STELLA MARYS COLLEGE OF ENGINEERING

[An Autonomous Institution | Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai | Accredited by NAAC | Accredited by NBA (Mech& CSE)]

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REGULATION – 2024

CURRICULUM AND SYLLABUS

B.E – ELECTRICAL AND ELECTRONICS ENGINEERING

(Outcome Based Education, Activity Based Learning & Choice Based Credit System)

Anna University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

Institution Vision and Mission

Vision:

To be a beacon of academic excellence, empowering future innovators with technical mastery to harness technology for positive global change.

Mission:

- To cultivate a vibrant learning environment where students delve into the frontiers of technical knowledge, hone their problem-solving skills, and embrace innovation to transform ideas into solutions that address global challenges.
- To bridge the gap between technical brilliance and real-world impact by forging strong industry partnerships, fostering cutting-edge research, and nurturing entrepreneurial drive in our students, empowering them to build a better future through technology.
- To ignite the spark of intellectual curiosity within every student, equip them with the tools and knowledge to become pioneers in their chosen fields, and guide them towards ethical and responsible use of technology for the betterment of humanity.

Department Vision and Mission

Vision:

To be a beacon of transformation, empowering rural students to become globally influential electrical engineers who illuminate the world with their technical brilliance and social responsibility.

Mission:

- To Ignite a passion for innovation in sustainable electrical and electronics engineering, equipping graduates with cutting-edge skills to address global challenges.
- To bridge the gap between academia and industry through collaborative learning, empowering future engineers to address emerging challenges.
- To cultivate ethical leaders in electrical engineering, equipping them with the technical brilliance and social responsibility to shape a more sustainable future.

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PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. Find employment in Core Electrical and Electronics Engineering and service sectors.
2. Get elevated to technical lead position and lead the organization competitively.
3. Enter into higher studies leading to post-graduate and research degrees.
   Become consultant and provide solutions to the practical problems of core organization.
4. Become an entrepreneur and be part of electrical and electronics product and service industries.

PROGRAMME OUTCOMES (POs)

After going through the four years of study, our Electrical and Electronics EngineeringGraduates will exhibit ability to:

PO#	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply knowledge of mathematics, basic science and engineering science.
2	Problem analysis	Identify, formulate and solve engineering problems.
3	Design/development of solutions	Design an electrical system or process to improve its performance, satisfying its constraints.
4	Conduct investigations of complexproblems	Conduct experiments in electrical and electronic systems and interpret the data.
5	Modern tool usage	Apply various tools and techniques to improve the efficiency of the system.
6	The engineer and society	Conduct themselves to uphold the professional and social obligations.
7	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8	Ethics	Interacting industry, business and society in a professional and ethical manner.
9	Individual and team work	Function in a multidisciplinary team.
10	Communication	Proficiency in oral and written communication
11	Project management and finance	Implement cost effective and improved system.
12	Life-long learning	Continue professional development and learning as a life-long activity.

PROGRAM SPECIFIC OUTCOMES (PSOs)

On completion of Electrical and Electronics Engineering program, the student will have the following Program Specific Outcomes.

1. **Foundation of Electrical Engineering:** Ability to understand the principles and working of electrical components, circuits, systems and control that are forming a part of power generation, transmission, distribution, utilization, conservation and energy saving. Students can assess the power management, auditing, crisis and energy saving aspects.
2. **Foundation of Mathematical Concepts**: Ability to apply mathematical methodologies to solve problems related with electrical engineering using appropriate engineering tools and algorithms.
3. **Computing and Research Ability:** Ability to use knowledge in various domains to identify research gaps and hence to provide solution which leads to new ideas and innovations.

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REGULATIONS 2024
CHOICE BASED CREDIT SYSTEM

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING CURRICULUM AND SYLLABI FOR SEMESTERS I TO VIII

BREAKUP CREDIT

SL. NO.	SUBJECT AREA	CREDITS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII/ VIII	VIII/ VII	
1.	HSMC	4	3	2	-	-	-	2	-	11
2.	BSC	12	7	4	-	-	-	-	-	23
3.	ESC	5	9	3	-	-	-	-	-	17
4.	PCC	-	6	12	20	15	11	3	-	67
5.	PEC	-	-	-	-	6	6	6	-	18
6.	OEC	-	-	-	-	3	3	3	-	9
7.	EEC	1	2	1	1	1	1	7	10	24
8.	IC				3					3
	Total	**22**	**27**	**22**	**24**	**25**	**21**	**21**	**10**	**172**
9.	**Mandatory Course (Noncredit)**						✓	✓		

L : Lecture
T : Tutorial
P : Practical
HSMC: Humanities and Social Sciences (including Management Courses)
OEC : Open Elective Courses
BSC : Basic Science Courses
ESC : Engineering Science Courses
EEC : Employability Enhancement Courses
PCC : Professional Core Courses
MC : Mandatory Course
PEC : Professional Elective Courses

SEMESTER WISE CREDIT DISTRIBUTION

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	**22**	**27**	**22**	**24**	**25**	**21**	**21**	**10**	**172**

Total Credits: 172

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SEMESTER – I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	24HS3152	Professional English – I	HSMC	3	0	0	3	3
3.	24MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	24PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	24CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	24GE3151	Problem Solving and PythonProgramming	ESC	3	0	0	3	3
7.	24GE3152	தமிழர் மரபு / Heritage ofTamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	24GE3171	Problem Solving and PythonProgramming Laboratory	ESC	0	0	4	4	2
9.	24BS3171	Physics and ChemistryLaboratory	BSC	0	0	4	4	2
10.	24GE3172	English Laboratory$	EEC	0	0	2	2	1
11.	24TP3101	Skill Enhancement-I	EEC	0	0	2	2	0
			TOTAL	**16**	**1**	**12**	**29**	**22**

$ Skill Based Course

SEMESTER – II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24HS3252	Professional English – II	HSMC	2	0	0	2	2
2.	24MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	24PH3202	Physics for Electrical Engineering	BSC	3	0	0	3	3
4.	24BE3255	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
5.	24GE3251	Engineering Graphics	ESC	2	0	4	6	4
6.	24EE3251	Electric Circuit Analysis	PCC	3	1	0	4	4
7.		NCC Credit Course Level1#	-	2	0	0	2	2#
8.	24GE3252	தமிழரும் தொழில் நுட்பமும் / Tamils and Technology	HSMC	1	0	0	1	1
PRACTICALS								
9.	24GE3271	Engineering PracticesLaboratory	ESC	0	0	4	4	2
10.	24EE3271	Electric Circuits Laboratory	PCC	0	0	4	4	2
11.	24GE3272	Communication Laboratory / Foreign Language$	EEC	0	0	4	4	2
12.	24TP3201	Skill Enhancement-II	EEC	0	0	2	2	0
			TOTAL	**17**	**2**	**18**	**37**	**27**

 # NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded inthe Mark Sheet, however the same shall not be considered for the computation

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SEMESTER – III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24MA3303	Engineering Mathematics-III	BSC	3	1	0	4	4
2.	24EE3301	Electromagnetic Fields	PCC	3	1	0	4	4
3.	24GE3301	Professional Ethics	HSMC	2	0	0	2	2
4.	24EE3303	Electron Devices and Circuits	PCC	3	0	0	3	3
THEORY COURSE WITH PRACTICAL COMPONENETS								
5.	24EE3302	Digital Logic Circuits	PCC	2	0	2	4	3
6.	24CS3353	C Programming and DataStructures	ESC	2	0	2	4	3
PRACTICALS								
7.	24EE3311	Electronic Devices and Circuits Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
8.	24TP3301	Skill Enhancement – III	EEC	0	0	2	2	1
			TOTAL	**15**	**2**	**10**	**27**	**22**

SEMESTER – IV

S. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24IC3401	Engineering Entrepreneurship Development	IC	2	0	2	4	3
2.	24EE3401	Transmission and Distribution	PCC	3	0	0	3	3
3.	24EE3402	Electrical Machines – I	PCC	3	0	0	3	3
4.	24EE3403	Measurements and Instrumentation	PCC	3	0	0	3	3
5.	24EE3404	Control Systems	PCC	3	1	0	4	4
THEORY COURSE WITH PRACTICAL COMPONENETS								
6.	24EE3405	Linear Integrated Circuits	PCC	2	0	2	4	3
PRACTICALS								
7.	24EE3411	Electrical Machines Laboratory – I	PCC	0	0	4	4	2
8.	24EE3412	Control and Instrumentation Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
9.	24TP3401	Skill Enhancement- IV	EEC	0	0	2	2	1
MANDATORY COURSE								
10.		Mandatory Course – I	MC	2	0	0	2	0
			TOTAL	**18**	**1**	**14**	**33**	**24**

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SEMESTER –V

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24EE3501	Power System Analysis	PCC	3	0	0	3	3
2.	24EE3502	Electrical Machines – II	PCC	3	0	0	3	3
3.	24EE3503	Microprocessor and Microcontrollers	PCC	3	0	0	3	3
4.	24EE3504	Power Electronics	PEC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Open Elective I	OEC	3	0	0	3	3
PRACTICALS								
7.	24EE3511	Microprocessor and Microcontrollers Laboratory	PCC	0	0	4	4	2
8.	24EE3512	Electrical Machines Laboratory – II	PCC	0	0	4	4	2
9.	24EE3513	Power Electronics Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
10.	24TP3501	Skill Enhancement– V	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**14**	**32**	**25**

SEMESTER –VI

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24EE3601	Protection and Switch gear	PCC	3	0	0	3	3
2.	24EE3602	Power System Operation and Control	PCC	3	0	0	3	3
3.		Professional Elective II	PEC	3	0	0	3	3
4.		Professional Elective III	PEC	3	0	0	3	3
5.		Open Elective – II	OEC	3	0	0	3	3
THEORY COURSE WITH PRACTICAL COMPONENETS								
6.	24EE3603	Embedded System Design	PCC	2	0	2	4	3
PRACTICALS								
7.	24EE3611	Power System Laboratory	PCC	0	0	4	4	2
EMPLOYABILITY ENHANCEMENT COURSES								
8.	24TP3601	Skill Enhancement – VI	EEC	0	0	2	2	1
MANDATORY COURSE								
9.		Mandatory Course-II	MC	2	0	0	2	0
			TOTAL	**19**	**0**	**8**	**27**	**21**

Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under Mandatory Course-II)

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SEMESTER –VII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	24EE3701	High Voltage Engineering	PCC	3	0	0	3	3
2.	24GE3702	Principles of Management	HSMC	2	0	0	2	2
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Open Elective – III	OEC	3	0	0	3	3
PRACTICALS								
7.	24EE3711	Internship	EEC	0	0	5	5	2
8.	24EE3712	Mini Project	EEC	4	0	0	4	4
EMPLOYABILITY ENHANCEMENT COURSES								
9.	24TP3701	Skill Enhancement – VII	EEC	0	0	2	2	1
			TOTAL	**18**	**0**	**7**	**25**	**21**

SEMESTER –VIII

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	24EE3811	Project Work / Internship	EEC	0	0	2	20	10

TOTAL CREDITS: 172

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PROFESSIONAL ELECTIVE COURSES – VERTICALS

VERTICAL I **Power Engineering**	**VERTICAL II** **Converters and Drives**	**VERTICAL III** **Embedded Systems**	**VERTICAL IV** **Electric Vehicle Technology**	**VERTICAL V** **Control Systems & Sensors Technology**	**VERTICAL VI** **Diversified Courses**
Power Plant Engineering	SMPS and UPS	Communication Engineering	Electric Vehicle Architecture	Digital Measurements and Instrumentation	Energy Management and Auditing
Utilization And Conservation of Electrical Energy	Solid State Drives	Real Time Operating Systems	Fundamentals of Electric and Hybrid Vehicles	Industrial Instrumentation	PLC Programming
Renewable Energy Systems	Special Electrical Machines	Embedded C-Programming	Electric Vehicle Design, Mechanics and Control	Process Control	IOT for Smart Grids
Power Quality	Analysis of Electrical Machines	Embedded Processors	Design of Motor and Power Converters for Electric Vehicles	Robotics And Control	Energy Storage Systems
Soft Computing Techniques	Multilevel Power Converters	Embedded Control For Electric Drives	Design of Electric Vehicle Charging System	Advanced Control Systems	Hybrid Energy Technology
Substation Engineering and Automation	Power Electronics for Renewable Energy Systems	Embedded And Linux System Programming	Testing of Electric Vehicles	MEMS Sensors and Actuators	Design and Modeling of Renewable Energy systems
Under Ground Cable Engineering	Control of Power Electronics Circuits	Smart System Automation	Modelling, Simulation and Control of Electric Vehicles	Model Based Control	Grid Integrating Techniques and Challenges
Smart Grids	FPGA based Power Electronics and Control	Embedded System For Automotive Applications	Grid Integration of Electric Vehicles	Energy Based Control	Sustainable and Environmental Friendly HV Insulation System

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VERTICAL I: POWER ENGINEERING

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24EE3001	Power Plant Engineering	PEC	3	0	0	3	3
2.	24EE3002	Utilization and Conservation of Electrical Energy	PEC	3	0	0	3	3
3.	24EE3003	Renewable Energy Systems	PEC	3	0	0	3	3
4.	24EE3004	Power Quality	PEC	3	0	0	3	3
5.	24EE3005	Soft Computing Techniques	PEC	3	0	0	3	3
6.	24EE3006	Substation Engineering and Automation	PEC	3	0	0	3	3
7.	24EE3007	Under Ground Cable Engineering	PEC	3	0	0	3	3
8.	24EE3008	Smart Grids	PEC	3	0	0	3	3

VERTICAL II: CONVERTERS AND DRIVES

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24EE3009	SMPS and UPS	PEC	2	0	2	4	3
2.	24EE3010	Solid State Drives	PEC	2	0	2	4	3
3.	24EE3011	Special Electrical Machines	PEC	2	0	2	4	3
4.	24EE3012	Analysis of Electrical Machines	PEC	2	0	2	4	3
5.	24EE3013	Multilevel Power Converters	PEC	2	0	2	4	3
6.	24EE3014	Power Electronics for Renewable Energy Systems	PEC	2	0	2	4	3
7.	24EE3015	Control of Power Electronics Circuits	PEC	1	0	4	5	3
8.	24EE3016	FPGA based Power Electronics and Control	PEC	2	0	2	4	3

VERTICAL III: EMBEDDED SYSTEMS

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24EE3017	Communication Engineering	PEC	3	0	0	3	3
2.	24EE3018	Real Time Operating Systems	PEC	2	0	2	4	3
3.	24EE3019	Embedded C-Programming	PEC	2	0	2	4	3
4.	24EE3020	Embedded Processors	PEC	2	0	2	4	3
5.	24EE3021	Embedded Control For Electric Drives	PEC	2	0	2	4	3
6.	24EE3022	Embedded And Linux System Programming	PEC	2	0	2	4	3
7.	24EE3023	Smart System Automation	PEC	2	0	2	4	3
8.	24EE3024	Embedded System For Automotive Applications	PEC	2	0	2	4	3

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VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24EE3025	Electric Vehicle Architecture	PEC	2	0	2	4	3
2.	24EE3026	Fundamentals of Electric and Hybrid Vehicles	PEC	3	0	0	3	3
3.	24EE3027	Electric Vehicle Design, Mechanics and Control	PEC	2	0	2	4	3
4.	24EE3028	Design of Motor and Power Converters for Electric Vehicles	PEC	2	0	2	4	3
5.	24EE3029	Design of Electric Vehicle Charging System	PEC	2	0	2	4	3
6.	24EE3030	Testing of Electric Vehicles	PEC	2	0	2	4	3
7.	24EE3031	Modelling, Simulation and Control of Electric Vehicles	PEC	3	0	0	3	3
8.	24EE3032	Grid Integration of Electric Vehicles	PEC	3	0	0	3	3

VERTICAL V: CONTROL SYSTEMS & SENSORS TECHNOLOGY

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24EE3033	Digital Measurements and Instrumentation	PEC	3	0	0	3	3
2.	24EE3034	Industrial Instrumentation	PEC	3	0	0	3	3
3.	24EE3035	Process Control	PEC	3	0	0	3	3
4.	24EE3036	Robotics And Control	PEC	3	0	0	3	3
5.	24EE3037	Advanced Control Systems	PEC	2	0	2	4	3
6.	24EE3038	MEMS Sensors and Actuators	PEC	3	0	0	3	3
7.	24EE3039	Model Based Control	PEC	3	0	0	3	3
8.	24EE3040	Energy Based Control	PEC	3	0	0	3	3

VERTICAL VI: DIVERSIFIED COURSES

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDIT S
				L	T	P		
1.	24EE3041	Energy Management and Auditing	PEC	3	0	0	3	3
2.	24EE3042	PLC Programming	PEC	3	0	0	3	3
3.	24EE3043	IOT for Smart Grids	PEC	3	0	0	3	3
4.	24EE3044	Energy Storage Systems	PEC	3	0	0	3	3
5.	24EE3045	Hybrid Energy Technology	PEC	2	0	2	4	3
6.	24EE3046	Design and Modeling of Renewable Energy systems	PEC	2	0	2	4	3
7.	24EE3047	Grid Integrating Techniques and Challenges	PEC	2	0	2	4	3
8.	24EE3048	Sustainable and Environmental Friendly HV Insulation System	PEC	3	0	0	3	3

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MANDATORY COURSES (0 credits)

MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	24MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	24MX3082	Indian knowledge systems	MC	3	0	0	3	0
3.	24MX3083	Production and Operations Management for Entrepreneurs	MC	3	0	0	3	0
4.	24MX3084	Disaster Risk Reduction and Management	MC	3	0	0	3	0
5.	24MX3085	Well -being with traditional practices-yoga, ayurveda	MC	3	0	0	3	0

MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	24MX3086	Environmental Sciences and Sustainability	MC	3	0	0	3	0
2.	24MX3087	History of Science and Technology in India	MC	3	0	0	3	0
3.	24MX3088	Political and Economic Thought for a Humane	MC	3	0	0	3	0
4.	24MX3089	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	24MX3090	Industrial Safety	MC	3	0	0	3	0

OPEN ELECTIVE COURSES (9 Credits)

OPEN ELECTIVES

[* Students shall choose the open elective courses, such that the course contents are not similar to any other course contents / title under other course categories.
**** Students are not permitted to opt for Open Elective (OE) courses offered by their parent department.]**

OPEN ELECTIVE – I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24OEEE01	Semiconductor Memories	OEC	3	0	0	3	3
2.	24OEEE02	Electrical Safety And Safety Management	OEC	3	0	0	3	3
3.	24OEEC01	IoT Concepts And Applications	OEC	2	0	2	3	3
4.	24OEEC02	Drone Technologies	OEC	3	0	0	3	3
5.	24OECE01	Plastic And E-Waste Management	OEC	3	0	0	3	3
6.	24OECE02	Remote Sensing And GIS Applications In Environmental Management	OEC	3	0	0	3	3
7.	24OECS01	Advanced Java Technologies	OEC	3	0	0	3	3
8.	24OECS02	Machine Learning Paradigms	OEC	3	0	0	3	3
9.	24OEME01	Fundamentals Of Aeronautical Engineering	OEC	3	0	0	3	3
10.	24OEME02	Energy Technology	OEC	3	0	0	3	3
11.	24OEAD01	Artificial Intelligence And Machine	OEC	3	0	0	3	3
12.	24OEAD02	Business Intelligence And Its Applications	OEC	3	0	0	3	3

OPEN ELECTIVE – II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24OEEE03	Energy Storage Systems	OEC	3	0	0	3	3
2.	24OEEE04	Energy Management And Auditing	OEC	3	0	0	3	3
3.	24OEEC03	Robotic Process Automation	OEC	2	0	2	3	3
4.	24OEEC04	Fundamentals Of Embedded And IoT	OEC	2	0	2	3	3
5.	24OECE03	Green Building Design	OEC	3	0	0	3	3
6.	24OECE04	Web User Interface Design	OEC	3	0	0	3	3
7.	24OECS03	IoT And Edge Computing	OEC	3	0	0	3	3
8.	24OECS04	IT In Agricultural System	OEC	3	0	0	3	3
9.	24OEME03	Environmental Engineering And Pollution	OEC	4	1	0	4	3
10.	24OEME04	Elements Of Marine Engineering	OEC	3	0	0	3	3
11.	24OEAD03	Augmented Reality / Virtual Reality	OEC	3	0	0	3	3
12.	24OEAD04	Digital Forensics	OEC	3	0	0	3	3

OPEN ELECTIVE – III

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	24OEEE05	Electric Vehicles	OEC	3	0	0	3	3
2.	24OEEE06	Green Energy Sources	OEC	3	0	0	3	3
3.	24OEEC05	Consumer Electronics	OEC	3	0	0	3	3
4.	24OEEC06	Sensors And Actuators	OEC	3	0	0	3	3
5.	24OECE05	Urban Agriculture	OEC	3	0	0	3	3
6.	24OECE06	Irrigation Engineering	OEC	3	0	0	3	3
7.	24OECS05	Deep Learning Techniques	OEC	3	0	0	3	3
8.	24OECS06	Ethical Hacking And Network Defense	OEC	3	0	0	3	3
9.	24OEME05	Alternative Fuels And Energy Systems	OEC	3	0	0	3	3
10.	24OEME06	Foundation Of Robotics	OEC	3	0	0	3	3
11.	24OEAD05	Block chain Architecture And Design	OEC	3	0	0	3	3
12.	24OEAD06	Full Stack Development	OEC	3	0	0	3	3

Anna University Nominee **Subject Expert 1** **Subject Expert 2** **Industrial Expert** **Alumni**

Anna University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

Enrollment for B.E. / B. Tech. (Honours) / Minor degree (Optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) Minor degree. For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

VERTICAL I Power Engineering	VERTICAL II Converters and Drives	VERTICAL III Embedded Systems	VERTICAL IV Electric Vehicle Technology	VERTICAL V Control Systems & Sensors Technology	VERTICAL VI Diversified Courses
Power Plant Engineering	SMPS and UPS	Embedded C-Programming	Electric Vehicle Architecture	Process Control	Energy Management and Auditing
Utilization And Conservation of Electrical Energy	Solid State Drives	Embedded Processors	Fundamentals of Electric and Hybrid Vehicles	Advanced Control Systems	PLC Programming
Renewable Energy Systems	Special Electrical Machines	Embedded Networking and Automation of Electrical System	Electric Vehicle Design, Mechanics and Control	Robotics And Control	Big Data Analytics
HVDC and FACTS	Analysis of Electrical Machines	Embedded Control for Electric Drives	Design of Motor and Power Converters for Electric Vehicles	Digital Measurements and Instrumentation	IOT for Smart Grids
Power Quality	Multilevel Power Converters	Smart System Automation	Design of Electric Vehicle Charging System	Industrial Instrumentation	Energy Storage Systems
Power System Transients	Power Electronics for Renewable Energy Systems	Embedded System for Automotive Applications.	Testing of Electric Vehicles	MEMS Sensors and Actuators	Hybrid Energy Technology
Substation Engineering and Automation	Control of Power Electronics Circuits	VLSI Design	Energy Storage & Management for Electric Vehicles	Model Based Control	Design and Modeling of Renewable Energy systems
Under Ground Cable Engineering		MEMS and NEMS		Non Linear Control	Grid Integrating Techniques and Challenges
Smart Grids		Real Time Operating Systems		Adaptive Control	Sustainable and Environmental Friendly HV Insulation System

Anna University Nominee | **Subject Expert 1** | **Subject Expert 2** | **Industrial Expert** | **Alumni**

24IP3151 INDUCTION PROGRAMME

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for thestudent for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting aplay etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarityetc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the studentsexposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. Thiswould familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:
Guide to Induction program from AICTE

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24HS3152 **PROFESSIONAL ENGLISH I** **LT P C**
3 0 0 3

COURSE OBJECTIVES :

- To improve the communicative competence of learners
- To learn to use basic grammatic structures in suitable contexts
- To acquire lexical competence and use them appropriately in a sentence and understand theirmeaning in a text
- To help learners use language effectively in professional contexts
- To develop learners' ability to read and write complex texts, summaries, articles, blogs,definitions, essays and user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course?What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 9

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel& technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9

Reading — Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; andHomophones, discourse markers (connectives & sequence words).

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9

Reading — Newspaper articles; Journal reports –and Non Verbal Communcation (tables, pie chartsetc,.).
Writing — Note-making / Note-taking (*Study skills to be taught, not tested); Writingrecommendations;
Transferring information from non verbal (chart , graph etc, to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed /Semi fixed expressions.

UNIT V EXPRESSION 9

Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL : 45 PERIODS

LEARNING OUTCOMES :

At the end of the course, learners will be able

CO1: To use appropriate words in a professional context

CO2: To gain understanding of basic grammatic structures and use them in right context.

CO3: To read and infer the denotative and connotative meanings of technical texts

CO4: To write definitions, descriptions, narrations and essays on various topics

TEXT BOOKS :

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English,Anna University, (2020 edition)
2. English for Science & Technology Cambridge University Press, 2021.
   Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr.KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Technical Communication — Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt.Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw HillEducation, ISBN : 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writing skills along with their grammatical and lexical competence.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
Avg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

24MA3151 **MATRICES AND CALCULUS**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES :

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branchesof engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals andtheir applications.

UNIT I MATRICES **9 + 3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS **9 + 3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES **9 + 3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications : Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS **9 + 3**

Definite and Indefinite integrals - Substitution rule - Techniques of Integration : Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications : Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS **9 + 3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications : Moments and centres of mass, moment of inertia.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

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

TEXT BOOKS :

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10^{th} Edition, NewDelhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44^{th} Edition ,2018.
3. James Stewart, " Calculus : Early Transcendentals ", Cengage Learning, 8^{th} Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES :

1. Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10^{th} Edition, 2016
2. Bali. N., Goyal. M. and Watkins. C., " Advanced Engineering Mathematics ", FirewallMedia (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7^{th} Edition, 2009.
3. Jain . R.K. and Iyengar. S.R.K., " Advanced Engineering Mathematics ", Narosa Publications,New Delhi, 5^{th} Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., " Calculus " Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., " Higher Engineering Mathematics ", McGraw Hill Education Pvt. Ltd,New Delhi,2016.
6. Srimantha Pal and Bhunia. S.C, " Engineering Mathematics " Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, " Thomas Calculus ", 14^{th} Edition, Pearson India, 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
2	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
3	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
4	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
5	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-
Avg.	3	3	1	1	0	0	0	0	2	0	2	3	-	-	-

ANNA University Nominee | **Subject Expert 1** | **Subject Expert 2** | **Industrial Expert** | **Alumni**

24PH3151 ENGINEERING PHYSICS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

UNIT I MECHANICS 9

Multiparticle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomicmolecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

UNIT II ELECTROMAGNETIC WAVES 9

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference — Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser –Basic applications of lasers in industry.

UNIT IV BASIC QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9

The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students should be able to

CO1: Understand the importance of mechanics.
CO2: Express their knowledge in electromagnetic waves.
CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.
CO4: Understand the importance of quantum physics.
CO5: Comprehend and apply quantum mechanical principles towards the formation of energybands.

TEXT BOOKS:

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

REFERENCES:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition),2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications,(Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	
5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
Avg.	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

24CY3151 **ENGINEERING CHEMISTRY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications ofenergy conversion and storage devices.

UNIT I WATER AND ITS TREATMENT 9

Water: Sources and impurities, **Water quality parameters:** Definition and significance of-colour,odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. **Municipal watertreatment:** primary treatment and disinfection (UV, Ozonation, break-point chlorination)**. Desalinationof brackish water**: Reverse Osmosis. **Boiler troubles:** Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. **Treatment of boiler feed water**: Internal treatment (phosphate,colloidal, sodium aluminate and calgon conditioning) and External treatment — Ion exchangedemineralisation and zeolite process.

