ideas. How to Manage Design Projects with User Experience Metrics. Two Measures that Will Justify Any Design Change. Evangelizing UX Research. How to Create a User Journey Map. Generating Solutions to Usability Problems. Building UX
Research Into the Design Studio Methodology. Dealing with Common objections to UX Research. The User
Experience Debrief Meeting. Creating a User Experience Dashboard.

SUGGESTED ACTIVITIES:
1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping

	TOTAL	**45**

Course Outcomes

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

CO1	Build UI for user Applications
CO2	Use the UI Interaction behaviors and principles
CO3	Evaluate UX design of any product or application
CO4	Demonstrate UX Skills in product development
CO5	Implement Sketching principles

REFERENCES

1. UX for Developers: How to Integrate User-Centered Design Principles Into Your Day-to-Day Development Work, Westley Knight. Apress, 2018

2. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson, Pardha Pyla. Morgan Kaufmann, 2012

3. UX Fundamentals for Non-UX Professionals: User Experience Principles for Managers, Writers, Designers, and Developers, Edward Stull. Apress, 2018

4. Lean UX: Designing Great Products with Agile Teams, Gothelf, Jeff, Seiden, and Josh. O'Reilly Media, 2016

5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

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M.E. Energy Engineering

P24OC520	PRINCIPLES OF MULTIMEDIA	L	T	P	C
		3	0	0	3

Course Objectives

1. To get familiarity with gamut of multimedia and its significance
2. To acquire knowledge in multimedia components.
3. To acquire knowledge about multimedia tools and authoring.
4. To acquire knowledge in the development of multimedia applications.
5. To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION — **9**

Introduction to Multimedia – Characteristics of Multimedia Presentation – Multimedia Components – Promotion of Multimedia Based Components – Digital Representation – Media and Data Streams – Multimedia Architecture – Multimedia Documents, Multimedia Tasks and Concerns, Production, sharing and distribution, Hypermedia, WWW and Internet, Authoring, Multimedia over wireless and mobile networks.

Suggested Activities:

1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:

1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA — **9**

Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.

Suggested Activities:

1. Flipped classroom on different file formats of various media elements.
2. External learning – Adobe after effects, Adobe Media Encoder, Adobe Audition.

Suggested Evaluation Methods:

1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III MULTIMEDIA TOOLS — **9**

Authoring Tools – Features and Types – Card and Page Based Tools – Icon and Object Based Tools – Time Based Tools – Cross Platform Authoring Tools – Editing Tools – Painting and Drawing Tools – 3D Modeling and Animation Tools – Image Editing Tools – Sound Editing Tools – Digital Movie Tools.

Suggested Activities:

1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:

1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV MULTIMEDIA SYSTEMS	**9**
Compression Types and Techniques: CODEC, Text Compression: GIF Coding Standards, JPEG standard – JPEG 2000, basic audio compression – ADPCM, MPEG Psychoacoustics, basic Video compression techniques – MPEG, H.26X – Multimedia Database System – User Interfaces – OS Multimedia Support – Hardware Support – Real Time Protocols – Play Back Architectures – Synchronization – Document Architecture – Hypermedia Concepts: Hypermedia Design – Digital Copyrights, Content analysis. **Suggested Activities:** 1. Flipped classroom on concepts of multimedia hardware architectures. 2. External learning – Digital repositories and hypermedia design. **Suggested Evaluation Methods:** 1. Quizzes on multimedia hardware and compression techniques. 2. Tutorial – Hypermedia design.	
UNIT V MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS	**9**
ADDIE Model – Conceptualization – Content Collection – Storyboard–Script Authoring Metaphors – Testing – Report Writing – Documentation. Multimedia for the web and mobile platforms. Virtual Reality, Internet multimedia content distribution, Multimedia Information sharing – social media sharing, cloud computing for multimedia services, interactive cloud gaming. Multimedia information retrieval. **Suggested Activities:** 1. External learning – Game consoles. 2. External learning – VRML scripting languages. **Suggested Evaluation Methods:** 1. Demonstration of simple interactive games. 2. Tutorial – Simple VRML program.	
	TOTAL **45**

Course Outcomes

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

CO1	Handle the multimedia elements effectively.
CO2	Articulate the concepts and techniques used in multimedia applications.
CO3	Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4	Design and implement algorithms and techniques applied to multimedia objects.
CO5	Design and develop multimedia applications following software engineering models.