UNIT II NANOCHEMISTRY 9

Basics: Distinction between molecules, nanomaterials and bulk materials; **Size-dependent properties** (optical, electrical, mechanical and magnetic); **Types of nanomaterials**: Definition, properties and uses of — nanoparticle, nanocluster, nanorod, nanowire and nanotube. **Preparation of nanomaterials:** sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. **Applications** of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III PHASE RULE AND COMPOSITES 9

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process.

Composites: Introduction: Definition & Need for composites; **Constitution**: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Properties and applications of**: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. **Hybrid composites** - definition and examples.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction: Classification of fuels; **Coal and coke**: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). **Petroleum and Diesel:** Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; **Power alcohol and biodiesel.**

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; **Ignition temperature**: spontaneous ignition temperature, Explosive range; **Flue gas analysis** - ORSAT Method. **CO_2 emission and carbon foot print.**

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor. **Solar energy conversion:** Principle, working and applications of solar cells**; Recent developments in solar cell materials. Wind energy; Geothermal energy;Batteries:** Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion-battery; **Electric vehicles-working principles; Fuel cells:** H_2-O_2 fuel cell, microbial fuel cell; **Supercapacitors:** Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the students will be able:

CO1: To infer the quality of water from quality parameter data and propose suitable treatmentmethodologies to treat water.

CO2: To identify and apply basic concepts of nanoscience and nanotechnology in designing thesynthesis of nanomaterials for engineering and technology applications.

CO3: To apply the knowledge of phase rule and composites for material selection requirements.

CO4: To recommend suitable fuels for engineering processes and applications.

CO5: To recognize different forms of energy resources and apply them for suitable applications inenergy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, NewDelhi, 2008.
3. S.S. Dara, “A text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018.

REFERENCES:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, “Text book of nanoscienceand nanotechnology”, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers andTechnologists, Springer Science Business Media, New York, 2nd Edition, 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	1	-	1	1	-	-	-	-	1	-	-	-
2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
5	3	1	2	1	-	2	2	-	-	-	-	2	-	-	-
Avg.	2.8	1.3	1.6	1	-	1.5	1.8	-	-	-	-	1.5	-	-	-

24GE3151 PROBLEM SOLVING AND PYTHON PROGRAMMING

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing — Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode,debugging; values and types: int, float, boolean, string, a nd list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals:Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if- elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays.Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL : 45 PERIODS

COURSE OUTCOMES:
Upon completion of the course, students will be able to

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop and execute simple Python programs.
CO3: Write simple Python programs using conditionals and loops for solving problems.
CO4: Decompose a Python program into functions.
CO5: Represent compound data using Python lists, tuples, dictionaries etc.
CO6: Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	2	-	-	-	-	-	2	2	3	3	-
2	3	3	3	3	2	-	-	-	-	-	2	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	2	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	2	-	-	2	-	-	-	-	-	1	-	2	-	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

24GE3152 HERITAGE OF TAMILS **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - ClassicalLiterature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the otherparts of India — Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation,Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

24GE3152 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்:** **3**

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை:** **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** **3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்:** **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
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10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – ReferenceBook.

24GE3171 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

Note: The examples suggested in each experiment are only indicative. The lab instructor is expected to design other problems on similar lines. The Examination shall not be restricted to the sample experiments listed here.

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacingcharacters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy.Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another,word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error,voter’s age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of the course, students will be able to:

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

CO3: Implement programs in Python using conditionals and loops for solving problems..

CO4: Deploy functions to decompose a Python program.

CO5: Process compound data using Python data structures.

CO6: Utilize Python packages in developing software applications.

TEXT BOOKS:

1. Allen B. Downey, “Think Python : How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCES:

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	-	-	-	-	-	3	2	3	3	-
2	3	3	3	3	3	-	-	-	-	-	3	2	3	-	-
3	3	3	3	3	2	-	-	-	-	-	2	-	3	-	-
4	3	2	-	2	2	-	-	-	-	-	1	-	3	-	-
5	1	2	-	-	1	-	-	-	-	-	1	-	2	-	-
6	2	-	-	-	2	-	-	-	-	-	1	-	2	-	-
Avg.	2	3	3	3	2	-	-	-	-	-	2	2	3	3	-

24BS3171 PHYSICS AND CHEMISTRY LABORATORY L T P C
0 0 4 2

PHYSICS LABORATORY : (Any Seven Experiments)

COURSE OBJECTIVES:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimentaldata.
- To determine error in experimental measurements and techniques used to minimize sucherror.
- To make the student as an active participant in each part of all lab exercises.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regularand irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
12. Michelson Interferometer.
13. Melde's string experiment
14. Experiment with lattice dynamics kit.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students should be able to

CO1: Understand the functioning of various physics laboratory equipment.
CO2: Use graphical models to analyze laboratory data.
CO3: Use mathematical models as a medium for quantitative reasoning and describing physicalreality.
CO4: Access, process and analyze scientific information.
CO5: Solve problems individually and collaboratively.

MAPPING OF COs WITH POs AND PSOs

CO's	PO's												PSO's		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
Avg.	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, suchas, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles

1. Preparation of Na_2CO_3 as a primary standard and estimation of acidity of a water sampleusing the primary standard
2. Determination of types and amount of alkalinity in water sample.
   - Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

TOTAL : 30 PERIODS

COURSE OUTCOMES :

CO1: To analyse the quality of water samples with respect to their acidity, alkalinity, hardness andDO.
CO2: To determine the amount of metal ions through volumetric and spectroscopic techniques
CO3: To analyse and determine the composition of alloys.
CO4: To learn simple method of synthesis of nanoparticles
CO5: To quantitatively analyse the impurities in solution by electroanalytical techniques

TEXT BOOKS :

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's Textbook ofQuantitative Chemical Analysis (2009).

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
2	3	1	2	-	-	1	2	-	-	-	-	1	-	-	-
3	3	2	1	1	-	-	1	-	-	-	-	-	-	-	-
4	2	1	2	-	-	2	2	-	-	-	-	-	-	-	-
5	2	1	2	-	1	2	2	-	-	-	-	1	-	-	-
Avg.	2.6	1.3	1.6	1	1	1.4	1.8	-	-	-	-	1.3	-	-	-

24GE3172 **ENGLISH LABORATORY** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials likelectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions(filling out a bank application for example).

UNIT II NARRATION AND SUMMATION 6

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 6

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking — Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

UNIT IV CLASSIFICATION AND RECOMMENDATIONS 6

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – SmallTalk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

UNIT V EXPRESSION 6

Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions- understanding a website- describing processes

TOTAL : 30 PERIODS

LEARNING OUTCOMES:

At the end of the course, learners will be able

CO1: To listen to and comprehend general as well as complex academic information

CO2: To listen to and understand different points of view in a discussion

CO3: To speak fluently and accurately in formal and informal communicative contexts

CO4: To describe products and processes and explain their uses and purposes clearly andaccurately

CO5: To express their opinions effectively in both formal and informal discussions

ASSESSMENT PATTERN

- One online / app based assessment to test listening /speaking
- End Semester **ONLY** listening and speaking will be conducted online.
- Proficiency certification is given on successful completion of listening and speaking internaltest and end semester exam.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-
Avg.	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

SEMESTER II

24HS3252 **PROFESSIONAL ENGLISH - II** **L T P C**
2 0 0 2

COURSE OBJECTIVES:

- To engage learners in meaningful language activities to improve their reading and writing skills
- To learn various reading strategies and apply in comprehending documents in professionalcontext.
- To help learners understand the purpose, audience, contexts of different types of writing
- To develop analytical thinking skills for problem solving in communicative contexts
- To demonstrate an understanding of job applications and interviews for internship andplacements

UNIT I MAKING COMPARISONS 6

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING 6

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING 6

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH 6

Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions

UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY 6

Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course, learners will be able

CO1: To compare and contrast products and ideas in technical texts.
CO2: To identify and report cause and effects in events, industrial processes through technicaltexts
CO3:To analyse problems in order to arrive at feasible solutions and communicate them in thewritten format.
CO4: To present their ideas and opinions in a planned and logical manner
CO5:To draft effective resumes in the context of job search.

TEXT BOOKS :

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Departmentof English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.

3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr.KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press.New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, TataMcGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990,Delhi.

ASSESSMENT PATTERN

Two internal assessments and an end semester examination to test students' reading and writingskills along with their grammatical and lexical competence.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
2	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
3	3	3	3	3	3	3	3	3	2	3	3	3	-	-	-
4	3	3	3	3	2	3	3	3	2	3	3	3	-	-	-
5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
Avg.	3	3	3	3	2.75	3	3	3	2.2	3	3	3	-	-	-

24MA3251 **STATISTICS AND NUMERICAL METHODS** **L T P C**
3 1 0 4

COURSE OBJECTIVES:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 9 + 3

Sampling distributions - Tests for single mean, proportion and difference of means (Large and smallsamples) – Tests for single variance and equality of variances – Chi square test for goodness of fit –Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9 + 3

One way and two way classifications - Completely randomized design – Randomized block design –Latin square design - 2^2 factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9 + 3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9 +3

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 9 +3

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the concept of testing of hypothesis for small and large samples in real life problems.

CO2: Apply the basic concepts of classifications of design of experiments in the field of agriculture.

CO3: Appreciate the numerical techniques of interpolation in various intervals and apply thenumerical techniques of differentiation and integration for engineering problems.

CO4: Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

CO5: Solve the partial and ordinary differential equations with initial and boundary conditions byusing certain techniques with engineering applications.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", KhannaPublishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics forEngineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning,New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, NewDelhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., " Fundamentals of Mathematical Statistics", Sultan Chand & Sons,New Delhi, 12th Edition, 2020.

5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ",Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
Avg.	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-

24PH3202	PHYSICS FOR ELECTRICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students to understand the basics of dielectric materials and insulation.
- To understand the electrical properties of materials including free electron theory, applicationsof quantum mechanics and magnetic materials.
- To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
- To establish a sound grasp of knowledge on different optical properties of materials, opticaldisplays and applications
- To inculcate an idea of significance of nano structures, quantum confinement and ensuingnano device applications.

UNIT I DIELECTRIC MATERIALS AND INSULATION 9

Matter polarization and relative permittivity: definition – dipole moment and polarization vector P- polarization mechanisms: electronic, ionic, orientational, interfacial and total polarization – frequency dependence – local field and Causius-Mossetti equation – dielectric constant and dielectric loss – Gauss's law and boundary conditions – dielectric strength, introduction to insulation breakdown in gases, liquids and solids – capacitor materials – typical capacitor constructions – piezoelectricity, ferroelectricity and pyroelectricity – quartz oscillators and filters – piezo and pyroelectric crystals.

UNIT II ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS 9

Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics –Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

UNIT III SEMICONDUCTORS AND TRANSPORT PHYSICS 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts –Schottky diode.

UNIT IV OPTICAL PROPERTIES OF MATERIALS 9

Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laserdiode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

UNIT V NANO DEVICES 9

Density of states for solids - Significance between Fermi energy and volume of the material – Quantum confinement – Quantum structures – Density of states for quantum wells, wires and dots – Band gap of nanomaterials –Tunneling – Single electron phenomena – Single electron Transistor. Conductivity of metallic nanowires – Ballistic transport – Quantum resistance and conductance –

Carbon nanotubes: Properties and applications - Spintronic devices and applications – Optics in quantum structures — quantum well laser.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1: know basics of dielectric materials and insulation.

CO2:gain knowledge on the electrical and magnetic properties of materials and their applications

CO3:understand clearly of semiconductor physics and functioning of semiconductor devices

CO4:understand the optical properties of materials and working principles of various optical devices

CO5:appreciate the importance of nanotechnology and nanodevices.

TEXT BOOKS:

1. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition),2006.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

REFERENCES:

1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Electrical Properties of Materials, Oxford Univ. Press (Indian Edition) 2015.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Mark Fox, Optical Properties of Solids, Oxford Univ.Press, 2001.
5. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
2	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
3	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
4	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
5	3	2	1	-	-	1	-	-	-	-	-	-	-	-	-
Avg.	3	2	1			1	-	-	-	-	-	-	-	-	-

24BE3255 BASIC CIVIL AND MECHANICAL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide the students an illustration of the significance of the Civil and Mechanical Engineering Profession in satisfying the societal needs.
- To help students acquire knowledge in the basics of surveying and the materials used for construction.
- To provide an insight to the essentials of components of a building and the infrastructure facilities.
- To explain the component of power plant units and detailed explanation to IC engines theirworking principles.
- To explain the Refrigeration & Air-conditioning system.

UNIT I PART A: OVERVIEW OF CIVIL ENGINEERING 5

Civil Engineering contributions to the welfare of Society - Specialized sub disciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering — National building code — terminologists: Plinth area, Carpet area, Floorarea, Buildup area, Floor space index - Types of buildings: Residential buildings, Industrial buildings.

UNIT I PART B: OVERVIEW OF MECHANICAL ENGINEERING 4

Overview of Mechanical Engineering - Mechanical Engineering Contributions to the welfare of Society – Specialized sub disciplines in Mechanical Engineering — Manufacturing, Automation, Automobile and Energy Engineering - Interdisciplinary concepts in Mechanical Engineering.

UNIT II SURVEYING AND CIVIL ENGINEERING MATERIALS 9

Surveying: Objects – Classification – Principles – Measurements of Distances and angles – Leveling – Determination of areas– Contours.

Civil Engineering Materials: Bricks – Stones – Sand – Cement – Concrete – Steel - Timber - Modern Materials, Thermal and Acoustic Insulating Materials, Decorative Panels, Water Proofing Materials. Modern uses of Gypsum, Pre-fabricated Building component (brief discussion only)

UNIT III BUILDING COMPONENTS AND INFRASTRUCTURE 9

Building plans – Setting out of a Building - Foundations: Types of foundations - Bearing capacity and settlement – Brick masonry – Stone Masonry – Beams – Columns – Lintels – Roofing – Flooring – Plastering.

Types of Bridges and Dams — Water Supply Network - Rain Water Harvesting — Solid Waste Management - Introduction to Highways and Railways - Introduction to Green Buildings.

UNIT IV INTERNAL COMBUSTION ENGINES AND POWER PLANTS 9

Classification of Power Plants- Working principle of steam, Gas, Diesel, Hydro -electric and Nuclear Power plants- Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines. Working principle of Boilers-Turbines, Reciprocating Pumps (single acting and double acting) and Centrifugal Pumps, Concept of hybrid engines. Industrial safety practices and protective devices

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system– Layout of typical domestic refrigerator–Window and Split type room Air conditioner.Properties of air - water mixture, concepts of psychometric and its process.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding profession of Civil and Mechanical engineering.
CO2: Summarise the planning of building, infrastructure and working of Machineries.
CO3: Apply the knowledge gained in respective discipline
CO4: Illustrate the ideas of Civil and Mechanical Engineering applications.
CO5: Appraise the material, Structures, machines and energy.

TEXT BOOKS:

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw HillEducation; First edition, 2018

REFERENCES:

1.Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018. 2.Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd, 2013.3.Seetharaman S., “Basic Civil Engineering”, Anuradha Agencies, 2005.
4. Shantha Kumar SRJ., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai,2000.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	-	-	1	-	-	1	2	1	2	-	1	-	-	-
2	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
3	2	-	-	-	-	-	1	2	2	2	-	2	-	-	-
4	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
5	2	-	-	-	-	-	1	2	1	2	-	2	-	-	-
Avg.	2	-	-	0.2	-	-	1	2	1.2	2	-	1.8	-	-	-

ANNA University Nominee | **Subject Expert 1** | **Subject Expert 2** | **Industrial Expert** | **Alumni**

24GE3251 **ENGINEERING GRAPHICS** **L T P C**
2 0 4 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications –– Use of drafting instruments –– BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.

UNIT I PLANE CURVES 6+12

Basic Geometrical constructions, Curves used in engineering practices: Conics –– Construction ofellipse, parabola and hyperbola by eccentricity method –– Construction of cycloid –– construction ofinvolutes of square and circle –– Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes -Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS AND FREE HAND SKETCHING 6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis isinclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6 +12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other –– obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids –– Prisms, pyramids cylinders and cones.

Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

Principles of isometric projection –– isometric scale —lsometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

Practicing three dimensional modeling of isometric projection of simple objects by CAD Software(Not for examination)

TOTAL: (L=30+P=60) 90 PERIODS

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

CO1: Use BIS conventions and specifications for engineering drawing.

CO2: Construct the conic curves, involutes and cycloid.

CO3: Solve practical problems involving projection of lines.

CO4: Draw the orthographic, isometric and perspective projections of simple solids.

CO5: Draw the development of simple solids.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 201

REFERENCES:

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

Publication of Bureau of Indian Standards:

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

COs	POs											PSOs		
	PO01	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
2	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
3	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
4	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
5	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-
Avg.	3	1	2	-	2	-	-	-	-	3	-	2	2	2	-

24EE3251 ELECTRIC CIRCUIT ANALYSIS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

- To introduce electric circuits and its analysis
- To provide key concepts to analyze and understand electrical circuits
- To impart knowledge on solving circuit equations using network theorems
- To educate on obtaining the transient response of circuits.
- To introduce the phenomenon of resonance in coupled circuits.
- To introduce Phasor diagrams and analysis of single &three phase circuits

UNIT I BASIC CIRCUITS ANALYSIS 9+3

Fundamentals concepts of R, L and C elements-Energy Sources- Ohm's Law -Kirchhoff 's Laws – DC Circuits — Resistors in series and parallel circuits - A.C Circuits — Average and RMS Value — Complex Impedance — Phasor diagram - Real and Reactive Power, Power Factor, Energy -Mesh current and node voltage methods of analysis D.C and A.C Circuits.

UNIT II NETWORK REDUCTION AND THEOREMS FOR DC AND AC CIRCUITS 9+3

Network reduction: voltage and current division, source transformation – star delta conversion. Theorems – Superposition, Thevenin's and Norton's Theorem – Maximum power transfer theorem – Reciprocity Theorem – Millman's theorem- Tellegen's Theorem-Statement, application to DC and AC Circuits.

UNIT III TRANSIENT RESPONSE ANALYSIS 9+3

Introduction — Laplace transforms and inverse Laplace transforms- standard test signals -Transientresponse of RL, RC and RLC circuits using Laplace transform for Source free, Step input and Sinusoidal input.

UNIT IV RESONANCE AND COUPLED CIRCUITS 9+3

Series and parallel resonance –frequency response – Quality factor and Bandwidth – Self and mutual inductance – Coefficient of coupling – Dot rule-Analysis of coupled circuits– Single Tuned circuits.

UNIT V THREE PHASE CIRCUITS 9+3

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completing this course, the students will be able to:

CO1: Explain circuit's behavior using circuit laws.

CO2: Apply mesh analysis/ nodal analysis / network theorems to determine behavior of the givenDC and AC circuit

CO3: Compute the transient response of first order and second order systems to step and sinusoidalinput

CO4: Compute power, line/ phase voltage and currents of the given three phase circuitCO5: Explain the frequency response of series and parallel RLC circuits

CO6: Explain the behavior of magnetically coupled circuits.

TEXT BOOKS:

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

2. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Second Edition, McGraw Hill, 2019.
3. Allan H. Robbins, Wilhelm C. Miller, “Circuit Analysis Theory and Practice”, Cengage Learning India, 2013.

REFERENCES

1. Chakrabarti A, “Circuits Theory (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi,2020.
2 Joseph A. Edminister, Mahmood Nahvi, “Electric circuits”, Schaum’s series, McGraw-Hill,First Edition, 2019.
4. M E Van Valkenburg, “Network Analysis”,Prentice-Hall of India Pvt Ltd, New Delhi, 2015.
5. Richard C. Dorf and James A. Svoboda, “Introduction to Electric Circuits”, 7th Edition, JohnWiley Sons, Inc. 2018.
6. udhakar A and Shyam Mohan SP, “Circuits and Networks Analysis and Synthesis”, McGraHill, 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3	3	3	2	2	-	2	1	-	-	-	3	3	3	3
CO2	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO3	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO4	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO5	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
CO6	3	3	3	3	2	-	2	1	-	-	-	3	3	3	3
Avg.	3	3	3	2.8	2	-	2	1	-	-	-	3	3	3	3

NCC Credit Course Level 1*

24NX3251	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

24NX3252	**(NAVAL WING) NCC Credit Course Level - I**	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

NCC Credit Course Level 1*

24NX3253	(AIR FORCE WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contributionof Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

24GE3252 TAMILS AND TECHNOLOGY LT P C
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age — Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins — Beads making-industries Stone beads -Glass beads - Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described inSilappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

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

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

24GE3252 **தமிழரும் தொழில்நுட்பமும்** L T P C 1 0 0 1

அலகு I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்:** 3

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:** 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு– சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ–சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்:** 3

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்:** 3

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:** 3

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

24GE3271 ENGINEERING PRACTICES LABORATORY LT P C
0 0 4 2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common household wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b) Preparing plumbing line sketches.
c) Laying pipe connection to the suction side of a pump
d) Laying pipe connection to the delivery side of a pump.
e) Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK:

a) Sawing,
b) Planing and
c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a) Studying joints in door panels and wooden furniture
b) Studying common industrial trusses using models.

PART II ELECTRICAL ENGINEERING PRACTICES 15

a) Introduction to switches, fuses, indicators and lamps - Basic switch board wiring withlamp, fan and three pin socket
b) Staircase wiring
c) Fluorescent Lamp wiring with introduction to CFL and LED types.
d) Energy meter wiring and related calculations/ calibration
e) Study of Iron Box wiring and assembly
f) Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g) Study of emergency lamp wiring/Water heater

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

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

ASSEMBLY WORK:

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

SHEET METAL WORK:

a) Making of a square tray

FOUNDRY WORK:

a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

a) Study an elements of smart phone.
b) Assembly and dismantle of LED TV.
c) Assembly and dismantle of computer/ laptop

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

CO2: Wire various electrical joints in common household electrical wire work.

CO3: Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.

CO4: Solder and test simple electronic circuits; Assemble and test simple electronic componentson PCB.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**P06**	**P07**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**	**PS03**
1	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
2	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
3	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1
Avg.	3	2	-	-	1	1	1	-	-	-	-	2	2	1	1

24EE3271 ELECTRIC CIRCUITS LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To simulate various electric circuits using Pspice/ Matlab/e-Sim / Scilab
- To gain practical experience on electric circuits and verification of theorems

LIST OF EXPERIMENTS

Familiarization of various electrical components, sources and measuring instruments

1. Simulation and experimental verification of series and parallel electrical circuit usingfundamental laws.
2. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
3. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
4. Simulation and experimental verification of electrical circuit problems using Superpositiontheorem.
5. Simulation and experimental verification of Maximum Power transfer theorem.
6. Simulation and Experimental validation of R-C,R-L and RLC electric circuit transients
7. Simulation and Experimental validation of frequency response of RLC electric circuit.
8. Design and implementation of series and parallel resonance circuit.
9. Simulation and experimental verification of three phase balance. and unbalanced star,delta networks circuit (Power and Power factor calculations).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Use simulation and experimental methods to verify the fundamental electrical laws for the given DC/AC circuit (Ex 1)

CO2: Use simulation and experimental methods to verify the various electrical theorems (Superposition, Thevenin , Norton and maximum power transfer) for the given DC/AC circuit (Ex 2-5)

CO3: Analyze transient behavior of the given RL/RC/RLC circuit using simulation and experimental methods (Ex 6)

CO4: Analyze frequency response of the given series and parallel RLC circuit usingsimulation and experimentation methods (Ex 7-8)

CO5: Analyze the performance of the given three-phase circuit using simulation and experimental methods (Ex 9)

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
2	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
3	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
4	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
5	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2
Avg.	3	3	3	3	3	-	2	1.5	3	-	-	3	3	3	2

24GE3272 COMMUNICATION LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES

- To identify varied group discussion skills and apply them to take part in effective discussions ina professional context.
- To analyse concepts and problems and make effective presentations explaining them clearlyand precisely.
- To be able to communicate effectively through formal and informal writing.
- To be able to use appropriate language structures to write emails, reports and essays
- To give instructions and recommendations that are clear and relevant to the context

UNIT I 12

Speaking-Role Play Exercises Based on Workplace Contexts, - talking about competition- discussing progress toward goals-talking about experiences- talking about events in life- discussing past events- Writing: writing emails (formal & semi-formal).

UNIT II 12

Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.

UNIT III **12**

Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages- making comparisons- discussing likes and dislikes-discussing feelings about experiences-discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.

UNIT IV **12**

Speaking: discussing the natural environment-describing systems-describing position and movement- explaining rules-(example- discussing rental arrangements)- understanding technical instructions- Writing: writing instructions-writing a short article.

UNIT V **12**

Speaking: describing things relatively-describing clothing-discussing safety issues(making recommendations) talking about electrical devices-describing controlling actions- Writing:
job application(Cover letter + Curriculum vitae)-writing recommendations.

TOTAL: 60 PERIODS

LEARNING OUTCOMES

At the end of the course, learners will be able

- Speak effectively in group discussions held in formal/semi formal contexts.
- Discuss, analyse and present concepts and problems from various perspectives to arrive atsuitable solutions
- Write emails, letters and effective job applications.
- Write critical reports to convey data and information with clarity and precision
- Give appropriate instructions and recommendations for safe execution of tasks

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
1	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
2	2	3	3	3	1	3	3	3	3	3	3	3	-	-	-
3	2	2	3	3	1	3	3	3	3	3	3	3	-	-	-
4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
Avg.	2.4	2.8	3	3	1.8	3	3	3	3	3	3	3	-	-	-

Assessment Pattern

- One online / app based assessment to test speaking and writing skills
- Proficiency certification is given on successful completion of speaking and writing.

24MA3303 ENGINEERING MATHEMATICS- III **L T P C**
4 0 0 4

COURSE OBJECTIVES:

- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals and to acquaint the students with Differential Equations which are significantly used in engineering problems
- To introduce the various methods of complex analysis and laplace transforms can be used for effectively solving the problems.
- To acquaint the student with Fourier, transform techniques used in wide variety of situations.
- This course aims at providing the required skill to apply the statistical tools in engineering problems. To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables

UNIT I ORDINARY DIFFERENTIAL EQUATIONS **12**

Higher order linear differential equations with constant coefficients – Method of variation of parameters– Homogenous equation of Euler's and Legendre's type – System of simultaneous linear first order differential equations with constant coefficients – Method of undetermined coefficients.

UNIT II LAPLACE TRANSFORMS **12**

Existence conditions- Transforms of elementary functions - Transform of unit step function and unit impulse function – Basic properties- Shifting theorems- transforms of derivatives and integrals – Initial and final value theorems- Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order differential equations with constant coefficients.

UNIT III FOURIER TRANSFORMS **12**

Statement of Fourier integral theorem — Fourier transform pair — Fourier sine and cosine transforms — Properties — Transforms of simple functions — Convolution theorem — Parsevals identity.

UNIT IV PROBABILITY AND RANDOM VARIABLES **12**

Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

UNIT V TWO DIMENSIONAL RANDOM VARIABLES **12**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables)

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: To acquaint the students with Differential Equations which are significantly used in engineering problems.

CO2: Use the effective mathematical tools for the solutions Eigen values and Eigen vectors diagonalization of a matrix, symmetric matrices.

CO3: Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering..

CO4: Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon

CO5: Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS

1. Grewal B.S., “Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., ManicavachagomPillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. B.V Ramana.., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, India, 2016.
3. G. James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. L.C Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
5. N.P. Bali. and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2014.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	2	1	-	-	-	-	-	-	-	-	-	1	-	-
2	3	3	3	3	2	-	-	-	-	-	-	-	2	1	-
3	3	3	1	-	-	-	-	-	-	-	-	-	3	1	-
4	3	3	3	3	1	-	-	-	-	-	-	-	2	1	-
5	3	3	3	1	1	-	-	-	-	-	-	-	2	-	-
Avg.	3	2.8	2.2	1.4	0.8	-	-	-	-	-	-	-	2	-	-

24EE3301 ELECTRO MAGNETIC FIELDS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To introduce the basic mathematical concepts related to electromagnetic vector fields
- To impart knowledge on the concepts of Electrostatic fields, electric potential, energy density and their applications.
- To impart knowledge on the concepts of Magneto static fields, magnetic flux density, vector potential and its applications
- To impart the different methods of emf generation and Maxwell’s equations
- To gain the knowledge of Electromagnetic waves and characterizing parameters

UNIT I ELECTROSTATICS – I 12

Introduction to Vector fields and Coordinate systems – Sources and effects of electromagnetic fields – Gradient, Divergence, Curl – theorems and applications - Coulomb’s Law – Electric field intensity and potential – Field due to discrete and continuous charges – Gauss’s law and applications.

UNIT II ELECTROSTATICS – II 12

Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor – Electric field in free space, conductors, dielectrics - Dielectric polarization –Dielectric strength – Boundary conditions, Poisson’s and Laplace’s equations, Capacitance, Energy density, Applications.

UNIT III MAGNETOSTATICS 12

Magnetic field intensity (H) ,Lorentz force – Biot–Savart’s Law - Ampere’s Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor– Magnetization,–Boundary conditions, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density,Applications.

UNIT IV ELECTRODYNAMIC FIELDS **12**

Faraday's law – Transformer and motional EMF – Displacement current -Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory – Applications.

UNIT V ELECTROMAGNETIC WAVES **12**

Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth - Poynting vector – Plane wave reflection and refraction.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Explain about the Gradient, Divergence, and Curl operations on electromagnetic vector fields and identify the electromagnetic sources and their effects

CO2: Analyze the electrostatic fields, electric potential, energy density along withtheir applications

CO3: Analyze magneto static fields, magnetic flux density, vector potential alongwith their applications

CO4: Evaluate the different methods of EMF generation and Maxwell's equations

CO5: Explain the concept of electromagnetic waves and characterizing parameters.

TEXT BOOKS:

1.Mathew N. O. Sadiku, S.V. Kulkarni 'Principles of Electromagnetics', 6th Edition, OxfordUniversity Press Inc. Asian edition, 2015.

2.William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill SpecialIndian edition, 2014.

3.Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill InternationalEditions, Fifth Edition, 2010.

REFERENCES:

1.K.A. Gangadhar and P.M. Ramanathan,'Electromagnetic Field Theory',Khanna Publishers,Standard Edition (1 January 1997)

2. Satya Prakash,'Electromagnetic Theory And Electrodynamics, Kedar Nath Ram Nath; 2021st Edition (1 January 2020); Kedar Nath Ram Nath, 132, R.G. College Roads, Meerut-250001 (U.P)

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
2	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
3	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
4	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
5	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3
Avg.	3	2	2	2	-	-	-	-	-	-	-	1	2	3	3

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24GE3301 PROFESSIONAL ETHICS IN ENGINEERING **L T P C**
2 0 0 2

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

UNIT I HUMAN VALUES **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II ENGINEERING ETHICS **9**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES **9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the relevance of core human values in promoting ethical and peaceful living.
CO2: Apply ethical principles and professional responsibilities in engineering practice.
CO3: Analyze moral dilemmas using ethical theories and decision-making models.
CO4: Evaluate professional rights and responsibilities to ensure workplace safety and fairness.
CO5: Analyze global ethical concerns and evaluate their impact on engineering practice.

TEXT BOOKS:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCES:

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	–	–	–	2	1	3	2	1	–	1	1	-	-	-
2	2	1	1	–	2	1	3	2	1	1	2	2	-	-	-
3	3	1	2	–	2	1	3	1	1	–	2	3	-	-	-
4	2	1	2	–	3	2	3	2	2	1	1	2	-	-	-
5	2	1	2	1	3	3	3	1	2	1	2	2	-	-	-
Avg.	2	0.8	1.4	0.2	2.4	1.6	3	1.6	1.4	0.6	1.6	2	-	-	--

24EE3302 DIGITAL LOGIC CIRCUITS L T P C
2 0 2 3

COURSE OBJECTIVES:

• To explain various number systems and characteristics of digital logic families.
• To inculcate the concepts of design and implementation of combinational logic circuits.
• To design various synchronous circuits using Flip Flops.
• To analyze and study asynchronous sequential circuits and Programmable Logic Devices.
• To familiarize Hardware descriptive language(HDL) for the implementation of combinational circuits.

UNIT I NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES 9

Number system, error detection, corrections & codes conversions, Boolean algebra: DeMorgan’s theorem- Digital Logic Families -comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.

UNIT II COMBINATIONAL CIRCUITS 9

Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps - Implementations of Logic Functions using NAND–NOR gates–multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

SR, JK, D and T flip flops - counters – Design of asynchronous and synchronous counter - Shift registers - Design and Analysis of synchronous sequential circuits – Moore and Mealy models.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABILITY LOGIC DEVICES 9

Asynchronous sequential logic Circuits-Transition table, flow table-races- Hazards- analysis of asynchronous sequential logic circuits. Introduction to Programmability Logic Devices: PROM – PLA –PAL-FPGA.

UNIT V VHDL 9

RTL Design –Operators of VHDL–Packages – Test bench-Combinational logic ,Sequential logic circuit using VHDL coding.(adders, counters, flip flops, Multiplexers & De multiplexers)

35 PERIODS

List of experiments

1.Study of Basic Digital IC's

2. Implementation of Boolean Functions, Adder and Subtractor circuits.

3.Implementation of code converters using logic gates.

4. Implementation of encoders and encoders using logic gates.

5. Design and implementation of 3-bit modulo counters in synchronous and asynchronous mode.

6. Design and implementation of 4-bit shift registers in SISO, SIPO, PIPO modes using suitable ICs..

25 PERIODS

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze logical expressions and reduce them using simplification techniques.

CO2: Design and implement combinational circuits using basic gates(basic digital ICs).

CO3: Design and implement various synchronous circuits.

CO4: Analyze and implement asynchronous sequential circuits and design combinational functions using PLDs.

CO5: Implement and simulate HDL programs for digital logic circuits.

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, "Digital Design with an introduction to VHDL", Pearson Education, 8 th edition, 2013.
2. Thomas L Floyd, "Digital fundamentals", Pearson Education Limited, 11th Edition, 2018
3. William Keitz, "Digital Electronics-A Practical Approach with VHDL", Pearson, 2013.
4. Salivahanan S and Arivazhagan S, "Digital Circuits and Design", Oxford University Press, 5th Edition, 2018.
5. Donald P.Leach and Albert Paul Malvino, "Digital Principles and Applications", 6th

Edition, McGraw Hill, 2003.

REFERENCES:

1. Charles H.Roth, Jr. Lizy Kurian John, “Digital System Design using VHDL”, Cengage, 3rd edition, 2017.
2 .John M.Yarbrough, “Digital Logic, Application & Design”, Thomson, 2002.
3.Botros, “HDL Programming Fundamentals, VHDL & Verilog”, Cengage, 2013.

MAPPING OF COs WITH POs AND PSOs

Cos	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
2	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
3	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
4	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
5	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1
Avg.	3	3	3	1	3	-	-	1	-	-	-	1	3	-	1

24EE3303 ELECTRON DEVICES AND CIRCUITS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the structure of basic electronic devices and be exposed to active and passive circuit elements
- To familiarize the operation of transistor like BJT and FET.
- To analyze the performance of different BJT and MOSFET amplifier configurations.
- To explore the characteristics of amplifier, gain and frequency response.
- To learn the required functionality of positive and negative feedback systems

UNIT I PN JUNCTION DEVICES 9

PN junction diode –structure, operation and V-I characteristics, — Clipping & Clamping circuits - Rectifiers – Half Wave and Full Wave Rectifier– Display devices- LED, Laser diodes, Zener diode characteristics- Zener diode Reverse characteristics — Zener diode as regulator.

UNIT II TRANSISTORS AND THYRISTORS 9

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT and IGBT - Structure and characteristics

UNIT III AMPLIFIERS 9

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –MOSFET small signal model– Analysis of CS and Source follower — Gain and frequency response

UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9

BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response –power amplifiers –Types (Qualitative analysis).

UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS **9**

Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, Wien bridge, Hartley, Colpitts and Crystal oscillators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the structure and operation of PN junction devices (diode, Zener diode, LED and Laser diode) and also outline the clipper, clamper, half wave and full wave rectifier, regulator circuits using PN junction diodes

CO2: Analyze the structure and characteristics BJT, FET, MOSFET, UJT, Thyristor and IGBT

CO3: Analyze the performance of various configurations of BJT and MOSFET based amplifier

CO4: Explain the characteristics of MOS based cascade and differential amplifier

CO5: Explain the operation of various feedback amplifiers and oscillators

TEXT BOOKS:

1. David A. Bell , "Electronic devices and circuits", Oxford University higher education, 5th edition 2008.
2. Sedra and smith, "Microelectronic circuits",7th Edition., Oxford University Press, 2017

REFERENCES:

1. Balbir Kumar, Shail.B.Jain, "Electronic devices and circuits" PHI learning private limited, 2nd edition 2014
2. Thomas L.Floyd, "Electronic devices" Conventional current version, Pearson prentice hall, 10th Edition, 2017.

Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition,2003.

3. Robert L.Boylestad, "Electronic devices and circuit theory", 11th edition, Pearson prentice Hall 2013.
4. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, Second edition, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1
2	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1
3	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1
4	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1
5	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1
Avg.	3	2	3	2	2	2	-	1	-	-	-	1	3	-	1

24CS3353 C PROGRAMMING AND DATA STRUCTURES **L T P C**

2 0 2 3

COURSE OBJECTIVES:

- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques.

UNIT I C PROGRAMMING - FUNDAMENTALS 7

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements -Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

UNIT II C PROGRAMMING – ADVANCED FEATURES 7

Structures – Union – Pointers: Pointers to Variables, Arrays and Functions– File Handling – Preprocessor Directives.

UNIT III LINEAR DATA STRUCTURES 7

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly- Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Queue ADT – Queue Implementation.

UNIT IV NON-LINEAR DATA STRUCTURES 7

Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing – Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing.

UNIT V SORTING AND SEARCHING TECHNIQUES 7

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

SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)

35 PERIODS

List of experiments

1. Practice of C programming using statements, expressions, decision making and iterative statements.
2. Practice of C programming using Functions and Arrays.
3. Implement C programs using Pointers and Structures.
4. Array implementation of List ADT.
5. Array implementation of Stack and Queue ADTs.
6. Implementation of Binary Trees and operations of Binary Tree
7. Implementation of searching techniques.
8. Implementation of Sorting algorithms : Insertion Sort, Quick Sort, Merge Sort.

25 PERIODS

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Use different constructs of C and develop applications.
CO2: Apply advanced features of C in solving problems.
CO3: Write functions to implement linear and non–linear data structure operations.
CO4: Suggest and use appropriate linear/non–linear data structure operations for solving a given problem.
CO5: Appropriately use sort and search algorithms for a given application.
CO6: Apply appropriate hash functions that result in a collision free scenario for data storage and retrieval.

TEXT BOOKS:

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1997.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

2. ReemaThareja, “Programming in C”, Second Edition, Oxford University Press, 2016.

REFERENCES:

1. Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4. Ellis Horowitz, SartajSahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
CO1	2	3	1	2	2	1	1	-	1	2	1	3	2	1	3
CO2	1	2	1	2	2	-	-	-	1	1	1	2	2	2	2
CO3	2	3	1	2	3	-	-	-	1	1	1	2	2	1	2
CO4	2	1	-	1	1	-	-	-	2	1	1	2	2	3	1
CO5	1	2	1	2	2	1	1	-	1	2	1	3	2	2	3
Avg	2	2	1	2	2	1	1	-	1	1	1	2	2	2	2

24EE3311 ELECTRONIC DEVICES AND CIRCUITS LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To understand semiconductor device behavior through experiments and familiar with the operation and characteristics of BJT
- Familiarize the operation and characteristics of transistor like JFET and UJT.
- To explore the frequency response of a Common Emitter amplifier, FET-based differential amplifier, and the characteristics of various oscillators.
- Explore the characteristics of half-wave and full-wave rectifier with and without filters experimentally
- Learn the required functionality of CRO and to analyze the frequency response characteristics of passive filters

LIST OF EXPERIMENTS

1. Characteristics of Semiconductor diode, Zener diode , photo diode , and photo transistor,
2. Characteristics of NPN Transistor under common emitter , common collector and common base configurations
3. Characteristics of JFET and draw the equivalent circuit
4. Characteristics of UJT and generation of saw tooth waveforms
5. Design and frequency response characteristics of a Common Emitter amplifier
6. Design and testing of RC phase shift and LC oscillators
7. Characteristics of Single Phase half-wave and full wave rectifiers with inductive andcapacitive filters
8. Design of Differential amplifiers using FET
9. Measurement of frequency and phase angle using CRO
10. Realization of passive filters

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the characteristics of PN, Zener diode and BJT in CE,CC,CB configurations experimentally

CO2: Analyze the characteristics of JFET and UJT experimentally

CO3: Analyze the frequency response of a Common Emitter amplifier and FET-based differential amplifier, along with the characteristics of RC phase shift and LC oscillators

CO4: Analyze the characteristics of half-wave and full-wave rectifier with and without filters experimentally

CO5: Calculate the frequency and phase angle using CRO experimentally and also analyze the frequency response characteristics of passive filters experimentally

MAPPING OF COs WITH POs AND PSO

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	-	-	-	3	3	-	-	1.5	-	-	3	-	-	3	3
2	-	-	3	3	3	-	-	1.5	-	-	3	-	-	3	3
3	-	3	3	3	3	-	-	1.5	-	-	3	-	-	3	3
4	-	-	-	-	3	-	-	1.5	-	-	-	-	-	3	3
5	-	-	-	-	3	-	-	1.5	-	-	3	-	-	3	3
Avg.	-	0.6	1.2	1.8	3	-	-	1.5	-	-	2.4	-	-	3	3

24TP3301 SKILL ENHANCEMENT – III L T P C
0 0 2 1

COURSE OBJECTIVE:

- To develop a strong foundation in quantitative problem-solving techniques involving arithmetic, algebra, and applied mathematics relevant to competitive and academic assessments.
- To enhance logical and analytical reasoning skills through practice with real-life and abstract reasoning problems, enabling better decision-making and problem-solving capabilities.
- To strengthen verbal ability and language proficiency by improving vocabulary, understanding idioms and phrases, and mastering word classification techniques.
- To cultivate creative thinking and spatial reasoning skills through visual-based problems involving Venn diagrams, cubes, dice, and figure matrices.
- To prepare students for competitive examinations and aptitude tests by equipping them with comprehensive strategies to approach a wide range of quantitative, reasoning, and verbal challenges.

UNIT I QUANTITATIVE ABILITY – I 6

Problems on Trains - Time and Distance - Height and Distance - Time and Work.

UNIT II QUANTITATIVE ABILITY – II **6**

Problems on Ages - Alligation or Mixture - Chain Rule - Simple Interest - Simple Equation - Theory Of Equation.

UNIT III REASONING ABILITY – I **6**

Analytical Reasoning - Pipes and Cistern - Logical Problems - Logical Games - Logical Deduction - Data Suficiency - Arithmetic Reasoning.

UNIT IV VERBAL ABILITY – I **6**

Idioms & Phrases - Synonyms - Antonyms - Classiication.

UNIT V CREATIVITY ABILITY – I **6**

Venn Diagrams, Cube and Cuboids, Dice, Cubes and Dice, Figure Matrix

TOTAL : 30 PERIODS

COURSE OUTCOMES:

On successful completion the students will be able to

CO1: Apply basic mathematical concepts to solve problems related to time, distance, work, and mixtures using quantitative techniques.

CO2: Solve real-life logical and numerical problems through reasoning strategies and analytical thinking.

CO3: Demonstrate verbal ability by identifying correct usage of idioms, phrases, synonyms, antonyms, and classification patterns.

CO4: Analyze and interpret visual and spatial data using Venn diagrams, cubes, dice, and figure matrices to enhance creative thinking.

CO5: Develop speed and accuracy in solving aptitude-related questions, preparing students for competitive exams and placement opportunities

MAPPING OF COs WITH POs AND PSO

COs	**POs**												**PSOs**		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	3	2	2	2	1	1	1	1	2	2	2	-	-	-
2	2	2	3	2	2	2	1	2	2	2	1	2	-	-	-
3	2	1	1	3	2	2	2	1	2	3	2	2	-	-	-
4	2	2	2	2	3	3	2	2	3	2	1	2	-	-	-
5	3	2	2	2	2	2	3	1	1	2	2	3	-	-	-
Avg.	2.4	2	2	2.2	2.2	2	1.8	1.4	1.8	2.2	1.6	2.2	-	-	-

ANNA University Nominee **Subject Expert 1** **Subject Expert 2** **Industrial Expert** **Alumni**

24IC3401 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
- Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
- Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
- Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
- Prepare and present an investible pitch deck of their practice venture to attract stakeholders

UNIT I ENTREPRENEURIAL MINDSET 9

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

UNIT II OPPORTUNITIES 9

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

UNIT III PROTOTYPING & ITERATION 9

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

UNIT IV BUSINESS MODELS & PITCHING 9

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

UNIT V ENTREPRENEURIAL ECOSYSTEM 9

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem- Building the right stakeholder network.

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types
CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers
CO3: Generate and develop creative ideas through ideation techniques
CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP
CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

TEXT BOOKS:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons. 4.
5. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
6. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
7. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
8. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	-	-	-	3	-	1	2	2	3	2	-	-	-
2	2	3	2	1	1	2	-	-	2	2	3	3	-	-	-
3	1	2	3	-	2	1	-	-	2	2	2	2	-	-	-
4	2	2	3	2	3	1	-	-	2	2	3	2	-	-	-
5	2	2	3	2	2	2	-	-	3	2	3	2	-	-	-
Avg.	1.8	2	2.2	1	1.6	1.8	-	0.2	2.2	2	2.8	2.2	-	-	-

24EE3401 TRANSMISSION AND DISTRIBUTION **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge about the configuration of the electrical power systems.
- To study the line parameters and interference with neighboring circuits.
- To understand the mechanical design and performance analysis of transmission lines.
- To learn about different insulators and underground cables.
- To understand and analyze the distribution system.

UNIT I TRANSMISSION LINE PARAMETERS 9

Structure of electric power system - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance, and capacitance of solid conductors - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects

UNIT II MODELLING AND PERFORMANCE OF TRANSMISSION LINES 9

Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines– Ferranti effect – Formation of Corona – Critical Voltages – Effect on line Performance

UNIT III MECHANICAL DESIGN OF OVERHEAD LINES 9

Line Supports –Types of towers – Tension and Sag Calculation for different weather conditions –- Insulators: Types, voltage distribution in insulator string, improvement of string efficiency, testing of insulators

UNIT IV UNDERGROUND CABLES 9

Underground cables – Types of cables – Construction of single-core and 3-core belted cables – Insulation Resistance – Potential Gradient – Capacitance of single-core and 3-core belted cables – Grading of cables – Power factor and heating of cables– DC cables

UNIT V **DISTRIBUTION SYSTEMS** **9**

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions –Concentrated and Distributed loading-– Distribution Loss – Types of Substations – Methods of neutral grounding.

TOTAL : 45 PERIODS

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

COURSE OUTCOMES:
At the end of the course, the students will be able to:

CO1:Analyze the structure and parameters of single and three-phase transmission lines.

CO2:Evaluate the performance of transmission lines and power flow characteristics.

CO3 :Design the overhead line with mechanical calculation , insulators and their efficiency

CO4:Classify the underground cables, and their electrical properties

CO5:Develop the distribution systems loading, substations and methods of grounding

TEXT BOOKS:

• 1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.

• 2. C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022. 3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

• 3.V.K.Metha and Rohith Metha,'Principles of Power Systems' S. Chand & Company Pvt. Ltd. (An Iso 9001 : 2008 Company) Ram Nagar, New Delhi – 110 055

REFERENCES:

• 1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.

• 2. C.L.Wadhwa, 'Electrical Power Systems', New Age International Ltd, seventh edition 2022. 3. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

• 3.V.K.Metha and Rohith Metha,'Principles of Power Systems' S. Chand & Company Pvt. Ltd. (An Iso 9001 : 2008 Company) Ram Nagar, New Delhi – 110 055

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2
2	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2
3	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2
4	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2
5	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2
Avg.	3	3	2	3	2	-	-	1	-	-	-	2	3	2	2

24EE3402 **ELECTRICAL MACHINES-I** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the concept of magnetic circuit and electro magneto force.
- To deliberate the working of transformers, auto transformer and three phase transformers.
- To understand the concept of electromechanical energy conversion system.
- To identify the appropriate machine for a given application based on its characteristics.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

- To identify the appropriate test to determine the performance parameters of a given machine.

UNIT I: MAGNETIC CIRCUITS AND MAGNETIC MATERIALS 9

Magnetic circuits –Laws governing magnetic circuits - Flux linkage, Inductance and energy – Statically and Dynamically induced EMF - Torque –Hysteresis and Eddy Current losses - AC excitation, introduction to permanent magnets.

UNIT II : TRANSFORMERS 9

Construction – principle of operation – equivalent circuit parameters – phasor diagrams, losses – testing – efficiency and voltage regulation-all day efficiency-Sumpner's test, per unit representation – inrush current - three phase transformers-connections -auto transformer – tap changing transformers- tertiary winding.

UNIT III: ELECTROMECHANICAL ENERGY CONVERSION AND CONCEPTS IN ROTATING MACHINES 9

Energy in magnetic system – Field energy and co energy-force and torque equations – singly and multiply excited magnetic field systems-mmf of distributed windings – Winding Inductances-, magnetic fields in rotating machines – rotating mmf waves – magnetic saturation and leakage fluxes.

UNIT IV: DC GENERATORS 9

Principle of operation, constructional details, EMF equation, armature reaction, commutation, methods of improving commutation, OCC and load characteristics of different types of DC Generators. Parallel operation of DC Generators, Applications of DC Generators.

UNIT V: DC MOTORS 9

Principle of operation, significance of back emf, torque equations and power developed by armature, speed control of DC motors, starting methods of DC motors, load characteristics of DC motors, losses and efficiency in DC machine, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Retardation test-applications of DC motors.

TOTAL:45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the concepts of magnetic circuits and electro magneto force.

CO2: Explain the working principle of transformer, auto transformer, three phase transformer with different types of connections.

CO3: Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.

CO4: Explain the construction and working principle of DC generator.

CO5: Explain the construction and working principle of DC motor.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 6th Edition 2017.
2. 3. M. G. Say, “Performance and design of AC machines”, CBS Publishers, First Edition 2008.
3. 1. I. J. Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 5th Edition, 2017.
4. P. S. Bimbhra, “Electric Machinery”, Khanna Publishers, 2nd Edition, 2021.
5. Stephen J. Chapman, ‘Electric Machinery Fundamentals’4th edition, McGraw Hill Education Pvt. Ltd, 2010

REFERENCES

1. A. E. Clayton and N. N. Hancock, “Performance and design of DC machines”, CBS Publishers, 2018.
2. Sahdev S. K. “Electrical Machines”, Cambridge University Press, 2018.
3. B.R. Gupta ,’Fundamental of Electric Machines’ New age International Publishers,3rd Edition ,Reprint 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	2	1	-	-	-	-	1	1	-	-	2	3	2	1
2	3	3	1	1	1	-	-	1	-	-	-	1	3	3	2
3	3	3	1	1	1	-	-	1	-	-	-	1	3	2	2
4	3	3	1	1	1	-	-	1	-	-	-	1	3	1	1
5	3	3	1	1	1	-	-	1	-	-	-	1	3	3	2
Avg.	3	2.8	1	0.8	1.2	-	-	1	0.2	-	-	1.2	3	2.2	1.2

24EE3403 MEASUREMENTS AND INSTRUMENTATION L T P C
3 0 0 3

COURSE OBJECTIVES:

- To explain the fundamental concepts and characteristics of measurement and errors.
- To describe the functional aspects of measuring instruments.
- To analyze the importance of various bridge circuits used with measuring instruments.
- To illustrate the fundamental working principles of sensors and transducers along with their applications.
- To summarize measurement and instrumentation concepts with an emphasis on digital instrumentation principles.

UNIT I CONCEPTS OF MEASUREMENTS 9

Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data.

UNIT II MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS 9

Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter –Power factor meter - Megger – Instrument transformers (CT & PT)

UNIT III AC/DC BRIDGES 9

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges.

UNIT IV TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS 9

Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.

UNIT V DIGITAL INSTRUMENTATION 9

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - D/A converters: types and characteristics- DSO- Data Loggers –Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Illustrate the fundamental art of measurement in engineering.

CO2: Build knowledge of various electrical instruments and their applications for measuring electrical quantities like voltage, current, power, and energy.

CO3: Develop the ability to analyze and use of various AC and DC different bridge circuits

CO4: Assess to select and apply appropriate transducers for measuring physical parameters

CO5: Illustrate the concept of digital instrumentation and virtual instrumentation

TEXT BOOKS:

1. H.S. Kalsi, 'Electronic Instrumentation and Measurements', Tata McGraw-Hill, New Delhi, 4th Edition 2019.
2. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, 7th Edition 2019.
3. F. C. Widdis, E. W. Golding, 'Electrical Measurements and Measuring Instruments ', Reem Publications, Edition 2011.
4. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2023.
5. Dr. Rajendra Prasad, 'Electrical Measurements & Measuring Instruments', Khanna Publishers, 2019.

REFERENCES:

1. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009
2. J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011
3. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3rd Edition 2014.
4. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", S Chand, 2016.
5. J.B.Gupta, 'Electrical Measurements and Measuring Instruments', S K Kataria and Sons, 2012

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	3	2	-	2	1	-	1	3	3	1	2
CO2	3	2	3	2	-	-	-	-	1	2	1	3	3	2	2
CO3	3	2	3	-	3	-	-	-	1	-	1	3	3	3	2
CO4	3	2	3	-	-	2	-	2	1	-	1	3	3	2	2
CO5	3	2	3	2	3	-	-		1	2	1	3	3	2	2
Avg	3	2	3	0.8	1.8	0.8	-	0.8	1	0.8	1	3	3	2	2

24EE3404 **CONTROL SYSTEMS** **LTP C**
3 1 0 4

COURSE OBJECTIVES:

- To make the students to familiarize with various representations of systems.
- To make the students to analyze the stability of linear systems in the time domain and frequency domain.
- To make the students to analyze the stability of linear systems in the frequency domain.
- To make the students to design compensator based on the time and frequency domain specifications.
- To develop linear models: mainly state variable model and Transfer function model.

UNIT I MODELING OF LINEAR TIME INVARIANT SYSTEM (LTIV) 12

Control system: Open loop and Closed loop – Feedback control system characteristics – First principle modeling: Mechanical, Electrical and Electromechanical systems – Transfer function representations: Block diagram and Signal flow graph.

UNIT II TIME DOMAIN ANALYSIS 12

Standard test inputs – Time response – Time domain specifications–Introduction to errors- Stability analysis: Concept of stability – Routh Hurwitz stability criterion – Root locus: Construction and Interpretation.

UNIT III FREQUENCY DOMAIN ANALYSIS 12

Bode plot, Polar plot and Nyquist plot: – Frequency domain specifications Introduction to closed loop Frequency Response.