REFERENCES

1. Li, Ze-Nian, Drew, Mark, Liu, Jiangchuan, “Fundamentals of Multimedia”, Springer, Third Edition, 2021.

2. Prabhat K.Andleigh, Kiran Thakrar, “MULTIMEDIA SYSTEMS DESIGN”, Pearson Education, 2015.

3. Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018. (digital book)

4. Ranjan Parekh, “Principles of Multimedia”, Second Edition, McGraw-Hill Education, 2017

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M.E. Energy Engineering

P24OC521	BLOCKCHAIN TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives

This course is intended to study the basics of Blockchain technology

During this course the learner will explore various aspects of Blockchain technology like application in various domains.

By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN — **9**

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital
Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY — **9**

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM — **9**

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, , Transactions, Receiving Ethers, Smart Contracts

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING — **9**

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS — **9**

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL — **45**

Course Outcomes

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

CO1	Understand and explore the working of Blockchain technology
CO2	Analyze the working of Smart Contracts
CO3	Understand and analyze the working of Hyperledger
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum
CO5	Develop applications on Blockchain

REFERENCES

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.

2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016

3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014.

4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018

5. D. Drescher, Blockchain Basics. Apress, 2017

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	2	2	2	-	-
CO2	1	1	1	2	-	-
CO3	3	2	3	3	-	-
CO4	2	3	1	2	-	-
CO5	2	2	2	1	-	-
AVG	2	2	1	2	-	-

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M.E. Energy Engineering

P24OC522	DEEP LEARNING	L	T	P	C
		3	0	0	3

Course Objectives

1. Develop and Train Deep Neural Networks.
2. Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
3. Build and train RNNs, work with NLP and Word Embeddings
4. The internal structure of LSTM and GRU and the differences between them
5. The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS — **6**

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT II NEURAL NETWORKS — **9**

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK — **10**

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R-CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT VI NATURAL LANGUAGE PROCESSING USING RNN — **10**

About NLP & its Toolkits. Language Modeling . Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co-occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING — **10**

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Autoencoders for Feature Extraction. Auto Encoders for Classification. Denoising Autoencoders. Sparse Autoencoders

TOTAL — **45**

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Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Feature Extraction from Image and Video Data
CO2	Implement Image Segmentation and Instance Segmentation in Images
CO3	Implement image recognition and image classification using a pretrained network (Transfer 68 Learning)
CO4	Traffic Information analysis using Twitter Data
CO5	Autoencoder for Classification & Feature Extraction

REFERENCES

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017

2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018

3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020

4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017

5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017

Meenakshi Sundararajan Engineering College

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M.E. Energy Engineering

P24OC528	INTEGRATED WATER RESOURCES MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives

Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM — **9**

Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS — **9**

Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS — **9**

Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT — **9**

Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM — **9**

Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security –- Irrigation efficiencies, irrigation methods - current water pricing policy– scope to relook pricing.

TOTAL — **45**

Course Outcomes

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

CO1	Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management
CO2	Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO3	Apply law and governance in the context of IWRM.
CO4	Discuss the linkages between water-health; develop a HIA framework.
CO5	Analyse how the virtual water concept pave way to alternate policy options

REFERENCES

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.

2. Mollinga .P. etal " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

3. Technical Advisory Committee, Integrated Water Resources management, Technical Advisory Committee Background Paper No: 4. Global water partnership, Stockholm, Sweden. 2002.

4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources Management, Technical Advisory Committee Background paper No: 3. Global water partnership, Stockholm, Sweden. 1999.