UNIT IV STATE VARIABLE ANALYSIS 12

State variable formulation – Non uniqueness of state space model – State transition matrix –Eigen values – Eigen vectors - Free and forced responses for Time Invariant and Time Varying Systems– Controllability – Observability

UNIT V DESIGN OF FEED BACK CONTROL SYSTEM 12

Design specifications – Lead, Lag and Lag-lead compensators using Root locus and Bode plot techniques – Effect of adding lag and lead compensators. Effect of adding poles and zeros in root locus- PID controller - Design using reaction curve and Ziegler-Nichols technique- PID control in State Feedback form.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop the transfer function and state variable forms of simple systems.
CO2: Analyze simple systems in time domain.
CO3: Examine simple systems in frequency domain.
CO4: Inspect the stability of systems in time and frequency domain.
CO5: Justify the system characteristics and provide solution for simple control problems.

TEXT BOOKS:

1. Benjamin C. Kuo, "Automatic Control Systems", 7th edition PHI Learning Private Ltd, 2010.
2. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers 2010.

REFERENCES:

1. Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Education Pearson, 3 Impression 2009.
2. John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor& Francis Reprint 2009.
3. Katsuhiko Ogata, "Modern Control Engineering", PHI Learning Private Ltd, 5thEdition, 2010
4. NPTEL Video Lecture Notes on "Control Engineering" by Prof.S.D.Agashe, IIT Bombay.
5. Dean K. Frederick, Joe H. Chow, 'Feedback Control Problems: Using MATLAB and the Control System Toolbox' S.Chand (G/L) & Company Ltd; edition 1991.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
2	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
3	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
4	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
5	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
Avg.	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3

24EE3405 LINEAR INTEGRATED CIRCUITS **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To explain the fabrication of monolithic ICs.
- To explain the characteristics and basic applications of Op-Amp.
- To employ Op-Amp based circuits for different applications.
- To explain functional blocks, characteristics and applications of special IC's

ANNA University Nominee **Subject Expert 1** **Subject Expert 2** **Industrial Expert** **Alumni**

- To explain the functional blocks, characteristics of application IC‘s.

UNIT I IC FABRICATION 6

IC classification, fundamental of monolithic IC technology, epitaxial growth, masking and etching, diffusion of impurities.Realisation of monolithic ICs and packaging.Fabrication of FETs and PV Cell.

UNIT II CHARACTERISTICS OF OPAMP 7

Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Voltage-shunt feedback and inverting amplifier - Voltage series feedback: and Non-Inverting Amplifier - Basic applications of op-amp –, summer, differentiator and Integrator.

UNIT III APPLICATIONS OF OPAMP 9

Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers- Analog multiplier & Divider, first and second order active filters, comparators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using OP-AMPs.

UNIT IV SPECIAL ICs 6

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

UNIT V APPLICATION ICs 7

AD623 Instrumentation Amplifier and its application as load cell weight measurement - IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators, switching regulator- SMPS - ICL 8038 function generator IC.

35 PERIODS

List of experiments

1. Design of inverting and non-inverting amplifier using op-amp.
2. Design of Adder and Comparator using op-amp
3. Design of Integrator and Differentiator using op-amp
4. Design Monostable Multivibrator using IC 555 timer
5. Voltage to frequency characteristics of NE/ SE 566 IC.
6. Variability Voltage Regulator using IC LM317.
7. Op-amp based square wave/Triangular waveform generator.
8. Wien Bridge Oscillator,RC phase shift oscillator using Op-amp.

25 PERIODS

TOTAL : 60 PERIODS

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COURSE OUTCOMES:

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

CO1: Explain the fabrication of monolithic ICs.

CO2: Explain the characteristics and basic applications of Op-Amp.

CO3 Employ Op-Amp based circuits for different applications.

CO4: Explain functional blocks, characteristics and applications of special IC‘s

CO5: Explain the functional blocks, characteristics of Application IC‘s .

TEXT BOOKS:

1 D. Roy Choudhary, Sheil B. Jani, Linear Integrated Circuits‘ , New Age, Fourth Edition, 2018.

2 David A. Bell, Op-amp & Linear ICs‘, Oxford, Third Edition, 2011

REFERENCES:

1 Fiore,Opamps& Linear Integrated Circuits Concepts & applications‖, Cengage, 2010.

2 Floyd ,Buchla,Fundamentals of Analog Circuits, Pearson, 2013.

3 Jacob Millman, Christos C.Halkias, Integrated Electronics - Analog and Digital circuits system‘, McGraw Hill, 2 nd Edition, 2017.

4 Robert F.Coughlin, Fredrick F. Driscoll, Op-amp and Linear ICs‘, Pearson, 6th edition,2012.

5 Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits‘, McGraw Hill, 2016 – Fourth Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1
CO2	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1
CO3	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1
CO4	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1
CO5	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1
Avg	3	1	2	2	2	-	-	1	-	-	-	1	3	2	1

24EE3411 **ELECTRICAL MACHINES-I LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To impart knowledge on the construction, working principles, and performance characteristics of DC machines and transformers.
- To enable students to perform standard tests (such as load test, no-load test, and back-to-back test) on DC motors, DC generators, and transformers.

- To analyze load characteristics, voltage regulation, losses, and efficiency of various types of DC machines and transformers.

LIST OF EXPERIMENTS:

1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.

45 PERIODS

COURSE OUTCOMES:

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

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

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1
2	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1
3	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1
4	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1
5	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1
Avg.	3	3	1	1	-	-	-	-	1	1	1	2	3	3	1

24EE3412 CONTROL AND INSTRUMENTATION LABORATORY LTPC
0 0 4 2

COURSE OBJECTIVES:

- To make the students familiarize with various representations of systems.
- To make the students analyze the stability of linear systems in the time domain and frequency domain.

- To make the students design compensator based on the time and frequency domain Specifications.
- To develop linear models mainly state variable model and transfer function model.
- To make the students to design a complete closed loop control system for the physical systems.

LIST OF EXPERIMENTS

1. Analog (op amp based) simulation of linear differential equations.
2. Numerical Simulation of given nonlinear differential equations.
3. Real time simulation of differential equations.
4. Mathematical modeling and simulation of physical systems in at least two fields. Mechanical, Electrical and Chemical process.
5. System Identification through process reaction curve.
6. Stability analysis using Pole zero maps and Routh Hurwitz Criterion in simulation platform.
7. Root Locus based analysis in simulation platform.
8. Determination of transfer function of a physical system using frequency response and Bode's asymptotes.
9. Design of Lag, lead compensators and evaluation of closed loop performance.
10. Design of PID controllers and evaluation of closed loop performance.
11. Discretization of continuous system and effect of sampling.
12. Test of controllability and observability in continuous and discrete domain in simulation platform.
13. State feedback and state observer design and evaluation of closed loop performance.
14. Mini Project 1: Simulation of complete closed loop control systems including sensor and actuator dynamics.
15. Mini Project 2: Demonstration of a closed loop system in hardware.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1: To analyze simple physical system models and simulate the performance in analog and digital platform.
CO2: To develop simple controllers in standard forms.
CO3: To design compensators based on time and frequency domain specifications.
CO4: To model a complete closed control loop for a behavioral change in simple physical systems.
CO5: To examine the stability of a physical system in both continuous and discrete domains.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
2	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
3	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
4	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
5	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3
Avg.	3	3	3	3	3	-	-	1	-	-	-	3	3	3	3

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24TP3401 SKILL ENHANCEMENT- IV **L T P C**
0 0 2 1

COURSE OBJECTIVE:

- Improve their quantitative ability.
- Improve their reasoning ability.
- Enhance their verbal ability through vocabulary building and grammar.
- Equip with creative thinking and problem solving skills.

UNIT I QUANTITATIVE ABILITY – III 6

Compound Interest - Proit and Loss - Partnership - Percentage - Set Theory

UNIT II QUANTITATIVE ABILITY – IV 6

True Discount - Ratio and Proportion - Simpliication - Problems on H.C.F and L.C.M

UNIT III REASONING ABILITY – II 6

Course of Action - Cause and Effect - Statement and Conclusion - Statement and Argument - Data Suficiency (DS) - Statement and Assumption - Making Assumptions.

UNIT IV VERBAL ABILITY – II 6

Change of Voice - Change of Speech - Letter and Symbol Series - Essential Part - Verbal Reasoning - Analyzing Arguments.

UNIT V CREATIVITY ABILITY – II 6

Seating Arrangement - Direction Sense Test - Character Puzzles – Missing

TOTAL : 30 PERIODS

COURSE OUTCOMES:
After studying the above subject, students should have the:

CO1: Solve advanced quantitative aptitude problems involving compound interest, profit & loss, percentages, ratios, and set theory with accuracy and efficiency.
CO2: Apply logical reasoning to evaluate arguments, draw conclusions, identify assumptions, and determine cause-effect relationships.
CO3: Demonstrate proficiency in complex verbal reasoning tasks such as voice/speech transformation, symbol series, and argument analysis.
CO4: Develop creative problem-solving skills through puzzles, direction tests, and seating arrangements using analytical approaches.
CO5: Enhance critical thinking and decision-making abilities necessary for success in competitive exams and professional assessment.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	**PO2**	**PO3**	**P04**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	3	3	2	2	2	2	1	1	1	2	1	2	-	-	-
2	2	2	1	1	1	2	2	2	3	2	1	2	-	-	-
3	2	1	1	2	2	2	1	1	2	3	2	2	-	-	-
4	2	2	2	2	2	3	2	2	2	2	2	2	-	-	-
5	2	2	2	3	2	2	2	2	2	2	2	3	-	-	-
Avg	2.2	2	1.6	2	1.8	2.2	1.6	1.6	2	2.2	2	2.2	-	-	-

ANNA University Nominee **Subject Expert 1** **Subject Expert 2** **Industrial Expert** **Alumni**

SEMESTER –V

24EE3501 **POWER SYSTEM ANALYSIS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To impact knowledge on need for operational studies, andTo model the power system under steady state operating condition
- To understand and apply iterative techniques for power flow analysis
- To model of carry out short circuit studies for power system during symmetrical fault
- To model of carry out short circuit – studies during
- To study about the various methods for analyzing power system stability

UNIT I POWER SYSTEM 9

Need for system planning and operational studies - Power scenario in India -Power system components, Representation - Single line diagram - per unit quantities - p.u. impedance diagram - p.u. reactance diagram, Network graph Theory - Bus incidence matrices, Primitive parameters, Formation of bus admittance matrix – Direct inspection method – Singular Transformation method.
Activities: Analyze real time transformer and generator nameplate data and convert to per unit impedance.

UNIT II POWER FLOW ANALYSIS 9

Bus classification - Formulation of Power Flow problem in polar coordinates - Power flow solution using Gauss Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton Raphson method – Flow charts – Comparison of methods
Activities: Form the Y bus of the 3-5 bus system manually and verify the results with MATLAB

UNIT III SYMMETRICAL FAULT ANALYSIS 9

Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages - Fault level - Current limiting reactors.
Activities: Make model based learning to demonstrate the faults.

UNIT IV UNSYMMETRICAL FAULT ANALYSIS 9

Symmetrical components - Sequence impedances - Sequence networks - Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG - unsymmetrical fault occurring at any point in a power system

Activities: Make model based learning to demonstrate the LG,LL faults.

UNIT V STABILITY ANALYSIS 9

Classification of power system stability - Power-Angle equation -Steady state stability - Swing equation – Solution of swing equation by step by step method - Swing curve, Equal area criterion - Critical clearing angle and time - modified Euler method.

Activities: Develop the program to convert per unit values into actual values for stability analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the concepts of single-line diagrams, per-unit systems, and graph theory to construct the Bus Admittance matrix for a given power system network

CO2: Analyze the operational state of a power system by solving the non-linear power flow equations using iterative numerical methods (Gauss-Seidel and Newton-Raphson).

CO3: Analyze the impact of three-phase symmetrical faults on a power system using the Bus Impedance matrix method to calculate fault currents and post-fault voltages

CO4: Apply the method of symmetrical components to analyze various types of unsymmetrical faults (LG, LL, LLG) at different locations in the power system

CO5: Evaluate the steady-state and transient stability of a power system by calculating the critical clearing time and angle using the Equal Area Criterion and numerical methods.

TEXT BOOKS:

1. Hadi Saadat, 'Power System Analysis', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010,3rd edition .

2. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, 5th Edition, 2022.

3. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', Mc Graw Hill Education (India) Private Limited, New Delhi, 2017.

REFERENCES:

1. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.

2. Pai M A, 'Computer Techniques in Power System Analysis', Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, Second Edition, 2007

3. J. Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Fifth Edition, 2012.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

4. P. Venkatesh, B. V. Manikandan, A. Srinivasan, S. Charles Raja, "Electrical Power Systems: Analysis, Security and Deregulation" Prentice Hall India (PHI), second edition - 2017
5. Gupta B.R., 'Power System - Analysis and Design', S. Chand Publishing, Reissue edition 2005.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	1	-	-	-	2	2	2
CO2	3	3	3	2	1	-	-	-	1	-	-	-	3	3	1
CO3	3	3	3	2	1	-	-	-	1	-	-	1	3	3	1
CO4	3	3	2	2	2	-	-	-	1	-	-	1	3	3	2
CO5	3	3	2	2	2	-	-	-	1	-	-	1	3	3	1
Avg	3	3	2	2	2	-	-	-	1	-	-	1	3	3	1

24EE3502 ELECTRICAL MACHINES II **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To determine the regulation of alternators.
- To analyze the performance and characteristics of synchronous motors.
- To study the construction, principle of operation and performance of an induction motor.
- To learn the starters and speed control methods of three phase induction motors.
- To learn the operation of a single phase induction motor and special machine.

UNIT I SYNCHRONOUS GENERATOR 9

Constructional details – Types of rotors – EMF equation – Synchronous reactance – Armature reaction – Voltage regulation – EMF, MMF, ZPF methods – Synchronizing and parallel operation – Synchronizing torque - Salient pole Machine: Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test.
Activities: Visit a substation and study the alternator synchronization panel.

UNIT II SYNCHRONOUS MOTOR 9

Principle of operation –Methods of starting – Torque equation –Phasor diagram – V and Inverted V curves – Power input and power developed equations –Current loci for constant power input, constant excitation and constant power developed-Hunting–synchronous condenser.
Activities: Observation and Analysis of Hunting and Vibration Control in Synchronous Motors.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT III THREE PHASE INDUCTION MACHINES 9

Constructional details – Types of rotors –- Principle of operation – Slip –Torque Equation-Condition for maximum torque–Torque-Slip characteristics – Loses and efficiency - Load test – No load and blocked rotor tests – Circle diagram -Equivalent circuit –cogging and crawling -Separation of loses – Double cage induction motors –Induction generators-Synchronous induction motor.

Activities: Real-Time Analysis of Industrial Induction Motors in Pump, Fan, and Conveyor Applications

UNIT IV STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR 9

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star- delta starters – Speed control – Voltage control, Frequency control and pole changing – Cascaded connection-V/f control – Slip power recovery scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

Activities: Visit an industry or motor control center, study the starter panel, analyze why different starters are used for different loads, and make a report.

UNIT V SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES 9

Constructional details of single phase induction motor – Double field revolving theory and operation - Starting methods of single-phase induction motors – Split phase Induction motor-Capacitor start capacitor run Induction motor- Shaded pole induction motor –No load and blocked rotor test – Equivalent circuit –Repulsion motor –Servo motors.

Activities: Study and Comparison of AC and DC Servomotors Used in Robotics, CNC Machines, and Conveyor Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Determine the generator Parameters, regulation and Characteristics of Synchronous generators.

CO2: Summarize the concept,principle and performance of Synchronous motor.

CO3: Apply the fundamental Knowledge of Induction motor in Determining the Motor parameters, equivalent circuit parameters and test the Induction motor using direct and Indirect loading methods

CO4: Discuss the starting and speed control methods for three phase induction motors.

CO5: Demonstrate the Principle and performance of Single phase induction motor and Special machines.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS:

1. Kothari D.P and Nagrath I.L., "Electric Machines", McGraw Hill Publishing Company Ltd , Fifth Edition,2017.
2. Bhimbhra P.S., "Electrical Machinery", Khanna Publishers, Seventh edition, 2011.
3. Theraja B.L., "A Text of Electrical Technology, Volume-II", S.Chand & Co Ltd, Re-print, 2020.
4. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Mc Graw Hill publishing Company Ltd, 6th Education 2017.

REFERENCES:

1. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, Reprint 2015.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.
3. M.N. Bandyopadhyay, 'Electrical Machines Theory and Practice', PHI Learning PVT LTD., New Delhi, 2019.
4. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education, 2016

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	-	-	1	-	-	-	-	3	3	3
CO2	3	3	2	3	3	-	-	1	-	-	-	-	3	3	3
CO3	3	3	2	3	3	-	-	1	-	-	-	-	3	3	3
CO4	3	3	1	1	2	-	-	1	-	-	-	-	3	3	3
CO5	3	3	1	1	2	-	-	1	-	-	-	-	3	2	3
Avg	3	3	2	2	2	-	-	1	-	-	-	-	3	3	3

24EE3503 MICROPROCESSOR AND MICROCONTROLLER **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To study the addressing modes & instruction set of 8085 &8051
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.
- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers

UNIT I INTRODUCTION TO 8085 ARCHITECTURE 9

Functional block diagram – Memory interfacing–I/O ports and data transfer concepts – Timing Diagram – Interrupt structure.

UNIT II 8085 INSTRUCTION SET AND PROGRAMMING 9

Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing - Look up table - Subroutine instructions, stack.

UNIT III INTERFACING BASICS AND ICS 9

Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8085 -A/D and D/A converter interfacing.

UNIT IV INTRODUCTION TO 8051 MICROCONTROLLER 9

Functional block diagram - Instruction format and addressing modes – Interrupt structure – Timer – I/O ports – Serial communication, Simple programming –keyboard and display interface Temperature control system –stepper motor control

UNIT V INTRODUCTION TO RISC BASED ARCHITECTURE 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Ability to write assembly language programs for microprocessor and microcontroller.
CO2: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller
CO3: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.
CO4: Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.
CO5: Ability to understand and appreciate advanced architecture evolving microprocessor field

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Pen ram International (P)ltd., Mumbai, 6th Education, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The 8051 Micro Controller and Embedded Systems', Pearson Education, Second Edition 2011
3. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010.

REFERENCES:

1. Douglas V. Hall, "Micro-processors & Interfacing", Tata McGraw Hill 3rd Edition, 2017.
2. Krishna Kant, "Micro-processors & Micro-controllers", Prentice Hall of India, 2007.
3. Mike Predko, "8051 Micro-controllers", McGraw Hill, 2009 4. Kenneth Ayala, 'The 8051 Microcontroller', Thomson, 3rd Edition 2004.'

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3
CO2	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3
CO3	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3
CO4	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3
CO5	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3
Avg	2	1	2	3	-	1	-	1	-	-	-	-	3	2	3

24EE3504 POWER ELECTRONICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To Understand the operating principles, static and switching characteristics of power semiconductor devices and their gate/drive requirements.
- To Analyze the operation and performance of uncontrolled and controlled rectifiers with different loads and filters.
- To Explain and design basic and isolated DC–DC switched-mode power converters for industrial applications.
- To Study DC–AC inverter topologies and PWM techniques for harmonic reduction and efficient power conversion.
- To Analyze AC voltage controllers, cycloconverters, and matrix converters with emphasis on power factor control and practical applications.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT I POWER SEMI-CONDUCTOR SWITCHES 9

Study of switching and static characteristics - Diode, BJT, MOSFET, IGBT, SCR,TRIAC, IPM. Introduction to Driver and snubber circuits - SIC and GAN Devices - Advantages and applications.

UNIT II RECTIFIERS 9

Uncontrolled Rectifiers: Single-Phase Circuits with Capacitor and LC Filter Rectifier - Power Factor - Controlled Rectifier : 2-pulse, 3-pulse and 6-pulse converters - Effect of source inductance.

Activities: Prepare Voltage Doubler Demonstration Model

UNIT III DC–DC SWITCHED-MODE CONVERTERS 9

The Three Basic Converters : Step-Down or Buck Converter, Step-Up or Boost Converter, Step-Up/Down or Buck–Boost Converter - Isolated Converters : Push–Pull Converter - Half-Bridge Converter - Flyback Converter.

UNIT IV INVERTERS 9

Single phase half bridge and full bridge inverters - Three-Phase Inverter Topologies: Six-Step Inverter. Pulse width modulation: single, multi pulse, sinusoidal – Harmonic elimination technique - CSI.

UNIT V AC PHASE CONTROLLERS 9

Single phase and Three phase AC voltage controllers – Control strategy - Power Factor Control – Multistage sequence control - single phase and three phase cyclo converters – Introduction to Matrix converters.

Activities: TRIAC based Dimmer light model.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the operation, characteristics, triggering, and protection of power semiconductor devices such as SCR, MOSFET, IGBT, and BJT.

CO2: Analyze uncontrolled and controlled rectifier circuits and evaluate performance parameters such as ripple factor, power factor, and effect of source inductance.

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CO3: Analyze and design basic and isolated DC–DC converters such as buck, boost, buck–boost, flyback, push–pull, and half-bridge converters.
CO4: Explain the operation of single-phase and three-phase inverter topologies and apply PWM techniques for harmonic reduction.
CO5: Analyze AC voltage controllers, cycloconverters, and matrix converters for power control and industrial applications.

TEXT BOOKS:

1. L. Umanand, "Power Electronics Essentials and Applications",Wiley India Pvt. Ltd., First Edition, 2009.
2. S. Ganesh Kumar, S.K. Patnaik and Marco Rivera," Power Converters, Drives and Control for sustainable operations", John Wiley and Sons, 2023.
3. Ned Mohan, T.M.Undeland, W.P.Robbins, "Power Electronics: Converters, applications and design", John Wiley and Sons, 3rd Edition (reprint), 2003

REFERENCES:

1. Muhammad H. Rashid, "Power Electronics: Devices, Circuits and Applications", Pearson Education, 4th Edition, 2014.
2. P.S. Bimbhra, "Power Electronics", Khanna Publishers, 5th Edition, 2018.
3. Joseph Vithayathil, ―Power Electronics, Principles and Applications, McGraw Hill Series, 2013.
4. Philip T. Krein, "Elements of Power Electronics", Oxford University Press, 2nd Edition, 2017.
5. S.Rama Reddy, ―Fundamentals of Power Electronics‖ Narosa Publications, 2014.

MAPPING OF COs with POs and PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	-	2	3	2	2
CO2	3	3	2	1	1	-	-	-	-	-	-	2	3	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3	3
CO4	3	3	2	1	2	-	-	-	-	-	-	2	2	3	3
CO5	3	3	2	1	2	-	-	-	-	-	-	2	3	2	2
Avg	3	3	2	1	2	-	-	-	-	-	-	2	3	2	2

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24EE3511 MICROPROCESSOR AND MICROCONTROLLER LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES:

- To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8085 & 8051
- To develop skills in simple program writing in assembly languages
- To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.
- To perform interfacing experiments with 8085
- To perform interfacing experiments with 8051

LIST OF EXPERIMENTS:

PROGRAMMING EXERCISES / EXPERIMENTS WITH 8085:

1. Simple arithmetic operations: Multi precision addition / subtraction /multiplication / division.
2. Programming with control instructions: Increment / Decrement, Ascending / Descending order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
3. Interface Experiments: A/D Interfacing. D/A Interfacing.
4.Traffic light controller
5. Stepper motor controller interface.

PROGRAMMING EXERCISES / EXPERIMENTS WITH 8051:

6. Simple arithmetic operations with 8051: Multi precision addition / subtraction / multiplication/ division.
7. Programming with control instructions: Increment / Decrement, Ascending / Descending. order, Maximum / Minimum of numbers, Rotate instructions, Hex / ASCII / BCD code conversions.
8. Interface Experiments: A/D Interfacing. D/A Interfacing. Traffic light controller
9. Stepper motor controller interface.
10. Programming PIC architecture with software tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should have the:

CO1: Ability to write assembly language programs for microprocessors.
CO2: Ability to write assembly language program for microcontroller
CO3: Ability to design and implement interfacing of peripheral with microprocessor and microcontroller
CO4: Ability to analyze, comprehend, design and simulate microprocessor based systems used for control and monitoring.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

CO5: Ability to analyze, comprehend, design and simulate microcontroller based systems used for control and monitoring.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3
CO2	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3
CO3	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3
CO4	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3
CO5	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3
Avg	2	1	2	3	-	1	-	-	-	-	-	-	3	2	3

24EE3512 ELECTRICAL MACHINES LABORATORY - II **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To expose the students to the operation of synchronous machines and induction motors and give them experimental skills.

LIST OF EXPERIMENTS:

1. Regulation of three phase alternators by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF method.
3. Regulation of three phase salient pole alternator by slip test.
4. V and Inverted V curves of Three Phase Synchronous Motor.
5. Load test on single-phase induction motor.
6. No load and blocked rotor test on single-phase induction motor.
7. Load test on three-phase induction motor.
8. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
9. Separation of No-load losses of three-phase induction motor.
10. Study of Induction Motor Starters

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student should have the:
CO1: Ability to understand and analyze EMF and MMF methods
CO2: Ability to analyze the characteristics of V and Inverted V curves

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CO3: Ability to understand and analyze Three phase induction motor.
CO4: Ability to understand and analyze Single phase induction motor.
CO5: Ability to acquire knowledge on separation of losses.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	2	1	-	-	3	3	3	2
CO2	3	3	1	1	-	-	-	2	1	-	-	3	3	3	2
CO3	3	3	1	1	-	-	-	2	1	-	-	3	3	3	2
CO4	3	3	1	1	-	-	-	2	1	-	-	3	3	3	1
CO5	3	3	1	1	-	-	-	2	1	-	-	3	3	2	1
Avg	3	3	1	1	-	-	-	2	1	-	-	3	3	3	2

24EE3513 POWER ELECTRONICS LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To understand the characteristics, operation, and applications of power semiconductor devices such as SCR, TRIAC, MOSFET, and IGBT.
- To analyze and simulate AC to DC converters, including half-controlled and fully controlled rectifiers.
- To study and simulate DC-DC converters (step-up and step-down choppers) using MOSFET and IGBT devices.
- To understand and simulate single-phase and three-phase PWM inverters and AC voltage controllers for various loads.
- To design and simulate switched-mode power converters and analyze their performance in practical applications.

LIST OF EXPERIMENTS:

1. Characteristics of SCR and TRIAC.
2. Characteristics of MOSFET and IGBT.
3. AC to DC half controlled converter.
4. AC to DC fully controlled converter.
5. Step down and step up MOSFET based choppers.
6. IGBT based single phase PWM inverter.
7. IGBT based three phase PWM inverter.
8. AC Voltage controller.

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9. Switched mode power converter.

10. Simulation of PE circuits (1Φ & 3Φ semi converter, 1Φ & 3Φ full converter, dc-dc converters, ac voltage control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Determine the characteristics and operating principles of SCR, TRIAC, MOSFET, and IGBT devices and their role in power electronics circuits.

CO2: Model and simulate AC to DC converters (half-controlled and fully controlled) and analyze their voltage/current waveforms.

CO3: Simulate step-up and step-down MOSFET/IGBT-based choppers and evaluate their steady-state and dynamic performance.

CO4: Design and simulate single-phase and three-phase PWM inverters, AC voltage controllers, and study their output characteristics.

CO5: Simulate switched-mode power converters, including DC-DC converters, AC voltage controllers, and basic power electronic circuits, and interpret their behavior under different conditions.