5. Technical Advisory Committee, Effective Water Governance". Technical Advisory Committee Background paper No: 7. Global water partnership, Stockholm, Sweden, 2003.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2
CO2	2	2	2	2	2	2
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	2	2	2	2	2
AVG	2	2	2	2	2	2

Meenakshi Sundararajan Engineering College

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

Department : Mechanical Engineering, R2024, CBCS

M.E. Energy Engineering

P24ON529	WATER, SANITATION AND HEALTH	L	T	P	C
		3	0	0	3

Course Objectives

Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario

UNIT I FUNDAMENTALS WASH	**9**

Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH

UNIT II MANAGERIAL IMPLICATIONS AND IMPACT	**9**

Third World Scenario – Poor and Multidimensional Deprivation--Health Burden in Developing Scenario - Factors contribute to water, sanitation and hygiene related diseases-Social: Social Stratification and Literacy Demography: Population and Migration- Fertility - Mortality- Environment: Water Borne-Water Washed and Water Based Diseases - Economic: Wage - Water and Health Budgeting -Psychological: Non-compliance -Disease Relapse - Political: Political Will

UNIT III CHALLENGES IN MANAGEMENT AND DEVELOPMENT	**9**

Common Challenges in WASH - Bureaucracy and Users- Water Utilities -Sectoral Allocation:- Infrastructure-Service Delivery: Health services: Macro and Micro- level: Community and Gender Issues- Equity Issues - Paradigm Shift: Democratization of Reforms and Initiatives

UNIT IV GOVERNANCE	**9**

Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V INITIATIVES	**9**

Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH

TOTAL	**45**

Course Outcomes

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

CO1	Capture to fundamental concepts and terms which are to be applied and understood all through the study.
CO2	Comprehend the various factors affecting water sanitation and health through the lens of third world scenario.
CO3	Critically analyse and articulate the underlying common challenges in water, sanitation and health.
CO4	Acquire knowledge on the attributes of governance and its say on water sanitation and health.
CO5	Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects.

REFERENCES

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2. Van Note Chism, N. and Bickford, D. J. (2002), Improving the environment for learning: An expanded agenda. New Directions for Teaching and Learning, 2002: 91–98. doi: 10.1002/tl.83Improving the Environment for learning: An Expanded Agenda

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5. Intersectoral Water Allocation Planning and Management, 2000, World Bank Publishers www. Amazon.com

6. Third World Network.org (www.twn.org)

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	1	2	1	-	-	-
CO2	1	2	1	3	3	3
CO3	1	2	1	3	2	3
CO4	1	2	1	3	3	3
CO5	1	2	1	3	3	2
AVG	1	2	1	3	3	3

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M.E. Energy Engineering

P24ON530	PRINCIPLES OF SUSTAINABLE DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives

To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES — **9**

Definition of sustainability – environmental, economical and social dimensions of sustainability - sustainable
development models – strong and weak sustainability – defining development- millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity – resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK — **9**

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20– Rio Principles of sustainable development – Agenda 21 natural step- peoples earth charter – business charter for sustainable development –UN Global Compact - Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING — **9**

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution - Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS — **10**

Sustainable Development Goals and Linkage to Sustainable Consumption and Production – Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity –Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings - Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD — **8**

Nature of sustainable development strategies and current practice- Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development – Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL — **45**

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M.E. Energy Engineering

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.
CO2	Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals
CO3	Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption
CO4	Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.
CO5	Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability

REFERENCES

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2012

2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris,2017

3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.

4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century - George Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008

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CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	-	2	1	3	-	-
CO2	-	2	1	3	-	-
CO3	-	2	1	3	-	-
CO4	-	2	1	3	-	-
CO5	-	2	1	3	-	-
AVG	-	2	1	3	-	-

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M.E. Energy Engineering

P24ON531	ENVIRONMENTAL IMPACT ASSESSMENT	L	T	P	C
		3	0	0	3

Course Objectives

To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION	**9**

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT INDENTIFICATION AND PREDICTION	**10**

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT	**8**

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN	**9**

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES	**9**

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL	**45**

Course Outcomes

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

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

REFERENCES

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India

2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India

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5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey

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7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO, PO Mapping

CO / PO	PO1	PO2	PO3	PSO1	PSO2	PSO3
CO1	-	-	2	2	-	-
CO2	-	-	2	-	2	2
CO3	-	-	2	-	2	-
CO4	-	-	2	-	2	2
CO5	-	-	2	-	-	-
AVG	-	-	2	2	2	2

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