MAPPING OF COs with POs and PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	2	-	2	1	3	3	3	2
CO2	3	3	3	3	2	-	-	3	-	2	1	3	3	3	2
CO3	3	3	3	3	2	-	-	3	-	2	1	3	3	3	2
CO4	3	3	3	3	2	-	-	3	-	2	1	3	3	3	2
CO5	3	3	3	3	2	-	-	3	-	2	1	3	3	3	3
Avg	3	3	3	3	2	-	-	3	-	2	1	3	3	3	2

24TP3501 SKILL ENHANCEMENT – V L T P C

0 0 2 1

COURSE OBJECTIVES:

- To enhance students' personal and professional development through self-discovery, grooming, effective communication, positive attitude building, and digital productivity. This course aims to foster confidence, creativity, professional etiquette, and essential workplace skills for academic and career success.

UNIT I QUANTITATIVE ABILITY 6

- Probability Applications in Hiring Assessments
- Number System (Advanced problem types)

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- Statistics: Distribution types, Outliers, Skewness
- Variance & Standard Deviation for real-world analytics
- Area & Mensuration – Industry case-based problems

Activities

- Solve 20 industry-based quantitative aptitude problems
- Perform variance & standard deviation calculation using real datasets

UNIT II VERBAL ABILITY 6

- Direct & Indirect Speech – advanced contextual usage
- Active–Passive Voice transformations in professional writing
- Applied Tenses for workplace & technical communication
- Vocabulary Building – domain-based word banks (IT, business, HR)

Activities

- Convert informal statements into formal business email language
- Rewrite 10 sentences using proper tense & voice transformation

UNIT III REASONING ABILITY 6

- Blood Relations – symbolic & coded
- Logical Arrangement & Ranking
- Direction-based reasoning
- Data Interpretation – charts & tables used in placements

UNIT IV EMPLOYABILITY APTITUDE 6

- Error spotting in professional communication
- Reading & interpreting English passages
- Word usage in business contexts
- Grammar application in real-time scenarios
- Pattern-based language solving

Activities

- Peer-review: Correct real-world grammatical errors in office communication
- Comprehension practice (short business passages)

UNIT V WORKPLACE COMMUNICATION & CAREER READINESS 6

- Foundations of workplace messaging
- Business email writing (formal tone, agenda clarity)
- Resume fundamentals – first resume creation
- Skills mapping & achievement recording

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- LinkedIn basics – headline, skills, visibility
- Identifying internship opportunities
- Digital learning platforms—Coursera/Udemy/TCS iON credential showcasing

Activities

- Create first professional resume (mandatory)
- Draft 3 internship-request emails
- Build LinkedIn headline & about section

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Apply quantitative and statistical methods to solve aptitude-based problems.

CO2: Use refined grammar and vocabulary to improve written communication.

CO3: Solve reasoning-based analytical problems accurately.

CO4: Interpret and correct language errors in contextual usage.

CO5: Prepare internship-oriented resumes and build an initial LinkedIn presence for career readiness.

REFERENCES:

1. Aggarwal, R. S., Quantitative Aptitude for Competitive Examinations, S. Chand Publishing, 2022.

2.Aggarwal, R. S., A Modern Approach to Verbal & Non-Verbal Reasoning, S. Chand Publishing, 2021.

3. Raman, M. and Sharma, S., Technical Communication: Principles and Practice, Oxford University Press, 2019.

4. Guffey, M. E. and Loewy, D., Business Communication: Process and Product, Cengage Learning, 2018.

5. Yate, M., Knock ’em Dead Resumes: A Killer Resume Gets More Job Interviews!, Adams Media, 2016.

MAPPING OF COs with POs and PSOs

COs	POs												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	2	1	0	0	0	2	0	0	2	1	3	2
CO2	0	0	0	0	2	0	0	0	3	3	1	2	–	1	2
CO3	3	3	0	2	0	0	0	0	2	0	0	2	1	3	2
CO4	0	0	0	0	3	0	0	0	2	3	2	2	–	1	1
CO5	0	0	0	0	3	0	0	0	3	2	3	3	–	–	3
Avg	1	1	0	1	2	0	0	0	2	2	1	2	0	2	2

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

SEMESTER –VI

24EE3601 **PROTECTION AND SWITCHGEAR** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the significance of protection, protection schemes and role of earthing.
- To study the characteristics, functions and application areas of various relays
- To acquire practical knowledge about common faults in power system apparatus and applying suitable protective schemes
- To understand the functioning of static relays and Numerical protection concepts
- To understand the problems associated with circuit breaking and to discuss various circuit breakers.

UNIT I PROTECTION SCHEMES 9

Significance and need for protective schemes – nature and causes of faults – types of faults Effects of faults - Zones of protection and essential qualities of protection – Types of Protection schemes - Power system Grounding and Methods of Grounding.
Activities: Poster presentation and Brain storms in the grounding system.

UNIT II BASICS OF RELAYS 9

Operating principles of relays –Universal torque equation - R-X diagram –Electromagnetic Relays – Over current, Directional and non-directional, Distance, Differential, Negative sequence and Under frequency relays.
Activities: Small coil demonstration for electromagnetic relays.

UNIT III OVERVIEW OF EQUIPMENT PROTECTION 9

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line.
Activities: Protection relay role play

UNIT IV STATIC RELAYS AND NUMERICAL PROTECTION 9

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, and distance protection of transmission lines.
Activities: Static Vs Numerical relay matchup

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V CIRCUIT BREAKERS 9

Physics of arcing phenomenon and arc interruption – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - current chopping - interruption of capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – HVDC Breaker.
Activities: Comparison chart creation for all types of circuit breakers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Understand and select proper protective scheme and type of earthing
CO2: Explain the operating principles of various relays
CO3: Suggest suitable protective scheme for the protection of various power system apparatus
CO4: Analyze the importance of static relays and numerical relays in power system protection.
CO5: Summarize the merits and demerits and application areas of various circuit breakers.

TEXT BOOKS:

1. B.Rabindranath and N.Chander, 'Power System Protection and Switchgear', New Age International (P) Ltd., Second Edition, 2018.
2. Badri Ram ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
3. Arun Ingole, 'Switch Gear and Protection' Pearson Education, 2018.
4. Sunil S.Rao, 'Switchgear and Protection', Khanna Publishers, New Delhi, Four Edition, 2010.

REFERENCES:

1. Y.G.Paithankar and S.R.Bhide, 'Fundamentals of power system protection', Second Edition,Prentice Hall of India Pvt. Ltd., New Delhi, 2013.
2. C.L.Wadhwa, 'Electrical Power Systems', 6th Edition, New Age International (P) Ltd., 2018
3. VK Metha," Principles of Power Systems", S. Chand, Reprint, 2013.
4.Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' Oxford University Press, 2nd Edition 2018.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	2	1	1	1	1	2	-	3	1	-
CO2	3	1	1	2	1	2	1	1	1	1	2	-	3	1	-
CO3	3	1	1	2	1	2	1	1	1	1	2	-	3	2	-
CO4	3	1	1	2	1	2	1	1	1	1	2	-	3	2	1
CO5	3	1	1	2	2	2	1	1	1	1	2	-	3	1	1
Avg	3	1	1	2	1	2	1	1	1	1	2	-	3	1	1

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3602 POWER SYSTEM OPERATION AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamental significance of power system operation and control.
- Real power– frequency interaction and design of power– frequency controller.
- Reactive power– voltage interaction and the compensators for maintaining the voltage profile.
- To Perform generation scheduling and manage the economic operation of a power system.
- SCADA and its application for real time operation and control of power systems.

UNIT I INTRODUCTION TO POWER SYSTEM OPERATION AND CONTROL 9

Overview of power system - Requirements of good power system - necessity of voltage and frequency regulation – real power vs Frequency and reactive power vs voltage control loops - system load variation, load curves , Load forecasting and load shedding.
Activities: Visit to a Substation or Power Plant Control Room to Study Voltage, Frequency, and Reactive Power Control.

UNIT II REAL POWER –FREQUENCY CONTROL 9

Basics of speed governing mechanisms and modelling -Speed regulation of two generators in parallel - Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases – Integral control of single area system-State variable model-LFC of two area system, Static and dynamic analysis of two area system.
Activities: Prepare a chart/ Model on automatic load frequency control used in power plants.

UNIT III REACTIVE POWER – VOLTAGE CONTROL 9

Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop - static and dynamic analysis —Methods of reactive power injection – Tap changing transformer, SVC and STATCOM for voltage control.
Activities: Prepare a chart/ Model on automatic generation control used in power plants.

UNIT IV ECONOMIC DISPATCH AND UNIT COMMITMENT 9

Statement of economic dispatch problem – Input and output characteristics of thermal plant incremental cost curve – Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) – Lambda–iteration method – Base point and participation factors method. Statement of Unit Commitment (UC) problem – Constraints on UC problem – Solution of UC problem using priority list.

Activities: Observe the power consumption pattern of your institute or a nearby commercial center and prepare a report analyzing peak demand, load variations, and energy-saving opportunities.

UNIT V COMPUTER CONTROL OF POWER SYSTEMS 9

Need of computer control of power systems - Concept of energy control centres –System hardware configuration – SCADA and EMS functions – Various operating states - State transition diagram.- State estimation - Measurements and errors – Weighted least square estimation.

Activities: Prepare report on role of SCADA in load dispatch center operation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the various load characteristics with load curve and load duration curve.

CO2: Analyze the real power–frequency interaction and design effective power–frequency controllers.

CO3: Explain Reactive Power-Voltage Control in Power Systems.

CO4: Solve economic dispatch problems and unit commitment problems in power systems.

CO5: Explain the role of computers in Power System Operation and control.

TEXT BOOKS:

1. Olle. I. Elgerd, 'Electric Energy Systems theory – An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 2nd edition, 2017.
2. Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 3rd edition, 2013.
3. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Fourth Edition, 2018.

REFERENCES:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw– Hill Education, Second Edition, Reprint 2018.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 23rd reprint, 2015.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015.
4. B.M. Weedy, B.J. Cory et al, 'Electric Power systems', Wiley, Fifth Edition, 2012.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	-	1	-	-	-	2	3	3	2
CO2	3	2	1	1	-	1	-	2	-	2	-	2	3	2	1
CO3	3	2	1	1	-	1	-	2	-	2	-	2	3	1	1
CO4	3	2	1	1	-	1	-	2	-	2	-	2	3	3	1
CO5	2	1	1	1	-	1	-	1	-	2	-	2	3	-	2
Avg	2	2	1	1	-	1	-	2	-	2	-	2	3	2	1

24EE3603 EMBEDDED SYSTEM DESIGN L T P C
2 0 2 3

COURSE OBJECTIVES:

- To Apply the knowledge of building blocks of embedded systems to design basic embedded hardware and software components.
- To Implement input/output interfacing and bus communication protocols in embedded applications.
- To Develop embedded firmware using various embedded development strategies for real-time applications.
- To Analyze the operation of real-time operating systems and their role in task scheduling and synchronization.
- To Examine and analyze different embedded system applications based on appropriate design approaches.

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 6

Introduction to Embedded Systems –Structural units in Embedded processor , DMA – Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator.

UNITII EMBEDDED NETWORKING 6

Embedded Networking: Introduction, I/O Device Ports & Buses– Serial Bus communication protocols RS232 standard – RS485 – CAN Bus- Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C).

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UNIT III EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT 6

Embedded Product Development Life Cycle- objectives, different phases of EDLC, Flow Graph, state machine model, Sequential Program Model, concurrent Model.

UNIT IV RTOS-BASED EMBEDDED SYSTEM DESIGN 6

Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, message passing- Interprocess Communication- Introduction to process synchronization using semaphores-Introduction to Programming.

UNIT V EMBEDDED SYSTEM APPLICATION AND DEVELOPMENT 6

Case Study of Washing Machine-ATM machine -Precision Agriculture- Autonomous car.

TOTAL: 30 PERIODS

LAB COMPONENT:

1.Laboratory exercise: Use any Embedded processor/IDE/open source platform to give hands-on training on basic concepts of embedded system design:

a. Introduction to IDE and Programming Environment.
b. Configure timer block for signal generation (with given frequency)
c. Interrupts programming example using GPIO
d. I2C communication with peripherals
e. Master-slave communication between processors using SPI
f. Networking of processor using Wi-Fi
g. Basic RTOS concept and programming

2. Embedded systems-based Mini project.

TOTAL: 30 PERIODS
TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the knowledge of embedded system building blocks to design simple hardware and software components for real-time applications.

CO2: Implement input/output interfacing techniques and bus communication protocols in embedded system applications.

CO3: Develop embedded firmware using suitable development tools and strategies for specific embedded tasks.

CO4: Analyze the functions of a real-time operating system (RTOS) with respect to task scheduling, synchronization, and resource management.

CO5: Examine and analyze various embedded system applications to identify appropriate design approaches and optimization methods.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

TEXT BOOKS:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons,2019.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 6th Edition 2017

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1. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2018
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, First Edition 2008.
3. Sahdev S. K. "Electrical Machines", Cambridge University Press, 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	1	2	1	1	2	2	2	2	3	3
CO2	3	2	1	-	-	1	2	1	1	2	1	2	2	3	3
CO3	3	3	3	3	3	1	2	3	1	2	3	2	2	3	3
CO4	3	3	3	3	3	1	2	3	1	2	3	2	2	3	3
CO5	3	2	2	3	-	3	3	2	3	3	3	3	2	3	3
Avg	3	2	2	2	1	1	2	2	1	2	2	2	2	3	3

24EE3611	**POWER SYSTEM LABORATORY**	**L T P C**
		0 0 4 2

COURSE OBJECTIVES:

- To provide a better understanding of modelling of transmission lines in impedance and admittance forms.
- To apply iterative techniques for power flow analysis and to carry out short circuit and stability studies on power systems.
- To analyze the load – frequency and voltage controls.
- To analyze optimal dispatch of generators and perform state estimation.
- To understand the operation of relays, characteristics, and applications

LIST OF EXPERIMENTS:

1. Computation and modelling of transmission lines.
2. Formation of Bus Admittance and Impedance Matrices.
3. Power Flow Analysis Using Gauss-Seidel Method.

4. Power Flow Analysis Using Newton Raphson Method.
5. Symmetric and Unsymmetrical Fault Analysis.
6. Transient Stability Analysis of the SMIB System.
7. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems.
8. Economic Dispatch in Power Systems.
9. State estimation: Weighted least square estimation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On the successful completion of the laboratory, students will be able to:

CO1: Model and analyze the performance of the transmission lines.
CO2: Perform power flow and short circuit analysis by forming y bus and z bus matrices.
CO3: Perform stability analysis for any power system network
CO4: Understand, design, and analyze the load frequency control mechanism.
CO5: Perform optimal scheduling of generators and compute the state of the power system.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO2	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO3	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO4	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
CO5	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3
Avg	3	3	2	2	3	-	-	2	1	2	-	3	3	3	3

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24TP3601 **SKILL ENHANCEMENT – VI** **L T P C**
0 0 2 1

COURSE OBJECTIVES:

- This course aims to strengthen students' advanced quantitative, verbal, and logical reasoning abilities to successfully tackle complex aptitude and analytical assessments required for competitive placements.
- This course aims to build students' professional readiness through advanced resume and portfolio development, cover letter creation, and effective workplace communication for successful career presentation and engagement.

UNIT I QUANTITATIVE ABILITY **6**

- Permutation & Combination (combinatorial thinking)
- Surds & Indices (exponent simplification)
- Geometry – advanced property-based problems
- Trigonometry – identities & applications in engineering

Activities

- Solve previous-year national-level aptitude tests (TCS NQT / AMCAT / CoCubes)

UNIT II VERBAL ABILITY **6**

- One-word substitution
- Sentence completion
- Data-arrangement in language contexts
- Vocabulary expansion – roots, etymology, prefixes/suffixes

Activities

- Build a vocabulary bank using root-based technique
- Practice one-word substitution exercises

UNIT III REASONING ABILITY **6**

- Critical reasoning arguments
- Clock reasoning
- Calendar reasoning
- Puzzle Tests (seating, floor, distribution, multi-layer constraints)

Activities

- Solve 10 advanced puzzles (including clock & calendar reasoning)
- Floor/seating arrangement puzzle-solving worksheets

UNIT IV CREATIVE & ANALYTICAL ABILITY **6**

- Para-jumbles
- Vocabulary analytics – semantic clusters
- Image analysis
- Grouping & visual recognition
- Pattern identification problems

Activities

- Perform visual pattern recognition tasks
- Semantic-cluster vocabulary mapping

UNIT V ADVANCED CAREER READINESS SKILLS **6**

- Advanced Resume tailoring (role-focused, ATS-optimized)
- STAR storytelling for experience & achievements
- Professional cover letters
- Specialized internship/job-oriented emails
- GitHub portfolio creation
- Showcasing project repositories
- Presentation & articulation for interviews
- PPT design for final-year project reviews

Activities

- Create a role-specific ATS-optimized resume
- Prepare a PPT for final-year project presentation
- Draft a professional cover letter

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Apply advanced quantitative concepts to solve complex aptitude assessments.

CO2: Improve verbal reasoning & structured language use.

CO3: Solve multi-layer logical puzzles and analytical reasoning tasks.

CO4: Demonstrate enhanced creative, linguistic & visual reasoning.

CO5: Develop advanced resumes, personal branding, GitHub & professional presentations.

REFERENCES:

1. Aggarwal, R. S., Objective Mathematics for Competitive Examinations, S. Chand Publishing, 2020.
2. Thorpe, E., Test of Reasoning, McGraw Hill Education, 2016.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

3. Norman Lewis, Word Power Made Easy, Goyal Publishers, 2014.
4. Guffey, M. E. and Loewy, D., Essentials of Business Communication, Cengage Learning, 2019.
5. Yate, M., Knock ’em Dead Cover Letters, Adams Media, 2017.

MAPPING OF COs with POs and PSOs

COs	POs												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	2	1	0	0	0	1	0	0	2	1	3	2
CO2	0	0	0	0	2	0	0	0	3	3	1	2	–	1	2
CO3	3	3	0	2	0	0	0	0	2	0	1	2	1	3	2
CO4	2	2	0	1	2	0	0	0	2	1	1	2	–	1	2
CO5	0	0	0	0	3	0	0	0	3	3	3	3	–	–	3
Avg	2	2	0	1	2	0	0	0	2	1	1	2	0	2	2

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

PROFESSIONAL ELECTIVE COURSES – VERTICALS

VERTICAL - I: POWER ENGINEERING

24EE3001 **POWER PLANT ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To explain the layout, construction and working principle of thermal power plants.
- To explain the layout, construction and working principle of the hydro electric power plant.
- To illustrate the energy harvest techniques by diesel, nuclear and gas turbine power plants.
- To illustrate the energy harvest techniques from solar systems ,growth of wind energy and its characteristics and types of other renewable energy sources.
- To comprehend the functions and characteristics of economic and environmental issues of power plants.

UNIT I COAL BASED THERMAL POWER PLANTS 9

Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants — Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.
Activities: Mini Power Plant Feasibility Study

UNIT II HYDRO POWER PLANTS 9

Hydro Electric Power Plants – Classification, Typical Layout and associated components including Turbines-Site selection- Small and Micro-Hydro power plant- Pumped storage system.
Activities: In teams, students design and construct a simple, working water wheel or turbine prototype using basic materials (plastic bottles, cardboard, dowels, etc.)

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium- Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.
Activities: Do fission reaction demo with glow sticks and LED circuits

UNIT IV POWER FROM RENEWABLE ENERGY 9

Principle, Construction and working of Wind, Tidal, Solar Photo Voltaic (SPV), Solar Thermal, Geo Thermal, Biogas and Fuel Cell power systems.
Activities: Discuss the role of Smart Grids and modern SCADA systems in managing variable renewable power.

UNIT V ENERGY, ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants.
Activities: Cost of Electricity Calculation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Understand the layout, construction and working of the components inside a thermal power plant and Cogeneration.
CO2: Describe the layout, construction, and working principles of the components used in hydro power plants and cogeneration systems..
CO3: Illustrate the layout, construction and working of the components inside nuclear power plants.
CO4: Demonstrate the application of renewable energy sources in modern power generation systems.
CO5: Evaluate power plant economics and assess the associated environmental impacts and hazards.

TEXT BOOKS:
1. A. Nag, Power Plant Engineering, Tata McGraw-Hill, 4th Edition.
2. P.K. Nag, Engineering Thermodynamics, McGraw-Hill Education, 6th Edition.
3. R.K. Rajput, Power Plant Engineering, Laxmi Publications, 5th Edition.

REFERENCES:
1. M.M. El-Wakil, "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Black & Veatch, Springer, "Power Plant Engineering", 1996.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Standard Handbook of Power Plant Engineering", Second Edition, McGraw – Hill, 1998.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

4. Godfrey Boyle, “Renewable energy”, Open University, Oxford University Press in association with the Open University, 2004.
5. Rajput R.K., “A Text book of Power plant Engineering”, 5th Edition, Lakshmi Publications, 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	P09	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	–	–	1	–	–	–	–	1	3	–	–
CO2	3	2	1	1	–	–	1	–	–	–	–	1	3	1	–
CO3	3	2	1	1	–	–	2	-	–	–	–	1	2	–	1
CO4	3	2	2	1	–	1	3	–	–	–	–	2	3	2	–
CO5	2	3	–	2	–	2	3	-	1	1	3	2	2	3	2
Avg	3	2	1	1	0	1	2	-	-	-	1	1	3	1	1

24EE3002 UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To understand selection of electric drives for different applications
- To analyse Energy Efficient illumination systems
- To understand the utilization of electrical energy for heating and welding purposes
- To study the importance of Industrial Energy Conservation
- To Perform Electrical Connection for domestic appliances.

UNIT I ELECTRIC DRIVES AND TRACTION 9

Fundamentals of electric drive - choice of an electric motor - application of motors for particular services traction generator set, traction motors, power transformers - characteristic features of traction motor - systems of railway electrification - electric braking - train movement and energy consumption - traction motor control - track equipment and collection gear.
Activities: To prepare a brief debate arguing why their system is superior for a specific scenario (e.g., urban metro vs. long-haul main line).

UNIT II ILLUMINATION 9

Introduction - definition and meaning of terms used in illumination engineering - classification of light sources - incandescent lamps, sodium vapour lamps, mercury vapour lamps, fluorescent lamps – design of illumination systems - indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting - energy saving lamps, LED.

Activities: Teams compare three standard lamp types: Incandescent, Fluorescent (CFL/Tube), and LED.

UNIT III HEATING AND WELDING 9

Introduction – advantages of electric heating – modes of heat transfer – methods of electric heating – resistance heating – arc furnaces – induction heating – dielectric heating – electric welding – types – resistance welding – arc welding – power supply for arc welding – radiation welding.

Activities: Teams research and create a comparative matrix for four key heating methods:

1. Resistance Heating (e.g., Electric Oven, Furnace)
2. Induction Heating (e.g., Induction Cooktop, Metal Treatment)
3. Dielectric Heating (e.g., Microwave Oven, Plywood Gluing)
4. Arc Heating (e.g., Arc Furnace for Steelmaking)

UNIT IV ENERGY CONSERVATION 9

Energy conservation and its importance-Energy conservation act 2001 and its features-Review of Industrial energy conservation-Energy conservation in electrical industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor).

Activities: Household Appliance Energy Audit,Mini-Audit of a Campus/Building Zone.

UNIT V DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9

House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

Activities: Students survey their home to identify major electrical appliances and to calculate the daily and monthly energy consumption and cost for each appliance.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain electric drives for different applications.

CO2: Explain Energy Efficient illumination systems.

CO3: Demonstrate the utilization of electrical energy for heating and welding purposes.

CO4: Explain the importance of Industrial Energy Conservation.

CO5: Explain Electrical Connection for domestic appliances.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

TEXT BOOKS:

1. N.V. Suryanarayana, ―Utilisation of Electric Power- Including Electric Drives and Electric Traction‖, Second Edition, New Age International Publishers, 2017.
2. J.B.Gupta,―Utilisation of Electric power and Electric Traction‖, S.K.Kataria and sons, 2009**.**

REFERENCES:

1. G.D.Rai, ―Non-Conventional Energy Sources‖, Khanna Publications Ltd., New Delhi 1997.
2. D.P.Kothari, K.C.Singal, Rakesh Ranjan, ―Renewable Energy Sources and Emerging Technologies‖, PHI Learning Private Limited, 2013.
3. Sarvesh Devraj, S C Bhatia, ―Industrial Energy Conservation, Volume I-II‖, Woodhead Publishing India,2018
4. K.Meenendranath Reddy, S.Sneha Madhuri, P.Sankar Babu, ―Electrical Energy conservation and Management‖ Lambert Academic Publishing, 2023.
5. Singh Tarlok , ―Utilization of Electric Energy‖, Kataria, S. K., & Sons,2021.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	2	-	-	2	-	3	2	1	1
CO2	3	3	2	2	1	-	-	-	1	3	2	3	3	2	2
CO3	3	3	1	2	2	-	-	1	-	3	2	3	3	1	2
CO4	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO5	2	2	2	1	1	3	3	2	3	1	2	2	2	2	1
Avg	3	2	2	2	2	1	1	1	1	2	2	3	3	2	2

24EE3003 **RENEWABLE ENERGY SYSTEMS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To develop an understanding of the environmental implications of various energy sources and create awareness of renewable energy technologies along with the current national and global energy scenario
- To provide knowledge on solar energy harvesting methods, enabling learners to analyze solar energy systems and their performance characteristics
- To familiarize students with wind energy conversion systems by studying their harvesting techniques, operating features, and technological advancements.
- To explain the fundamental types, working principles, and key characteristics of bio and fuel cell energy systems.
- To enable students to comprehend the functional block diagrams, operational characteristics, and hybrid integration techniques of multiple renewable energy systems.

UNIT I INTRODUCTION OF ENERGY SOURCES 9

Primary energy sources, Types of renewable energy sources, Environmental consequences of fossil fuel and renewable sources, renewable vs. non-renewable energy sources, Limitations of RE sources, environmental impact of energy sources, renewable energy resources in India, Present Indian energy scenario of conventional and RE sources.

Activities: Energy Source Mapping & Modeling

UNIT II SOLAR ENERGY 9

Solar Radiation and its measurements, Solar Thermal Energy Conversion and its Types, Solar Ponds. Direct Solar Electricity Conversion from Photovoltaic, Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking. Application solar PV system.

Activities: Shadow analysis using a stick(simple outdoor experiment) measure the length and direction of the shadow every hour ,plot a curve time vs solar radiation.

UNIT III WIND ENERGY 9

Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and 77 78 applications, Grid integration issues of WPPs.

Activities: Demonstrate lift and drag using paper airfoils and suitable site survey.

UNIT IV BIO-ENERGY AND FUEL CELLS 9

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, Fuel cell – types - principle and working–VI Characteristics of Fuel cell-Applications.

Activities: Survey local biogas plants,site assessment based on availability of sources.

UNIT V OTHER TYPES OF ENERGY 9

Fuel cells: Principle of working- various types, Geo thermal energy Resources, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants. Tidal and wave energy: Potential and conversion techniques, mini- hydel power plants.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

Activities: Demonstrate fuel cell operations,group presentation and quiz

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the environmental impacts of conventional energy sources and summarize the national and international renewable energy scenario

CO2: Explain the working principles, harvesting techniques, and performance characteristics of solar energy systems.

CO3: Describe the harvesting methods, operational characteristics, and technological development of wind energy systems.

CO4: Explain the types, operating principles, and key characteristics of bio and fuel cell energy systems.

CO5: Interpret functional block diagrams, compare characteristics, and evaluate hybrid integration techniques of different renewable energy systems.

TEXT BOOKS:

1. Chetan Singh Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, 3rd Edition, 2015.

2. Twidell, J.W. and Weir, A., "Renewable Energy Sources", EFN Spon Ltd., 2005.

3. B.H.Khan, "Non Conventional energy resources", McGraw-Hill Education, 3rd Edition, 2017.

4.Sukhatme S P, Nayak J K, "Solar Energy: Principles of Solar Thermal Collection and Storage", McGraw Hill, 2008.

REFERENCES:

1. Kothari D. P &Singal K. C &Ranjan, Rakesh, "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, New Delhi, 2013.

2. TasneemAbbasi&AbbasiSa, "Renewable Energy Sources", PHI Learning Private Limited, New Delhi, 2013.

3. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", Second Edition, John Wiley & Sons, 2013

4. Rashid M. H "power electronics Hand book", Academic press, 2001.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	1	-	3	3	1	-	1	1	2	1	3	2
CO2	3	2	2	1	1	-	2	-	-	-	-	2	3	2	1

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

CO3	3	2	2	1	-	-	2	-	-	-	-	2	3	2	1
CO4	3	2	2	1	-	-	2	-	-	-	-	2	3	2	1
CO5	2	3	3	2	2	1	3	1	1	1	2	3	2	3	3
Avg	3	2	2	1	-	1	2	-	-	-	1	2	2	2	2

24EE3004 **POWER QUALITY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To learn the basic definitions in Power Quality
- To study the power quality issues in Single Phase and Three Phase Systems
- To understand the principles of Power System Harmonics.
- To know the way to use DSTATCOM for Harmonic Mitigation
- To learn the concepts related to Series Compensation.

UNIT I INTRODUCTION 9

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.
Activities: Through safe demonstration students observe the variation of bulb brightness and record the data.

UNIT II ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM 9

Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.
Activities: Students match PQ issues of single phase and three phase system.

UNIT III MITIGATION OF POWER SYSTEM HARMONICS 9

Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

– Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.

Activities: Use any current and voltage waveforms to identify the dominant harmonic orders using simple software.

UNIT IV LOAD COMPENSATION USING DSTATCOM 9

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced –Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.

Activities: Use a light lamp or fan with a small AC load and show how adding a shunt current source reduces flicker

UNIT V SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM 9

Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.

Activities: Draw the DVR block diagram on the board students trace the series injection and control signal flow.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Classify and explain the various categories and definitions of Power Quality phenomena

CO2: Differentiate between the operational characteristics of linear and nonlinear loads and analyze the system response to non-sinusoidal sources in both single-phase and three-phase power systems.

CO3: Apply engineering principles to design and evaluate the effectiveness of passive and active harmonic filters for the mitigation of power system harmonics according to industry standards

CO4: Simulate or implement a Distribution Static Compensator (DSTATCOM) and determine its optimal operating strategy for effective reactive power compensation and power factor correction in distribution systems

CO5: Analyze the operating principles and control strategies of Custom Power Devices (CPDs) and evaluate their specific roles in enhancing power quality in distribution systems.

TEXT BOOKS:

1. Arindam Ghosh and Gerad Ledwich "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, First Edition,2002

2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, Second Edition, 2011

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

3. George J. Wakileh, “Power System Harmonics – Fundamentals, Analysis and Filter Design”, Springer – Verlag Berlin Heidelberg, New York, 2019

REFERENCES:

1. R.C.Duggan “Electric Power Systems Quality”, Tata MC Graw Hill Publishers, Third Edition, 2012.
2. Arrillaga “Power System Harmonics”, John Wiely and Sons, 2003 2nd Edition
3. Derek A.Paice “Power Electronic Converter Harmonics” IEEE Press, 1995, Wiley – IEEE Press 1999, 18th Edition.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	1	-	-	-	-	-	-	-	2	3	3
CO2	3	3	1	2	3	-	-	-	-	-	-	-	2	3	3
CO3	3	3	1	3	1	-	-	-	-	-	-	-	2	3	3
CO4	2	3	1	2	3	-	-	-	-	-	-	-	2	3	3
CO5	3	3	1	3	1	-	-	-	-	-	-	-	2	3	3
Avg	3	3	1	3	2	-	-	-	-	-	-	-	2	3	3

24EE3005 SOFT COMPUTING TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge about the following topics:
- Basics of artificial neural networks.
- Concepts of modelling and control of neural and fuzzy control schemes.
- Features of hybrid control schemes.

UNIT I ARTIFICIAL NEURAL NETWORK 9

Review of fundamentals – Biological neuron, artificial neuron, activation function, single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning.

Activities: Create a mind map or flowchart illustrating how the vigilance parameter in ART affects cluster formation

UNIT II NEURAL NETWORKS FOR MODELING AND CONTROL 9

Modelling of non-linear systems using ANN – Generation of training data – Optimal architecture– Model validation – Control of non-linear systems using ANN – Direct and indirect

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

neuro control schemes – Adaptive neuro controller – Familiarization with neural network toolbox.

Activities: Model a simple non-linear system (e.g., a simple pendulum or a DC motor with saturation) using an ANN. Generate synthetic training data from the system's differential equation and train the network for system identification

UNIT III FUZZY SET THEORY 9

Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions.

Activities: For a given crisp input, step-by-step demonstrate the process of Fuzzification and then the final Defuzzification (e.g., using the Center of Gravity method) to obtain the crisp output.

UNIT IV FUZZY LOGIC FOR MODELING AND CONTROL 9

– Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox.

Activities:

UNIT V HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN – Neuro fuzzy systems – ANFIS – Fuzzy neuron– GA – Optimization of membership function and rule base using Genetic Algorithm – Introduction to other evolutionary optimization techniques, support vector machine– Case study – Familiarization with ANFIS toolbox.

Activities: Conduct a case study on a specific application (e.g., traffic control, autonomous vehicle path planning, load frequency control in power systems) where a Hybrid Control Scheme (Neuro-Fuzzy, GA-Fuzzy, or SVM-based) is used. Present the scheme's architecture, advantages, and limitations.

TOTAL: 45PERIODS

COURSE OUTCOMES:

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

CO1: List the fundamental components, architectures, and learning algorithms of Artificial Neural Networks (ANNs).

CO2: Explain the essential features of Fuzzy Logic, including fuzzy sets, membership functions, and linguistic variables.

CO3: Illustrate the basic concepts and working principle of Adaptive Resonance Theory (ART) and its variants.

CO4: Develop mathematical models for systems using ANNs (e.g., feedforward networks) for approximation or identification tasks.

CO5: Implement the steps of a Fuzzy Inference System (FIS) using appropriate fuzzy operators and defuzzification methods for a given application.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS:

1.Fundamentals of Neural Networks: Architectures, Algorithms and Applications,Laurene V. Fausett,Prentice Hall / Pearson Education,1993

2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill Inc., 2017(4th edition)

3. Zhang Huaguang and Liu Derong, “Fuzzy Modeling and Fuzzy Control Series: Control Engineering”, 2006

REFERENCES:

1. Goldberg, “Genetic Algorithm in Search, Optimization and Machine learning”, Addison Wesley Publishing Company Inc. 1989

2. Millon W.T., Sutton R.S. and Webrose P.J., “Neural Networks for Control”, MIT press, 2018?(2nd edition)

3. Ethem Alpaydin, “Introduction to Machine learning (Adaptive Computation and Machine Learning series)’, MIT Press, 4th Edition, 2020.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1(	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	1	-	-	-	-	-	-	1	1	1	-
CO2	3	3	3	2	3	-	-	-	1	-	-	2	3	3	2
CO3	3	2	2	1	2	-	-	-	1	-	-	2	2	2	1
CO4	2	3	3	3	2	1	-	1	2	1	-	3	3	2	3
CO5	3	3	3	3	3	1	1	1	2	2	1	3	3	3	3
Avg	3	2	2	2	2	-	-	-	1	1	-	2	2	2	2

24EE3006 SUBSTATION ENGINEERING AND AUTOMATION **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To help engineering students to have a holistic understanding of the concepts behind substation engineering and design
- The course aims to give an exposure to the students to the requirements of practical aspects including an overview of civil and mechanical aspects
- Course aims to enhance the knowledge, and give the practical guidelines for site selection,construction, protection along with maintenance, safety in a substation
- It also aims at providing knowledge about state-of-the-art technology in substation automation systems.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT I SUBSTATION DESIGN DEVELOPMENT 9

Substation Introduction and Classifications, Different bus bar switching schemes for Substation. Standards and Practices, Factors Influencing Substation Design - Altitude, Ambient Temperature, Earthquake and seismic zones, pollution and corrosion etc., Testing of Electrical Equipment, Concept and development of Single Line Diagram. Requirement of substation calculation.

Activities: Make a quiz and circulate to students to complete.

UNIT II SUBSTATION EQUIPMENT 9

Selection and sizing of main substation equipment: Transformer, Isolator, Circuit Breaker, surge arrestor, Instrument transformers, classification of equipment with a practical overview, and the performance parameters. Classifications of MV Switchgear and Key Design Parameters, MV/LV Switchgear construction and design of control scheme. Station Auxiliary equipment: Diesel Generator System, Basics of AC/DC Auxiliary Power System & Sizing of Aux. Transformer, DC System Components, Battery Sizing & charger Sizing, DG Set Classification, and sizing. Introduction to gas insulated substation: Operating principle of GIS, Advantage over AIS, construction of GIS

Activities: Draw and compare the GIS and AIS layout to identify the components.

UNIT III PROTECTION AND SUBSTATION AUTOMATION 9

Power System protection, Overcurrent and Earth Fault protection and coordination. Distribution Feeder Protection, Transformer – Unit/Main Protection, Familiarization of NUMERICAL Relays, distance/differential protection for transmission line. Substation Automation: Evolution of Substation Automation, Communication System Fundamentals-Protocol fundamental and choosing the right protocol. Substation integration and automation functional architecture, Substation signal list - DI, DO, AI, AO– Bay Control Unit (BCU), Remote Terminal Unit RTU

Activities: Demonstrate the relay operation in front of the class room .

UNIT IV SUBSTATION DESIGN & LAYOUT ENGINEERING 9

Layout aspects of Outdoor Air Insulated Substation and GIS: Statutory Clearances, Equipment Layout engineering aspects for Outdoor Substation/GIS and related calculations, and guide lines, Cable routing layout, Erection Key Diagram (EKD), switchyard earthing design as per IEEE80, Importance and Types of Earthing, Earthing Design, Types of Earthing Material, Direct stroke Lightning Protection for switchyard with IS/ IEC 62305. LV Cables - Power & Control, MV

Cables, Methods for Cable Installation, Practical aspects of Cable Sizing, Cable accessories, Illumination System Design.
Activities: Poster presentation and virtual demonstration of lightning strokes.

UNIT V INTERFACE ENGINEERING 9

Civil & Structural Engineering - Familiarization of site development plan, equipment supports structures, foundation for equipment, familiarization of control building and substation building, infrastructure development, Mechanical System- Fire Detection, Alarm System and Fire Suppression System for transformer, Heating, Ventilation and Air-conditioning (HVAC) for Substation.
Activities: Video recording ,show models and drawings of mechanical and civil structures for fire detection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Understand the working principles, classifications, and influencing factors for substation design, including different bus bar and switching schemes
CO2: Apply selection and sizing criteria for major substation equipment (Transformer, Circuit Breaker, Isolator, Instrument Transformers, Surge Arrestor, etc.) and auxiliary systems
CO3: Analyze the operational requirements and implement standard protection and coordination schemes for transmission lines, transformers, and feeders using numerical relays.
CO4: Design and develop the physical layout, earthing grid, and lightning protection system for Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) as per relevant IEEE/IEC standards
CO5: Evaluate the multi-disciplinary requirements of a substation project, integrating civil, structural, mechanical (HVAC, Fire), and control systems for comprehensive project development.

TEXT BOOKS:
1. McDonald John D, “Electric Power Substations Engineering”, CRC Press, 3rd Edition, 2012
2. B. Ravindranath and M. Chander, “Power System Protection and Switchgear”, New Age International, 2nd Edition, (Various Print Years)
3. Er. R.S. Dahiya, “Sub-Station Engineering: Design, Concepts & Computer Applications”, S.K. Kataria & Sons, (Edition Varies), (2013/Latest Reprint)
4. Badri Ram, D. N. Vishwakarma, Soumya R. Mohanty, “Power System Protection and Switchgear”, McGraw Hill Education, 3rd Edition, 2022.

REFERENCES:
1. Partap Singh Satnam, P.V. Gupta, “Sub-station Design and Equipment”, Dhanpat Rai Publications, 1st Edition, 2013

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

2. Sunil S. Rao, “Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)”, Khanna Publications, 14th Edition, 2019
3. Electrical substation and engineering & practice by S.Rao, 3rd Edition, Khanna Publishers 20154
4. Manual on Substation by Central Board of irrigation and Power (CBIP) Publication No 342., 2006.
5. Substation automation system Design and implementation by Evelio Padilla by Wiley Publications, 1st Edition, 2015 November

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	2	-	-	2	-	3	2	1	1
CO2	3	3	2	2	1	-	-	-	1	3	2	3	3	2	2
CO3	3	3	1	2	2	-	-	1	-	3	2	3	3	1	2
CO4	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3
CO5	2	2	2	1	1	3	3	2	3	1	2	2	2	2	1
Avg	3	2	2	2	2	1	1	1	1	2	2	3	3	2	2

24EE3007 UNDER GROUND CABLE ENGINEERING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understanding Power Cable Characteristics and Applications
- Cable Manufacturing and Installation of underground power cables
- To underground cable System Fault Locating
- Testing and maintenance of Underground cable system
- Cable Performance and Field Assessment of Power Cables

UNIT I INTRODUCTION TO ELECTRICAL POWER CABLES 9

Development of Underground Cables - Electric Lighting- Distribution of Energy for Lighting- - Paper Insulated Cables - Underground Residential Distribution Systems- Underground Residential Distribution Systems- Medium Voltage Cable Development.
Activities: Show students a sample paper insulated cable discussing the development of underground residential distribution with evolution.

UNIT II CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS 9

Architecture of Underground Cabling System - Basic Dielectric Theory of Cable – Conductors -Armour and Protective Finishes - Cable Characteristics: Electrical- Fundamentals of Electrical

Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings
Activities: Measure insulation thickness and dielectric properties cables.

UNIT III SUPPLY DISTRIBUTION SYSTEMS AND CABLES 9

Supply Distribution Systems - Distribution Cable Types, Design and Applications - Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables - Testing of Distribution Cables
Activities: Compare the different distribution cables to perform insulation resistance test using multimeters.

UNIT IV TRANSMISSION SYSTEMS AND CABLES 9

Basic Cable Types for A.C. Transmission - Self-contained Fluid-filled Cables - Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages - Techniques for Increasing Current Carrying Capacity - Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric Cables.
Activities: Students trace the current flow and identify the techniques to increase current carrying capacity cables using models.

UNIT V CABLE INSTALLATION, TESTING, MAINTENANCE 9

Installation of Transmission Cables -Splicing, Terminating, and Accessories - Sheath Bonding and Grounding-Testing of Transmission Cable Systems - Underground System Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests – PD measurements.
Activities: Demonstrate the cable jointing splicing on a sample cable students perform a mock location of fault.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Understand the historical development, necessity, and classifications of underground electrical power cables.
CO2: Analyze the architecture, dielectric theory, and electrical characteristics to determine cable design parameters and ratings
CO3: Apply the knowledge of various cable types (Paper, PVC, Polymeric) to design and select appropriate cables for different distribution systems.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

CO4: Evaluate the types of high-voltage transmission cables and techniques for increasing current capacity in AC and pressure-assisted systems

CO5: Create installation plans, perform testing, implement maintenance practices, and utilize condition monitoring for cable systems.

TEXT BOOKS:

1. William Thue, 'Electrical Power Cable Engineering', CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742, 3rd Edition 2017.

2. G. F. Moore, 'Electric Cables Handbook' -Third edition, Blackwell Science Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

3. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3rd Edition 2012

REFERENCES:

1.Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground Transmission Systems (Springer Theses), 2014, March.

2..https://kafactor.com/content/technical-resources/kerite-underground-cable-engineering-handbook.pdf

3.Handbook on Cable Fault Localization (April 2020) https://rdso.indianrailways.gov.in/works/uploads/File/Handbook

4.K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVDN: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.

5.R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, "Underground cable fault location: A handbook to TD-153," BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977. [Online]. Available: https://www.osti.gov/servlets/purl/7233049, doi: 10.2172/7233049, January 1997.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	-	-	1	-	3	1	-	-	-
CO2	3	3	1	2	1	1	-	1	3	2	3	3	1	2	1
CO3	3	2	2	1	-	1	-	-	2	2	3	2	2	1	-
CO4	3	3	2	2	1	2	1	1	3	2	3	3	2	2	1
CO5	2	2	3	3	3	3	3	3	2	3	2	2	3	3	3
Avg	3	2	2	2	1	1	1	1	2	2	3	2	2	2	1

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3008 **SMART GRIDS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the evolution of Smart and Interconnected energy systems
- To understand the various challenges and benefits of smart grid and the national and international initiatives taken
- To understand the concepts related with transmission and distribution in smart grid technologies.
- To get an insight of the various smart measurement technologies.
- To understand the various computing technologies for Smart Operation of the Grid.

UNIT I INTRODUCTION 9

Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional & Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid
Activities: Compare conventional and smart grid using a small layout or flowchart.

UNIT II SMART METERING 9

Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU).
Activities: Students record readings ,observe real time data and discuss the benefits of PMU

UNIT III SMART GRID TECHNOLOGIES (Transmission) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.
Activities: Use a substation or transmission system model in any power system software.

UNIT IV SMART GRID TECHNOLOGIES (Distribution) 9

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, Electric Vehicles.
Activities: Demonstrate fault detection and isolation in small distribution network model or simulation for V/VAR control.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

Activities: Simulate LAN/WAN network for a smart grid using IoT or cloud based control and identify the cybersecurity measures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the fundamental importance, objectives, and architecture of a conventional Power System Grid.

CO2: Analyze the foundational concepts, components, and characteristics that distinguish a Smart Grid from a traditional power grid.

CO3: Identify and Discuss the operation, functionalities, and associated communication technologies of smart metering devices

CO4: Evaluate the architecture, control strategies, and benefits of Microgrids and their integration with Electric Vehicle (EV) charging technology

CO5: Assess the role of modern computing technologies, including Big Data and the Internet of Things (IoT), in enhancing the efficiency and operation of a Smart Grid.

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase,CRC, 2018

2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley,2012

3. James Momoh ,Smart Grid Fundamentals of Design and Analysis, IEEE press 2012

REFERENCES:

1. Ahmed F. Zobaa, Trevor J. Bihl, Big data analytics in future power systems, 1st Edition, CRC press 2018

2. C. Gungor et al., "Smart Grid Technologies: Communication Technologies and Standards," in IEEE Transactions on Industrial Informatics, vol. 7, no. 4, pp. 529-539, Nov. 2011.doi: 10.1109/TII.2011.2166794

3. X. Fang, S. Misra, G. Xue and D. Yang, "Smart Grid — The New and Improved Power Grid: A Survey," in IEEE Communications Surveys & Tutorials, vol. 14, no. 4, pp. 944- 980, Fourth Quarter 2012. doi: 10.1109/SURV.2011.101911.00087.

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

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	-	-	2	-	3	1	-	-	-
CO2	3	3	1	2	1	2	-	1	3	2	3	3	1	2	1
CO3	2	2	1	1	2	1	2	1	2	2	2	2	1	1	2
CO4	3	3	2	2	2	3	1	2	3	3	3	3	2	2	2
CO5	3	3	2	2	3	2	2	2	3	3	3	3	2	2	3
Avg	3	2	1	2	1	2	1	1	2	2	3	2	1	1	2

ANNA University Nominee | **Subject Expert 1** | **Subject Expert 2** | **Industrial Expert** | **Alumni**

VERTICAL II: CONVERTERS AND DRIVES

24EE3009 **SMPS AND UPS** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To understand and analyze the operation, steady-state behavior, and design of non-isolated DC–DC converters in CCM and DCM.
- To examine isolated converter topologies and perform SMPS and magnetic component design with relevant simulations.
- To develop dynamic models of DC–DC converters using state-space and circuit averaging and validate through simulation.
- To design and evaluate P/PI/PID controllers for DC–DC converters using frequency-domain stability analysis.
- To understand power conditioning requirements, UPS systems, filter design, and front-end battery charging circuits.

UNIT I ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 6

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady state relationships – Introduction to discontinuous conduction mode.

UNIT II ANALYSIS OF ISOLATED DC-DC CONVERTERS 6

Introduction - classification- forward- flyback- pushpull – half bridge – full bridge topologies- C'uk converter as cascade combination of boost followed by buck – isolated version of Cuk converter - design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

UNIT III CONVERTER DYNAMICS 6

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

UNIT IV CONTROLLER DESIGN 6

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of controller for buck, boost and buck-boost converters.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V POWER CONDITIONERS AND UPS 6

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simulation of Basic topologies.
2. Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.
3. Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.
4. Simulation study of controller design for basic topologies.
5. Simulation of battery charger for EV applications.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze and design non-isolated DC–DC converters (Buck, Boost, Buck-Boost) in CCM and DCM using volt–second and charge balance principles.

CO2: Explain and evaluate isolated converter topologies and perform SMPS and magnetic component design, including simulations for EV-based bidirectional converters.

CO3: Develop and validate dynamic models of DC–DC converters using AC equivalent models, state-space averaging, and circuit averaging techniques.

CO4: Design, simulate, and analyze P/PI/PID controllers for basic DC–DC converter topologies using frequency-domain stability tools.

CO5: Analyze power conditioning systems, UPS configurations, and EV battery chargers, and simulate filters and charging circuits for power electronic applications.

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, ” Fundamentals of Power Electronics”, Third Edition, 2020
2. S. Ganesh Kumar, S.K. Patnaik and Marco Rivera,“ Power Converters, Drives and Control for sustainable operations”, John Wiley and Sons, 2023.
3. Ned Mohan,” Power Electronics: A First Course”, John Wiley, Second Edition 2022.

REFERENCES:

1.Marian K. Kazimierczuk and Agasthya Ayachit,”Laboratory Manual for Pulse-Width Modulated DC– DC Power Converters”, Wiley 2016.
2.Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
3.Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
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CO1	3	3	2	2	1	-	-	-	-	2	-	2	3	2	2
CO2	3	2	3	2	2	-	-	-	-	2	-	2	3	3	3
CO3	3	3	2	3	2	-	-	-	-	2	-	3	3	3	2
CO4	3	3	2	3	2	-	-	-	-	3	-	3	3	3	2
CO5	3	2	3	2	2	-	-	-	-	2	-	2	2	3	3
Avg	3	3	2	2	2	-	-	-	-	2	-	2	3	3	2

24EE3010 SOLID STATE DRIVES L T P C
2 0 2 3

COURSE OBJECTIVES:

- To understand the dynamic characteristics of electric drives and analyze motor–load interaction under multi-quadrant operation.
- To analyze and evaluate converter- and chopper-fed DC motor drives including control strategies and four-quadrant operation.
- To examine various induction motor drive control methods such as stator voltage control, V/f control, rotor control, and vector control.
- To understand synchronous motor drive control including V/f, self-control, margin angle control, and voltage/current source-fed operation.
- To design and analyze controllers for electrical drives using transfer functions, feedback loops, and appropriate converter selection.

UNIT I DRIVE CHARACTERISTICS 6

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.

UNIT II CONVERTER / CHOPPER FED DC MOTOR DRIVE 6

Steady state analysis of the single and three phase converter fed separately excited DC motor drive– continuous conduction – Time ratio and current limit control – 4 quadrant operation of converter / chopper fed drive-Applications.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

UNIT III INDUCTION MOTOR DRIVES **6**

Stator voltage control–V/f control– Rotor Resistance control-qualitative treatment of slip power recovery drives-closed loop control— vector control- Applications.

UNIT IV SYNCHRONOUS MOTOR DRIVES **6**

V/f control and self-control of synchronous motor: Margin angle control and power factor control- Three phase voltage/current source fed synchronous motor- Applications.

UNIT V DESIGN OF CONTROLLERS FOR DRIVES **6**

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

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simulation of converter and chopper fed DC drive
2. Simulation of closed loop operation of stator voltage control of induction motor drive
3. Simulation of closed loop operation of v/f control of induction motor drive
4. Simulation of synchronous motor drive

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze the dynamic behavior of electric drives, motor–load characteristics, and multi-quadrant operation for proper motor selection.

CO2: Evaluate and simulate converter- and chopper-fed DC motor drives under continuous conduction, time-ratio control, and four-quadrant operation.

CO3: Examine and implement various induction motor drive control methods including stator voltage control, V/f control, rotor control, and vector control.

CO4: Analyze and simulate synchronous motor drives using V/f control, self-control, margin angle control, and voltage/current source-fed operation.

CO5: Design and simulate closed-loop current and speed controllers for electrical drives using transfer-function models and appropriate converter selection.

TEXT BOOKS:

1. Gopal K.Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, 2nd Edition January 2002.

2. S. Ganesh Kumar, S.K. Patnaik and Marco Rivera,“ Power Converters, Drives and Control for sustainable operations”, John Wiley and Sons, 2023.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

3. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2020 2nd Edition.
4. S.K.Pillai, A First course on Electrical Drives, Wiley Eastern Limited, 3rd Edition 2012.

REFERENCES:

1. Murphy J.M.D and Turnbull, Thyristor Control of AC Motor, Pergamon Press, Oxford 1988, 1st Edition.
2. Gopal K.Dubey, Power semiconductor controlled Drives, Prentice Hall Inc., New Jersey,1989, 1 st Edition.
3. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1st Edition.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
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CO3	3	3	2	3	2	-	-	-	-	1	-	2	3	3	2
CO4	3	2	2	3	2	-	-	-	-	1	-	2	3	2	2
CO5	3	2	3	3	2	-	-	-	-	2	-	3	3	3	3
Avg	3	3	2	3	2	-	-	-	-	1	-	2	3	3	2

24EE3011 SPECIAL ELECTRICAL MACHINES L T P C
2 0 2 3

COURSE OBJECTIVES:

- To introduce the construction, operating principles, characteristics, and control methods of stepper motors for precise positioning applications.
- To develop an understanding of switched reluctance motors (SRM), including torque production, controllers, sensorless operation, and design considerations.
- To analyze permanent magnet brushless DC motors (BLDC), covering magnetic circuits, EMF/torque equations, dynamic modeling, and design of current and speed controllers.
- To explain the operating principles, characteristics, and control strategies of permanent magnet synchronous motors (PMSM) and synchronous reluctance motors.
- To provide knowledge on the operation, features, and applications of other special electrical machines such as hysteresis motors, AC series motors, and linear motors.

UNIT I STEPPER MOTORS 6

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications

UNIT II SWITCHED RELUCTANCE MOTORS 6

Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods-sensor less rotor position estimation-inductance based estimation –applications.

UNIT III PERMANENT MAGNET BRUSHLESS DC MOTORS 6

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.

UNIT IV PERMANENT MAGNET SYNCHROUNOUS MOTORS 6

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

UNIT V STUDY OF OTHER SPECIAL ELECTRICAL MACHINES 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:
Using electromagnetic software
1) Simulation of BLDC motor
2) Simulation of SRM motor
3) Simulation of stepper motor
4) Simulation of PMSM motor
5) Simulation of any other special machines

TOTAL: 30 PERIODS
TOTAL: 30 + 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

COURSE OUTCOMES:

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

CO1: Analyze the construction, operating principles, torque characteristics, drive circuits, and control methods of stepper motors, including closed-loop operation.

CO2: Evaluate switched reluctance motor (SRM) drives, including torque production, speed/current control, sensorless operation, and power electronics-based control.

CO3: Examine the operation, EMF/torque characteristics, and controller design of permanent magnet brushless DC (BLDC) motors, and simulate their dynamic behavior.

CO4: Analyze permanent magnet synchronous motors (PMSM) and synchronous reluctance motors, including EMF/torque equations, phasor diagrams, torque-speed characteristics, and current/speed controller design.

CO5: Understand and simulate other special electrical machines such as hysteresis motors, AC series motors, and linear motors, applying electromagnetic simulation tools to study their characteristics.

TEXT BOOKS:

1. Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008.
2. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2022.
3. Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2010

REFERENCES:

1. T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, 2000 Dekker 2009
2. T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Clarendon press, London, 1993
3. R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	-	2	-	2	3	2	1
CO2	3	3	3	2	2	-	-	-	-	2	1	2	3	3	2
CO3	3	3	3	3	2	-	-	-	-	2	1	3	3	3	2
CO4	3	3	3	3	2	-	-	-	-	2	1	3	3	3	2
CO5	3	2	2	2	2	-	-	-	-	1	1	2	3	2	2
Avg	3	3	3	2	2	-	-	-	-	2	1	2	3	3	2

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3012 **ANALYSIS OF ELECTRICAL MACHINES** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To understand the fundamentals, operation, and state-space modeling of brushed DC machines (shunt, series, and compound).
- To introduce reference frame theory and transformations for AC machine analysis and modeling.
- To develop modeling and simulation skills for three-phase induction machines under no-load and loaded conditions.
- To study synchronous machine modeling, including voltage and torque equations in machine and rotor reference frames.
- To understand the concepts, modeling, and applications of multiphase (more than three-phase) machines for industrial and specialized applications.

UNIT I MODELING OF BRUSHED-DC ELECTRIC MACHINERY 6

Fundamentals of Operation – Introduction – Governing equations and modeling of Brushed DC-Motor – Shunt, Series and Compound – State model derivation – Construction of Model of a DC Machine using state equations- Shunt, Series and Compound.

UNIT II REFERENCE FRAME THEORY 6

Historical background – phase transformation and commutator transformation – transformation of variables from stationary to arbitrary reference frame .

UNIT III INDUCTION MACHINES 6

Three phase induction machine - equivalent circuit– free acceleration characteristics – voltage and torque equations in machine variables and arbitrary reference frame variables – Simulation under no load and load conditions- Machine variable form, arbitrary reference variable form.

UNIT IV SYNCHRONOUS MACHINES 6

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

UNIT V MULTIPHASE (MORE THAN THREE-PHASE) MACHINES CONCEPTS 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Modeling of DC machines.
2. Simulation under no-load and loaded conditions for a PMDC motor
3. Simulation of smooth starting for DC motor.
4. Simulation under no-load and load conditions of a three phase induction machine in machine variable form and arbitrary reference variable form.
5. Simulation under no-load and load conditions of a three phase synchronous machine in machine variable form and arbitrary reference variable form.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Develop mathematical models and state-space representations for brushed DC machines (shunt, series, and compound) and analyze their dynamic behavior.

CO2: Apply reference frame theory to transform machine variables between stationary, arbitrary, and rotor reference frames for AC machines modeling.

CO3: Model and simulate three-phase induction machines under no-load and loaded conditions using both machine variables and arbitrary reference frame variables.

CO4: Analyze three-phase synchronous machines using voltage and torque equations in machine and rotor reference frames (Park's equations) and simulate their performance.

CO5: Understand the principles, advantages, and modeling techniques of multiphase (more than three-phase) machines, including induction and synchronous machines, and their applications.

TEXT BOOKS:

1. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.

2.Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011, 1st Edition.

3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek, "Analysis of Electric Machinery and Drive Systems", 4th Edition, Wiley-IEEE Press, 2025.

4. S. Ganesh Kumar, S.K. Patnaik and Marco Rivera," Power Converters, Drives and Control for sustainable operations", John Wiley and Sons, 2023.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

REFERENCE:

1. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Pearson Education, 1st Imprint, 2025.
2. R.Ramanujam, Modeling and Analysis of Electrical Machines, I.k.International Publishing House Pvt.Ltd,2018.
3. Chee Mun Ong, Dynamic Simulation of Electric Machinery using MATLAB, Prentice Hall, 1997, 1 st Edition.
4. Atif Iqbal,Shaikh Moinoddin, Bhimireddy Prathap Reddy, Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Wiley,2021,1st Edition.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	1	-	-	-	-	2	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	2	1	2	3	3	2
CO3	3	3	3	3	2	-	-	-	-	2	1	3	3	3	2
CO4	3	3	3	3	2	-	-	-	-	2	1	3	3	3	2
CO5	3	2	2	2	2	-	-	-	-	1	1	2	3	2	2
Avg	3	3	3	3	2	-	-	-	-	2	1	2	3	3	2

24EE3013 MULTILEVEL POWER CONVERTERS L T P C
2 0 2 3

COURSE OBJECTIVES:

- To introduce the fundamentals and different topologies of multilevel converters, including symmetric, asymmetric, and generalized structures.
- To understand the operation, modulation schemes, and PWM techniques for cascaded H-bridge multilevel inverters.
- To study the diode-clamped multilevel converter, including voltage balancing techniques and performance analysis.
- To analyze flying capacitor multilevel converters, their modulation schemes, and dynamic voltage balancing.
- To explore multilevel inverter structures with reduced switch count and understand their working principles and pulse generation methods.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT I MULTILEVEL TOPOLOGIES 6

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT II CASCADED H-BRIDGE MULTILEVEL INVERTERS 6

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level - Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes - Staircase Modulation.

UNIT III DIODE CLAMPED MULTILEVEL CONVERTER 6

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.

UNIT IV FLYING CAPACITOR MULTILEVEL CONVERTER 6

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNIT V MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 6

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simulation of Fixed PWM, Sinusoidal PWM for an inverter,
2. Simulation of H bridge inverter with R load .
3. Simulation of three level diode clamped MLI with R load.
4. Simulation of three level capacitor clamped MLI with R load
5. Simulation of MLI with reduced switch configuration.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

CO1: Analyze and simulate various multilevel converter topologies, including symmetric, asymmetric, and generalized structures.
CO2: Design and implement cascaded H-bridge multilevel inverters with different PWM strategies such as bipolar, unipolar, phase-shifted, and level-shifted modulation.
CO3: Model and simulate diode-clamped multilevel converters, applying voltage balancing techniques and evaluating performance under different operating conditions.
CO4: Analyze flying capacitor multilevel converters and perform dynamic voltage balancing using simulation tools.
CO5: Understand and simulate multilevel converters with reduced switch configurations for efficient pulse generation and operation.

TEXT BOOKS:

1. S. Ganesh Kumar, S.K. Patnaik and Marco Rivera,“ Power Converters, Drives and Control for sustainable operations”, John Wiley and Sons, 2023.
2. Rashid M.H,”Power Electronics Circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition.
3. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,”Multilevel Converters for Industrial Applications”, CRC Press, 2014, 1st Edition.
4. BinWu, Mehdi Narimani, High Power Converters and AC drives by IEEE press 2017, 2nd Edition.

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice, D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1st Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc, 2021, 1st Edition.
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1st Edition.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	-	-	2	-	2	-	2	3	3	2
CO2	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2
CO3	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2
CO4	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2
CO5	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2
Avg	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3014 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS **L T P C 2 0 2 3**

COURSE OBJECTIVES:

- To introduce the fundamentals, classification, and environmental impacts of renewable energy sources, including solar, wind, ocean, biomass, and hydrogen.
- To study the construction, principles, and operational analysis of electrical machines used in wind energy conversion systems (SCIG, DFIG, PMSG).
- To analyze and design power converters for solar PV systems, including line-commutated converters, buck/boost converters, inverter selection, and PV array/battery sizing.
- To understand and analyze power converters used in wind energy systems, such as AC-DC-AC converters, PWM inverters, AC voltage controllers, and matrix converters.
- To examine hybrid renewable energy systems, including various combinations, case studies, and Maximum Power Point Tracking (MPPT) techniques.

UNIT I INTRODUCTION TO RENEWABLE ENERGY SYSTEMS 6

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 6

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT IV POWER CONVERTERS FOR WIND SYSTEMS 6

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 6

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, WindPV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simulation on modelling of Solar PV System- V I Characteristics
2. Simulation on Modelling of fuel cell- V I Characteristics
3. Simulation of self- excited Induction Generator.
4. Simulation of DFIG/ PMSG based Wind turbine.
5. Simulation on Grid integration of RES.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Analyze different renewable energy sources, their environmental impacts, and operational principles of solar PV, fuel cells, and wind energy systems.

CO2: Evaluate and simulate the performance of electrical machines used in wind energy systems, including SCIG, DFIG, and PMSG.

CO3: Design and simulate power converters for solar PV systems, including array sizing, battery sizing, and inverter selection, and analyze their dynamic performance.

CO4: Analyze and simulate power converters for wind energy systems, including rectifiers, PWM inverters, grid-interactive inverters, and matrix converters.

CO5: Understand, design, and simulate hybrid renewable energy systems integrating multiple energy sources, with emphasis on MPPT and grid integration.

TEXT BOOKS:

1. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 2009, 7th impression.
2. Rashid .M. H “Power electronics Hand book”, Academic press, 5th Edition, 2023.
3. Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6th Edition, 2017.

REFERENCES:

1. Rai. G.D,” Solar energy utilization”, Khanna publishers, 5th Edition, 2008.
2. Gray, L. Johnson, “Wind energy system”, Prentice hall of india, 2nd Edition, 2006.
3. H.Khan "Non-conventional Energy sources ",Tata McGraw-hill Publishing Company, New Delhi, 2017, 3rd Edition.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	-	-	2	-	2	-	1	3	3	2
CO2	3	3	3	3	2	-	-	2	-	2	1	2	3	3	2
CO3	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2
CO4	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2
CO5	3	3	3	3	2	-	-	3	-	2	1	2	3	3	3
Avg	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2

24EE3015 CONTROL OF POWER ELECTRONICS CIRCUITS L T P C
1 0 4 3

COURSE OBJECTIVES:

- To introduce the fundamentals of simulation in control systems, including transfer functions, poles/zeros analysis, time-response, Bode plots, and state-space modeling.
- To develop proficiency in symbolic calculations for polynomial expressions, matrices, and system modeling in control applications.
- To study the principles and applications of sliding-mode control, particularly for DC-DC converters like buck converters.
- To understand the operating principles and control design of single-phase power factor correction (PFC) circuits using boost converters.
- To analyze and design advanced PFC circuits using SMPS topologies like C'uk and SEPIC converters, including bridgeless configurations.

UNIT I SIMULATION BASICS IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT II SYMBOLIC CALCULATIONS 6

Symbolic Variables - Symbolic Vector Variables, Commands for Handling Polynomial Expressions - Extracting Parts of a Polynomial -. Factorization and Roots of Polynomials, Symbolic Matrix Algebra - Operations with Symbolic Matrices - Other Symbolic Matrix Operations.

UNIT III SLIDING MODE CONTROL BASICS 6

Introduction- Introduction to Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter.

UNIT IV POWER FACTOR CORRECTION CIRCUITS 6

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

UNIT V CONTROLLER DESIGN FOR PFC CIRCUITS 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:

1.Simulation exercises on zero, first and second order basic blocks.
2. Simulation exercises based on symbolic calculations.
3. Simulation of Sliding mode control based buck converter.
4. Simulation of Single-Phase PFC circuit employing boost converter.
5. Simulation of Single-Phase PFC circuit employing Cuk converters.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Build and simulate transfer function models, identify poles/zeros, plot time-response and Bode plots, and convert between state-space and transfer function representations.

CO2: Apply symbolic computation techniques for vector/matrix operations, polynomial manipulation, and system modeling in control simulations.

CO3: Design and simulate sliding-mode control strategies for DC-DC converters and analyze dynamic performance.

CO4: Design and simulate single-phase PFC circuits using boost converters, including inner current and outer voltage control loops.

CO5: Analyze, design, and simulate PFC circuits using advanced topologies such as C'uk, SEPIC, and bridgeless converters for improved efficiency.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS:

1. Feedback Control problems using MATLAB and the Control system tool box By Dean Frederick and Joe Chow, 2000, 1st Edition, Cengage Learning.
2. Ned Mohan,"Power Electronics: A First Course", Johnwiley, 2013, 1st Edition.
3. Marian K. Kazimierczuk and AgasthyaAyachit,"Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters", Wiley 2016, 1st Edition.
4. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002, 1 st Edition.

REFERENCES:

1. Sliding mode control for Switching Power Converters:, Techniques and Implementation, Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, 1st Edition, CRC Press, 2018
2. Andre Kislovski, "Dynamic Analysis of Switching-Mode DC/DC Converters", Springer 1991.
3. MATLAB Symbolic Algebra and Calculus Tools, Lopez Cesar, Apress, 2014.

MAPPING OF COs with POs and PSOs

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CO3	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2
CO4	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2
CO5	3	3	3	3	2	-	-	3	-	2	1	2	3	3	3
Avg	3	3	3	3	2	-	-	3	-	2	1	2	3	3	2

24EE3016 FPGA BASED POWER ELECTRONICS AND CONTROL **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To Introduce FPGA architecture and HDL-based digital design for power electronic control.
- To Develop FPGA-based PWM and digital control techniques for DC–DC converters.
- To Implement advanced digital control strategies for high-performance power converters.
- To Apply FPGA control to inverters, AC converters, and electric drives.
- To Provide hands-on experience through real-time FPGA-based case studies and experiments.

UNIT I FUNDAMENTALS OF FPGA ARCHITECTURE & DIGITAL DESIGN 6

FPGA architecture, HDL design flow, Basics of VHDL, PWM concepts, dead-time insertion, sensor interfacing basics.

UNIT II FPGA-BASED CONTROL OF BUCK & BOOST CONVERTERS 6

Buck and Boost converter operation, digital modeling, PI/PID control, closed-loop implementation.

UNIT III MULTIPHASE & HIGH-PERFORMANCE DIGITAL CONTROL 6

Multiphase and Multilevel converters, DPWM architectures, nonlinear control basics.

UNIT IV FPGA IN AC CONVERTERS & ELECTRIC DRIVES 6

FPGA-based SPWM/SVPWM, inverter control, BLDC/PMSM basics, digital firing circuits.

UNIT V CASE STUDIES ON FPGA-BASED POWER ELECTRONICS 6

FPGA-Based Buck Converter for Solar PV Systems - FPGA-Controlled Boost Converter for EV Chargers - FPGA-Based Inverter for Grid-Tied Renewable Energy - FPGA Implementation in Electric Drives.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

CO1: Describe FPGA architecture, design flow, and implement basic digital modules using VHDL/Verilog.

CO2: Design and implement FPGA-based PWM and closed-loop control for Buck and Boost converters.

CO3: Apply multiphase and advanced digital control techniques using FPGA.

CO4: Implement FPGA-based control of inverters, AC converters, and electric drives.

CO5: Develop and demonstrate FPGA-based power electronics systems through laboratory experiments and case studies.

LAB COMPONENT:

1. Implementation of FPGA-Based PWM Generator with Dead-Time Control
2. Closed-Loop Voltage Control of Buck Converter Using FPGA
3. FPGA-Based SPWM Control of Single-Phase Inverter
4. FPGA Based speed control of BLDC motor.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

TEXT BOOKS:

1.Ned Mohan, Tore M. Undeland, William P. Robbins, Power Electronics: Converters, Applications, and Design, John Wiley & Sons, 3rd Edition, 2009.

2.Romeo Ortega, José Guadalupe Romero, Pablo Borja, Alejandro Donaire, PID Passivity-Based Control of Nonlinear Systems with Applications, Wiley-IEEE Press, 1st Edition, 2021.

3.Arjan van der Schaft, L_2-Gain and Passivity Techniques in Nonlinear Control, Springer, 2nd Edition, 2000.

4. Daniel W. Hart, Power Electronics, McGraw-Hill Education, 1st Edition, 2010.

REFERENCES:

1. Stephen Brown, Zvonko Vranesic, Fundamentals of Digital Logic with VHDL Design, McGraw-Hill, 3rd Edition, 2013.

2. Volnei A. Pedroni, Circuit Design and Simulation with VHDL, MIT Press, 2nd Edition, 2010.

3. M. Morris Mano, Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, Pearson, 5th Edition, 2013.

4.Uwe Meyer-Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer, 4th Edition, 2014.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	-	-	-	-	-	-	2	1	3	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	3	3	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2	3	3	2
CO4	3	2	3	2	3	-	-	-	-	-	-	2	3	3	3
CO5	2	2	3	2	3	-	-	-	-	-	-	3	3	3	3
Avg	3	2	2	2	3	-	-	-	-	-	-	2	3	3	2

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

VERTICAL III: EMBEDDED SYSTEMS

24EE3017 **COMMUNICATION ENGINEERING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To Understand the concepts of AM, DSB-SC, SSB-SC, VSB, FM, and PM along with their modulation and demodulation techniques.
- To Understand sampling, quantization, PAM, PCM, DPCM, DM, ADM, line coding, and multiplexing principles.
- To Apply suitable digital modulation and pulse shaping techniques to reduce ISI and improve communication quality.
- To Apply coding and decoding methods such as syndrome calculation and Viterbi decoding to achieve reliable communication.
- To Understand PN sequences, DSSS, FHSS, jamming resistance, synchronization, and multiple access schemes (FDMA, TDMA, CDMA).

UNIT I ANALOG MODULATION 9

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – modulators and demodulators – Angle modulation – PM and FM, modulators and demodulators – Super heterodyne receivers, Comparison of AM, FM and PM.
Activity:Simulate AM and FM signals and observe time-domain waveforms.

UNIT II PULSE MODULATION 9

Low pass sampling theorem – Quantization – Pulse Amplitude Modulation (PAM) – Line coding – Pulse Code Modulation (PCM), DPCM, Delta Modulation (DM), and ADM, Channel Vocoder - Time Division Multiplexing, Frequency Division Multiplexing.
Activity:Verify the Sampling Theorem using a sine wave.

UNIT III DIGITAL MODULATION AND TRANSMISSION 9

Phase shift keying – BPSK, DPSK, QPSK – Principles of M-arysignaling M-ary PSK & QAM – Comparison, ISI – Pulse shaping – Duo binary encoding – Cosine filters – Eye pattern, equalizers.
Activity:Simulate BPSK modulation and demodulation.

UNIT IV INFORMATION THEORY AND CODING 9

Measure of information – Entropy – Source coding theorem – Shannon–Fano coding, Huffman Coding, LZ Coding – Channel capacity – Shannon-Hartley law – Shannon's limit – Error control codes – Cyclic codes, Syndrome calculation – Convolution Coding, Sequential and Viterbi decoding.
Activity:Construct Huffman code for a given symbol set.

UNIT V SPREAD SPECTRUM AND MULTIPLE ACCESS 9

PN sequences – properties – m-sequence – Direct Sequence Spread Spectrum (DSSS) – Processing gain, Jamming – Frequency Hoping Spread Spectrum (FHSS) – Synchronization and tracking – Multiple Access – FDMA, TDMA, CDMA, Application of wireless communication – GSM.
Activity:Generate and study PN sequence

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Explain the operating principles of AM, DSBSC, SSBSC, VSB, FM, PM, and the functioning of modulators, demodulators, and superheterodyne receivers.
CO2: Describe sampling, quantization, PAM, PCM, DPCM, DM, ADM, line coding, and multiplexing mechanisms.
CO3: Apply pulse-shaping, duobinary encoding, cosine filtering, and equalization methods to improve digital signal transmission.
CO4: Use cyclic codes, syndrome methods, convolutional encoding and Viterbi/Sequential decoding to achieve reliable communication.
CO5: Discuss PN sequences, DSSS, FHSS, processing gain, jamming effects, and multiple access techniques such as FDMA, TDMA, and CDMA.

TEXT BOOKS:
1. H. Taub, D. L. Schilling, G. Saha, “Principles of Communication Systems,” 4/e, McGraw Hill, 2013.
2. S. Haykin, “Digital Communications,” 5/e, John Wiley & Sons, 2013.
REFERENCES:
1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 3rd edition, Oxford University Press, 2007.
2. H P Hsu, Schaum Outline Series – “Analog and Digital Communications” TMH 2006.
3. B.Sklar, Digital Communications Fundamentals and Applications” 2/e Pearson Education 2007.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	3	-	-	-	3	1	2	2	2	2
CO2	2	1	1	1	1	3	-	-	-	2	1	2	3	3	3
CO3	2	1	3	1	1	3	-	-	-	2	1	3	2	2	2
CO4	2	1	3	1	1	3	-	-	-	2	1	3	2	2	2
CO5	2	1	1	1	3	3	-	-	-	3	3	2	3	3	3
Avg	2	1	2	1	2	3	-	-	-	2	2	2	2	2	2

24EE3018 **REAL TIME OPERATING SYSTEMS** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To apply the fundamental concepts of operating systems, including processes, files, system calls, and inter-process communication, to embedded and distributed environments.
- To analyze real-time operating system (RTOS) structures such as task management, scheduling, and synchronization mechanisms for real-time requirements.
- To apply realtime models, languages, and scheduling techniques to design real-time applications with proper memory and interrupt handling.
- To analyze real-time kernel design issues and compare different RTOS platforms such as VxWorks, Linux-based RTOS, and C-executive systems.
- To apply and analyze Linux-supported RTOS and uCOS/C-Executive environments for developing real-time embedded applications through practical case studies.

UNIT I REVIEW OF OPERATING SYSTEMS 6

Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system – Embedded operating systems.

UNIT II OVERVIEW OF RTOS 6

RTOS Task and Task state –Multi threaded Preemptive scheduler- Process Synchronization- Message queues– Mail boxes -pipes – Critical section – Semaphores – Classical synchronization problem – Deadlocks

UNIT III REALTIME MODELS AND LANGUAGES 6

Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.

UNIT IV REALTIME KERNEL 6

Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and Basic study of various RTOS like – VX works – Linux supportive RTOS – C Executive.

UNIT V REALTIME OPERATING SYSTEM IN EMBEDDED SYSTEM 6

Interrupt handling and ISR concepts - Inter task communication using semaphores queues and message passing - Synchronization and conflict avoidance - Memory management and timing control in RTOS - Introduction to FreeRTOS and RTLinux.

TOTAL: 30 PERIOD

LAB COMPONENT:

1. Create an application that creates two tasks that wait on a timer whilst the main task loops.
2. Write an application that creates a task which is scheduled when a button is pressed, which illustrates the use of an event set between an ISR and a task
3. Write an application that creates a two task to Blinking two different LEDs at different timings
4. Write an application that creates two tasks of the same priority and sets the time slice period to illustrate time slicing.
5. Interfacing Programs: Write an application that creates a two task to Blinking two different LEDs at different timings.

TOTAL: 30 PERIOD

TOTAL: 30 +30 PERIOD

COURSE OUTCOMES:

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

CO1: Apply the concepts of operating system structures, processes, files, and inter-process communication to embedded and distributed systems

CO2: Analyze RTOS task management, scheduling methods, and synchronization mechanisms for real-time operation.

CO3: Apply real-time models, programming languages, and interrupt-handling techniques to design reliable real-time applications.

CO4: Analyze real-time kernel design issues and compare various RTOS platforms such as VxWorks, Linux-based RTOS, and C-executive systems.

CO5: Apply and analyze Linux-supported RTOS and uCOS/C-Executive environments to develop and evaluate real-time embedded applications.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

TEXT BOOKS:

1. K. C. Wang, “Embedded and Real-Time Operating Systems”, Springer, 2nd Edition, 2023.
2. Ivan Cibrario Bertolotti & Gabriele Manduchi, “Real-Time Embedded Systems with Open-Source Operating Systems”, Routledge, 2nd Edition, 2026.
3. Dr. K. V. K. Prasad, “Embedded / Real-Time Systems: Concepts, Design and Programming Black Book”, Wiley-Dreamtech Press, 1st Edition, 2005 (reprint available).

REFERENCES:

1. Brian Amos, “Hands-On RTOS with Microcontrollers”, Packt Publishing, 2nd Edition, 2024.
2. Hermann Kopetz, “Real-Time Systems: Design Principles for Distributed Embedded Applications”, Springer, 2nd Edition, 2020 (latest edition).
3. Richard Barry, Mastering the FreeRTOS Real-Time Kernel, 2024 Edition,
4. Christopher Hallinan, Embedded Linux Primer, 3rd Ed., Prentice Hall, Updated 2022/23.
5. Jonathan Corbet, Alessandro Rubini & Greg Kroah-Hartman, Linux Device Drivers, O’Reilly, 3rd Ed., 2023 Reprint.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO2	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO3	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO4	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO5	2	3	3	3	3	-	3	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	1	-	3	2	1	2	2	3	3

24EE3019 **EMBEDDED C-PROGRAMMING** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To introduce the fundamental concepts of C programming, including program structure.
- To apply Embedded C concepts of structured coding for real-time applications.
- To develop 8051 microcontroller programs in C involving data types and time delays.
- To understand and implement serial communication and interrupt programming in 8051.
- To interface the 8051 microcontroller with external peripherals for embedded system design.

ANNA University Nominee **Subject Expert 1** **Subject Expert 2** **Industrial Expert** **Alumni**

UNIT I BASIC C- PROGRAMMING 6

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II EMBEDDED C 6

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Creating loop timeouts - Creating hardware timeouts.

UNIT III 8051 PROGRAMMING IN C 6

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051-Accessing code ROM space in 8051, Data serialization using 8051.

UNIT IV 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 6

8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

UNIT V 8051 INTERFACING 6

8051:ADC interfacing , DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor interfacing, Keypad interfacing.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Laboratory exercise: Use8051 microcontroller/Embedded processor/IDE/open source platform to give hands-on training on EmbeddedC- programming.

a. Introduction to IDE (likecodeblocks,vs code,etc) and Programming Environment (like Keililu vision, Proteus)
b. Configuring an I/O port using bit wise programming.
c. Configuring timer for generating hardware delay.
d. Flashing an LED using an interrupt
e. Serial communication using UART port of 8051
f. Interfacing an ADC with 8051
g. Interfacing an analog sensor with 8051
h. Interfacing 16x2 LCD with 8051
i. Configuring timer for generating PWM signal

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

j. Interfacing a stepper motor with 8051
2. Assignment:Introduction to Arduino IDE, Raspberry Pi
3. EmbeddedC-Programming-basedMiniproject

TOTAL: 30 PERIODS
TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Apply the fundamental concepts of C programming, including program structure and control logic, to develop basic applications.
CO2: Apply Embedded C structured coding techniques to meet real-time constraints in embedded applications.
CO3: Develop 8051 microcontroller programs in C using appropriate data types, timing delays, and I/O operations.
CO4: Analyze and implement serial communication and interrupt-based programming techniques on the 8051 microcontroller.
CO5: Integrate and interface the 8051 microcontroller with external peripherals such as ADC, DAC, sensors, LCDs, and motors for embedded system design.

TEXT BOOKS:
1.Paul Deiteland Harvey Deitel, "C How to Program", 9th Edition, Pearson Education Limited, 2022,1st edition.
2. Michael J Pont,"Embedded C",Addison-Wesley,Animprint of Pears on Education, 2002.
3. Gowri Shankar Sand Veena A,"Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.

REFERENCES:
1. Noel Kalicharan,"Learn to Program with C",A press Inc.,2015,1stedition.
2. Steve Oualline,"Practical C programming",O'Reilly Media,1997,3rdedition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, 'The 8051 Microcontroller and EmbeddedSystems' Prentice Hall, 2nd Edition 2007.
4. Myke Predko, "Programming and customizing the 8051 microcontrollers",McGraww Hill 2000, 1st edition.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITES:
- https://www.hackerrank.com/
- https://www.cprogramming.com/
- https://onlinecourses.nptel.ac.in/noc19_cs42/preview

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

- https://microcontrollerslab.com/8051-microcontroller-tutorials-c/
- https://www.circuitstoday.com/getting-started-with-keil-uvision

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1(	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO2	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO3	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO4	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO5	2	3	3	3	3	-	-	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	-	-	3	2	-	2	2	3	3

24EE3020 **EMBEDDED PROCESSORS** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To apply the concepts of ARM architecture to analyze processor operations.
- To develop and test programs using ARM and Thumb instruction sets on ARM microcontrollers.
- To interface and configure ARM peripherals for embedded applications.
- To analyze the operation of ARM communication protocols in real-time data exchange.
- To apply Raspberry Pi architecture and Python programming to design and interface peripheral-based embedded systems.

UNIT I ARM ARCHITECTURE 6

Architecture – Memory Organization– addressing modes-Registers–Pipeline -Interrupts–Coprocessors – Interrupt Structure.

UNIT II ARM MICROCONTROLLER PROGRAMMING 6

ARM general Instruction set–Thumb instruction set –Introduction to DSP on ARM- basic programming.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

UNIT III PERIPHERALS OF ARM 6

ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC– ADC/DAC Interfacing-stepper motor interfacing

UNIT IV ARM COMMUNICATION 6

ARM With CAN, I2C, and SPI protocols.

UNIT V INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR 6

Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Laboratory exercise:

a. Programming with IDE-ARM microcontroller
b. Advanced Timer Features, PWM Generator.
c. RTC interfacing with ARM using Serial communication programming, Stepper motor control.
d. ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.

2. Seminar:

a. ARM and GSM/GPS interfacing
b. Introduction to ARM Cortex Processor

3. Raspberry Pi based Mini project.

TOTAL: 30 PERIODS
TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the concepts of ARM architecture, memory organization, addressing modes, and interrupt mechanisms to understand processor functionality.

CO2: Develop embedded programs using ARM and Thumb instruction sets and perform basic DSP operations on ARM-based platforms.

CO3: Implement interfacing of ARM peripherals such as EEPROM, SRAM, timers, UART, ADC/DAC, and stepper motors for real-time applications.

CO4: Analyze the operation and performance of communication protocols like CAN, I2C, and SPI in ARM-based communication systems.

CO5: Apply Raspberry Pi architecture and Python programming to design embedded systems that interact with sensors and external peripherals.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

TEXT BOOKS:

1. Steve Furber,‘ARM system on chip architecture’,Addison-Wesley,2nd Edition,2015.
2. Andrew N.Sloss, Dominic Symes,Chris Wright,John Ray field’s ARM System Developer’s Guide Designing and Optimizing System Software’, Elsevier 2004, 1st Edition.

REFERENCES:

1. William Hohl, ‘ARM Assembly Language ’Fundamentals and Techniques, CRC Press, 2nd Edition 2014.
2. Raj Kamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.
3. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors.
4. ARM System Developer’s Guide: Designing and Optimizing System Software 1st Edition (Designing and Optimizing System Software) Publisher: Morgan Kaufmann Publishers, 2011.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITES:

1. https://nptel.ac.in/courses/117106111
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarch.pdf
4. https://maxembedded.com/2013/07/introduction-to-single-board-computing/
5. https://www.youtube.com/watch?v=J4fhE4Pp55E&list=PLGs0VKk2DiYypuwUUM2wxzcI9BJHK4Bfh

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO2	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO3	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO4	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO5	2	3	3	3	3	-	-	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	-	-	3	2	-	2	2	3	3

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24EE3021 EMBEDDED CONTROL FOR ELECTRIC DRIVES **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To apply the basic concepts and classifications of electrical drives to analyze their operation in modern systems.
- To apply embedded processors, sensors, and IoT modules for motor control in electrical drive applications.
- To analyze speed control methods and PWM techniques for induction motors using embedded controllers.
- To apply and analyze speed control techniques for BLDC motors using PWM and embedded processors.
- To apply PWM-based speed control methods and analyze the performance of SRM motors using embedded processor implementations.

UNIT I INTRODUCTION TO ELECTRIC DRIVES **6**

Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives

UNIT II EMBEDDED SYSTEM FOR MOTOR CONTROL **6**

Embedded Processors choice for motor control-Sensors and interface modules for Electric drives- IoT for Electrical drives applications

UNIT III INDUCTION MOTOR CONTROL **6**

Speed control methods-PWM techniques-VSI fed three-phase induction motor-Fuzzy logic Based speed control for three-phase induction motor-Embedded processor based three phase induction motor speed control.

UNIT IV BLDC AND SRM MOTOR CONTROL **6**

Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.Stepper motor interfacing Overview of SRM Motor-Speed control methods-PWM techniques-Embedded processor based SRM motor speed control.

UNIT V MACHINE LEARNING AND OPTIMIZATION **6**

Introduction to Machine learning and optimization techniques for electrical drives.

TOTAL: 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

LAB COMPONENT:

1. Laboratory exercise:Use any System level simulator / MATLAB / open source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phase inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
2. Seminar:IoT-based Control and Monitoring for DC Motor/any Electric drives.
3. Miniproject.:Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Apply the basic concepts and classifications of electrical drives to understand and analyze their operation in different applications.

CO2: Apply embedded processors, sensors, and IoT modules for controlling various types of electric drives.

CO3: Analyze different speed control methods and PWM techniques for induction motors using embedded controllers.

CO4: Apply and analyze PWM-based speed control techniques for BLDC motors using embedded processors.

CO5: Apply embedded processor techniques and analyze PWM-based speed control of SRM motors.

TEXT BOOKS:

1. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control" ,Prentice-Hall of India Pvt. Ltd.,New Delhi,2010, 1st Edition.
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization"Willey, 2007, 1st Edition.

REFERENCES:

1. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata Mc Graw-Hill publishing company Ltd., New Delhi, 2002 , 2nd Edition.
2. K.Venkataratnam, Special Electrical Machines, Universities Press, 2014, 1st Edition.
3. Steve Furber,'ARM system on chip architecture', Addision Wesley, 2nd Edition 2015.
4. Ron Sass and Andrew G.Schmidt, "Embedded System design with platform FPGAs: Principles and Practices", Elsevier, 2010, 1st Edition.
5. Tim Wescott, Applied Control Theory for Embedded Systems, Elsevier, 2006 ,1st Edition.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITES:

1) https://archive.nptel.ac.in/courses/108/104/108104140/

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

2) https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/
3) https://www.e3sconferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf
4) https://www.electronics-tutorials.ws/blog/pulse-width-modulation.html
5) http://kaliasgoldmedal.yolasite.com/resources/SEM/SRM.pdf

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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CO3	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO4	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO5	2	3	3	3	3	-	-	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	-	-	3	2	-	2	2	3	3

24EE3022 EMBEDDED AND LINUX SYSTEM PROGRAMMING **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To Apply essential C programming concepts, pointer operations, dynamic memory, and data structures to develop embedded software modules
- To Apply knowledge of processor specifications, peripheral interfaces (I2C, SPI, UART, GPIO), and vendor BSPs to build microcontroller-based applications.
- To Analyze the interactions between user space and kernel space, evaluating process behavior during creation, execution, and termination.
- To Analyze IPC performance and reliability by comparing different methods under various system constraints.
- To Apply multithreading techniques, synchronization primitives (mutexes, semaphores), timers, and file operations to develop concurrent applications.

UNIT I FUNDAMENTALS OF EMBEDDED C PROGRAMMING 6

Introduction to Embedded C – Differences between C and Embedded C – Data types and variables used in embedded systems – Operators and simple expressions – Basic input/output operations in Embedded C – Control statements (if, switch, loops) – Functions and modular programming – Arrays and simple pointer concepts – Using structures for grouping data – Writing delay routines in Embedded C – Basics of debugging using print statements.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT II MICROCONTROLLER PROGRAMMING 6

Understand Processor specifications – RAM, ROM, Flash; Understand peripheral interfaces – I2C, SPI, GPIO, UART; Interfacing external sensors; C Microcontroller Programming with vendor provided BSPs, IDEs, Libraries; GPIO Programming, Timer Programming, Handling Interrupts

UNIT III LINUX SYSTEM PROGRAMMING 6

Introduction - System Programming Concepts – User Space, Kernel Space, Basic Commands; Process – Creation, Monitoring and Termination; Threads – Creation, Monitoring and Termination; Linux Scripting; Shared & Static Libraries; Vim, Build & Makefiles

UNIT IV INTER PROCESS COMMUNICATION 6

Inter Process Communications – Shared Memory, Message Queues, Pipes, Signals, Sockets

UNIT V MULTI-THREADED PROGRAMMING 6

Multi-processes, Multi-threading, Synchronization Mechanisms – Semaphores & Mutex, File Operations, Timers, Time API, Process management – Scheduling, Priorities, Affinity, Real Time Process

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Laboratory exercise:

a. Programs to understand the process handling in Linux C.
b. Programs to understand the Message Queues in Linux C
c. Programs to understand the various clock configurations.
d.Programs to understand the timer configurations and event handlers.
e.Programs to understand the file management in Linux C.
f. Programs to understand the threads and mutex in Linux C.

3. Linux C based Mini project.

TOTAL: 30 PERIODS
TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Implement embedded programs using control structures, functions, arrays, pointers, and structures suitable for microcontroller applications.
CO2: Develop microcontroller applications involving memory components, GPIO, timers, UART, I2C, SPI, and sensor interfaces.
CO3: Construct system programs using Linux processes, threads, system calls, shell scripting,

and build tools.
CO4: Compare and interpret the effectiveness of different IPC methods under varied communication needs.
CO5: Assess scheduling strategies, priority settings, processor affinity, and real-time constraints to optimize system responsiveness

TEXT BOOKS:
1.Brian W. Kernighan, Dennis M. Ritchie, The C Language Programming, Prentice Hall Software Series,1998.
2. Mark Mitchell, Jeffrey Oldham, and Alex Samuel, Advanced Linux Programming, New Riders Publishing, 2001

REFERENCES:
1. Simon Monk, Programming Arduino: Getting Started with Sketches, Tata McGraw Hill, Second Edition
2. Kirk Zurell, Sofie Beerens, C Programming For Embedded Systems, CRC Press (March 1, 2000); eBook (R&D Books)
3. Richard Reese, Understanding and Using C Pointers, Orielly,2013
4. Robert Love, Linux System Programming, O'Reilly Media, 2007
5. Israel Gbati, Georgios Papanikolaou, Bare-Metal Embedded C Programming, Packt publishers, 2024

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO2	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO3	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO4	2	2	1	3	3	-	-	-	3	1	-	2	2	3	3
CO5	2	3	3	3	3	-	-	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	-	-	3	2	-	2	2	3	3

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24EE3023 SMART SYSTEM AUTOMATION **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To apply basic smart system concepts by choosing suitable hardware, software, sensors, and communication methods.
- To analyze home automation systems by studying their architecture, components, and design needs like sensing and security
- To apply smart appliances and smart meter techniques for better energy use and management.
- To analyze wearable device technologies, including sensors and communication methods, for health and activity monitoring.
- To apply and analyze embedded system concepts in simple robotic designs such as pick-and-place robots, mobile robots, and UAVs.

UNIT I INTRODUCTION 6

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

UNIT II HOME AUTOMATION 6

Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 6

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.

UNIT IV SMART WEARABLE DEVICES 6

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

UNIT V EMBEDDED SYSTEMS AND ROBOTICS 6

Introduction to ROS (Robot Operating System) - Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

TOTAL: 30 PERIOD

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

LAB COMPONENT:

1. Laboratory exercise: Use Arduino/ R pi/ any other Embedded processors to give hands on training to understand concepts related to smart automation.

a. Hands on experiments based on Ubidots & Thing speak / Open-source Analytics Platform

b. Design and implementation of a smart home system .

c. Bluetooth Based Home Automation Project using Android Phone

d. GSM Based Home Devices Control

e. Pick and place robots using Arduino/ any suitable Embedded processor

2. Assignment: Revolution of Smart Automation system across the world and its current scope available in India

3. Mini project: Design of a Smart Automation system (for any application of students choice)

TOTAL: 30 PERIOD

TOTAL: 30 +30 PERIOD

COURSE OUTCOMES:

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

CO1: Apply the principles of smart system design by selecting appropriate hardware, software, sensors, and communication methods for different applications.

CO2: Analyze home automation setups by evaluating system architecture, key components, sensing needs, and data security aspects.

CO3: Apply smart appliance technologies and smart meter functions to support effective energy monitoring and management.

CO4: Analyze the operation of wearable devices, including their sensors and communication protocols, for healthcare and activity-based applications.

CO5: IApply and analyze embedded system concepts in developing basic robotic models such as pick-and-place robots, mobile robots, and UAVs.

TEXTBOOKS:

1. Nilanjan Dey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016, 1st Edition.

2. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition.

3. Kazem Shoraby, Daniel Minoli and Taiebnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.

REFERENCES:

1. Karim Yaghmour, Embedded Android, O'Reilly, 2013.

2. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress , 2013.

3. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

4. Thomas Bräunl, Embedded Robotics, Springer, 2003.
5. C.K. Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO2	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO3	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO4	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO5	2	3	3	3	3	-	3	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	3	-	3	2	2	2	2	3	3

24EE3024 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS L T P C
2 0 2 3

COURSE OBJECTIVES:

- To apply the basic concepts of automotive systems to analyze factors such as fuel economy, air–fuel ratio, emissions, and vehicle performance.
- To apply knowledge of automotive sensors and actuators and analyze how they interact with the ECU in a vehicle.
- To analyze the functioning of major vehicle management systems like energy management, cruise control, ABS, and safety systems.
- To apply basic on board diagnostic methods and analyze automotive communication protocols like Bluetooth, CAN, and LIN.
- To apply and analyze recent automotive technologies such as navigation systems, autonomous driving, and IoT-based vehicle systems.

UNIT I INTRODUCTION TO AUTOMOTIVE SYSTEMS 6

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.

UNIT II SENSORS AND ACTUATORS FOR AUTOMOTIVES 6

Review of automotive sensors- sensors interface to the ECU,Smart sensor and actuators for automotive applications.

UNIT III VEHICLE MANAGEMENT SYSTEMS 6

Energy Management system-Adaptive cruise control-anti-locking braking system- Safety and Collision Avoidance

UNIT IV ONBOARD DIAGNOSTICS AND COMMUNICATION 6

OBD,Vehicle communication protocols-Bluetooth, CAN,LIN, FLEX RAY and MOST.

UNIT V RECENT TRENDS 6

Navigation-Autonomous car-Role of IoT in Automotive systems-Cyber security in Connected Vehicles – AI-based Predictive Maintenance.

TOTAL: 30 PERIOD

LAB COMPONENT:

1.Laboratory exercise: Use MATLAB SIMULINK / equivalent simulation /opensource tools

a) Simulation study of automotive sensors and actuators components

b) Adaptive cruise control, Anti-Lock Braking System

c) CAN Connectivity in an Automotive Application using vehicle network tool box

d) Interfacing a sensor used in a car with a microcontroller.

e) Establishing connection between Bluetooth module and microcontroller.

2. Assignment: AUTO SAR

3. Miniproject: Battery Management system for EV batteries.

TOTAL: 30 PERIOD

TOTAL: 30 +30 PERIOD

COURSE OUTCOMES:

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

CO1: Apply the fundamentals of automotive systems to evaluate fuel economy, emission limits and vehicle performance.

CO2: Implement appropriate sensors and actuators by interfacing them with the ECU for basic automotive functions.

CO3: Analyze the operation of vehicle management systems such as ABS, adaptive cruise control and collision avoidance.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

CO4: Apply onboard diagnostics and communication protocols to identify and interpret vehicle faults.
CO5: Analyze recent trends such as autonomous driving, IoT integration and cybersecurity challenges in modern automotive systems.

TEXT BOOKS:

1. William B. Ribbens,"Understanding Automotive Electronics", Elsevier, 8th Edition, 2017.
2. L.Vlacic, M.Parent, F.Harahima," Intelligent Vehicle Technologies",SAE International, 2001, 1stEdition, 2017.
3. Jurgen,R. ,Automotive Electronics HandBook, McGraw Hill, 2nd Edition, 1999.

REFERENCES:

1. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec, Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage ,2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford 2nd Edition, 2004.
4. Automotive Electricals/ Electronics System and Components,Tom Denton,5thEdition,2017.
5. Uwe Kiencke, Lars Nielsen,"Automotive Control Systems: For Engine, Drive line, and Vehicle", Springer; 1stEdition, 2005.

LIST OF OPEN SOURCE SOFTWARE / LEARNING WEBSITES:

1) https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2) https://microcontrollerslab.com/can-communication-protocol/
3) https://ackodrive.com/car-guide/different-types-of-car-sensors/
4) https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
5) https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6) https://www.synopsys.com/automotive/what-is-autonomous-car.html

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO2	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO3	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO4	2	2	1	3	3	-	3	-	3	2	3	3	2	3	3
CO5	2	3	3	3	3	-	3	-	3	2	3	3	2	3	3
Avg	2	2	2	3	3	-	3	-	3	2	2	2	2	3	3

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

VERTICAL IV: ELECTRIC VEHICLE TECHNOLOGY

24EE3025	**ELECTRIC VEHICLE ARCHITECTURE**	**L T P C**
		2 0 2 3

COURSE OBJECTIVES:

- To Understand evolution and architectures of electric vehicles.
- To Learn vehicle mechanics, forces, motion, and propulsion concepts.
- To know about the details and specifications for Electric Vehicles.
- To Understand hybrid vehicle supervisory and control strategies.
- To Study construction, working and charging of PHEVs.

UNIT I VEHICLE ARCHITECTURE AND SIZING 6

Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Case studies of EV architectures in two-wheelers, Electric cars and heavy-duty EVs-details and specification.

UNIT II VEHICLE MECHANICS 6

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT III POWER COMPONENTS AND BRAKES 6

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

UNIT IV HYBRID VEHICLE CONTROL STRATEGY 6

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

UNIT V PLUG-IN HYBRID ELECTRIC VEHICLE 6

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

TOTAL: 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

LAB COMPONENT:

1. Simulation to Compare Series and Parallel Hybrid Electric Vehicle Architectures
2. Simulation for Motor and Battery Sizing in Electric Vehicles
3. Simulation of Longitudinal Vehicle Dynamics During Acceleration and Braking
4. Simulation to Analyze Regenerative Braking and Energy Recovery in EVs
5. Simulation to Examine Charging Behavior and Grid Load Profile of PHEVs

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Differentiate various EV architectures with their applications.

CO2: Analyze vehicle dynamics and propulsion power requirements.

CO3: Perform EV/HEV powertrain sizing using engineering concepts.

CO4: Apply suitable hybrid control strategies for energy management.

CO5: Explain PHEV components, operation, charging and advantages.

TEXT BOOKS:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 3rd edition 2018

REFERENCES:

1. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, Third Edition 2013.

2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.

3. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.

4. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021

5. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020

6. Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles, Rogelio León , Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, Thermo, 2021, 1, 134–150. https://doi.org/10.3390/thermo1020010.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO2	3	-	2	-	-	-	-	1	-	-	-	2	3	3	3
CO3	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO4	3	-	2	-	-	-	-	1	-	-	-	2	3	-	-
CO5	3	3	3	3	3	-	-	1	-	-	-	2	3	3	3
Avg	3	3	2	3	3	–	–	1	–	–	–	2	3	3	3

24EE3026 FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the fundamentals of electric and hybrid vehicles.
- To gain an understanding of the working principles of electric propulsion systems
- To understand the energy storage techniques used in electric and hybrid vehicles.
- To understand the concept of the regenerative braking system.
- To gain knowledge about the concept and working of fuel cell vehicles.

UNIT I ELECTRIC VEHICLES 9

Introduction - Configurations of Electric Vehicles, Performance of electric vehicles – Traction motor characteristics, -tractive effort, transmission requirements, vehicle performance, Tractive Effort in Normal Driving, energy-consumption, advantage and limitations-Autonomous Vehicles.
Activities : Study on the role of electric vehicles in autonomous mobility and presentation on EV– Autonomous vehicle integration

UNIT II HYBRID ELECTRIC VEHICLES 9

Introduction - Need for HEV - Architectures of Hybrid Electric Drive Trains- Series Hybrid Electric Drive Trains- Parallel Hybrid Electric Drive Trains - Torque coupling, speed coupling and both – Electric and hybrid vehicles- comparison.
Activities : Team presentation comparing electric and hybrid vehicles with respect to architecture, efficiency, cost, energy management and operational advantages

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

UNIT III ELECTRIC PROPULSION SYSTEMS 9

DC motor drives- Principle of Operation and Performance- induction motor drives- Basic Operation Principles & Steady-State Performance - Permanent magnetic BLDC motor drives - Basic Principles & Construction and Classification - switched reluctance motor drives - Basic Magnetic Structure, Torque Production, SRM Drive Converter, Modes of Operation.
Activities : Investigation write up of current trends and technological advancements in electric propulsion motors and their application in modern EVs and HEVs

UNIT IV ENERGY STORAGES AND REGENERATIVE BRAKING 9

Basics of Electrochemical batteries - Ultra-capacitors- Ultra High-Speed Flywheels - Regenerative braking - Braking energy consumed in urban driving – braking energy vs vehicle speed, braking power, vehicle speed, vehicle deceleration rate – braking energy on front and rear axles – brake system of EV, HEV and FCV
Activities : Demonstration of energy storage devices (battery, ultra-capacitor, flywheel) and observation of energy recovery during regenerative braking using simulation

UNIT V FUEL CELLS 9

Principles of Fuel Cells-Fuel Cell Technologies- Proton Exchange Membrane, Alkaline, Phosphoric Acid, Molten Carbonate, Solid Oxide, Direct Methanol fuel cells - Fuel Supply-Hydrogen Storage, Hydrogen Production.
Activities: Design a fuel cell-based energy system for a small vehicle by selecting appropriate fuel cell type and hydrogen storage method

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Explain the configurations and performance characteristics of electric vehicles.
CO2: Identify and categorize hybrid electric vehicles and their significance.
CO3: Evaluate various types of electric propulsion systems.
CO4: Compare different energy storage systems and regenerative braking concepts.
CO5: Describe the working principles and relevance of fuel cell technologies.

TEXT BOOKS:
1. Mehrdad Ehsani, Yimin Gao, Stefano Longo Kambiz M. Ebrahimi, “Modern Electric, Hybrid

Electric, and Fuel Cell Vehicles", 3rd Edition, CRS Press, 2018

REFERENCES:

1. Iqbal Husain "Electric and Hybrid Vehicles: Design Fundamentals" 3rd Edition CRC Press, 2021
2. SerefSoylu "Electric Vehicles - The Benefits and Barriers" InTech Publishers, Croatia, 2011.
3. AuliceScibioh M. and Viswanathan B "Fuel Cells – Principles and Applications" University Press,India, 2008.
4. Barbir F "PEM Fuel Cells: Theory and Practice" Academic Press, Cambridge, 2012.
5. James Larminie and John Loury "Electric Vehicle Technology-Explained" John Wiley & Sons Ltd.,2nd Edition, 2012.

MAPPING OF COs with POs and PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	1	-	1	1	-	1	3	2	1
CO2	3	2	2	2	2	-	1	1	1	1	-	1	3	1	1
CO3	3	3	3	2	2	-	1	1	2	1	-	1	3	2	1
CO4	3	2	2	2	2	-	2	1	1	1	-	1	3	2	1
CO5	3	2	2	2	2	-	2	1	1	1	-	1	3	1	2
Avg	3	2	2	2	2	-	1	1	1	1	-	1	3	2	1

24EE3027 ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL L T P C
2 0 2 3

COURSE OBJECTIVES:

- To understand the fundamentals of electric vehicles and vehicle mechanics
- To gain knowledge of electric vehicle architecture
- To explore concepts related to energy storage systems
- To develop battery models and learn about different battery types and their charging methods
- To learn the basic control principles for DC-DC converters

UNIT I INTERNAL COMBUSTION ENGINES 6

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT II ELECTRIC VEHICLES AND VEHICLE MECHANICS 6

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT III BATTERY MODELING, TYPES AND CHARGING 6

Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT IV CONTROL PRELIMINARIES 6

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

UNIT V CONTROL OF AC MACHINES 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Develop a model that could estimate Soc and SoH of Li-Ion Battery.
2. Modelling and thermal analysis of Li-Ion Battery.
3. Simulation of boost converter and calculating gain and phase margin from the transfer function.
4. Simulation of vector control of induction motor

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

COURSE OUTCOMES:

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

CO1: Explain the concepts of EV and HEV, and compare them with internal combustion engine vehicles.

CO2: Determine the gain margin and phase margin for different transfer functions of a boost converter.

CO3: Demonstrate the control of AC machines.

CO4: Describe the concepts related to batteries and their key parameters.

CO5: Explain PHEV components, operation, charging and advantages.

TEXT BOOKS:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.

REFERENCES:

1. Power Electronic Converters: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH.
2. Ali Emadi, Mehrdad Ehsani, John M.Miller, “Vehicular Electric Power Systems”, Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
3. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.
4. Wie Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, John Wiley & Sons, 2017, 2nd Edition.
5. Dynamic Simulation of Electric Machinery using MATLAB, Chee Mun Ong, Prentice Hall,1997, 1st Edition.
6. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley, 2021, 1st Edition.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	–	1	2	–	2	3	–	3
CO2	3	3	2	–	–	–	–	–	1	3	–	2	3	–	3
CO3	3	2	2	–	2	–	2	–	1	2	–	2	3	–	3
CO4	3	2	2	2	2	–	2	–	1	2	–	2	3	2	3
CO5	3	2	3	2	–	–	2	–	1	2	–	2	3	2	3
Avg	3	2	2	1	1	0	1	0	1	2	0	2	3	1	3

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24EE3028 DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

L T P C
2 0 2 3

COURSE OBJECTIVES:

- To study various electric vehicle drive cycles and understand their performance requirements.
- To gain knowledge of the operating principles of motors used in electric vehicles.
- To analyze and model the operation of buck and boost converters, and to design them effectively.
- To learn the fundamentals of control system simulation.
- To derive the transfer functions for different DC–DC converters.

UNIT I ELECTRIC VEHICLE DYNAMICS 6

Standard drive cycles-Dynamics of Electric Vehicles-Tractive Force-Maximum speed, torque, power, energy requirements of EVs.

UNIT II MOTORS FOR ELECTRIC VEHICLES 6

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Choice of electric machines for EVs.

UNIT III BASICS OF SIMULATION IN CONTROL SYSTEMS 6

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, basic bode plot for control system, state space modelling-transfer function from state space Model.

UNIT IV MODELING OF DC-DC CONVERTERS 6

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling - Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 6

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simple simulation exercises of basic control systems
2. Bode plots and calculation of Gain margin and Phase margin for power stage transfer function via simulation.
3. Design of buck converter
4. Design of boost converter
5. Simulation of buck, boost and buck boost converter-open loop (With power circuit and Transfer function).

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Identify and select a suitable electric machine for electric vehicle applications.

CO2: Calculate transfer functions involving constants, integral and differential terms, and first- and second-order factors in both numerator and denominator.

CO3: Determine transfer functions from state-space models.

CO4: Compute power stage transfer functions for various DC–DC converters.

CO5: Simulate DC–DC converters and analyze gain margin and phase margin.

TEXT BOOKS:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

REFERENCES:

1. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications

2. Feedback Control problems using MATLAB and the Control system tool box, Dean Frederick and Joe Cho, 2000, 1st Edition, Cengage learning.

3. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.

4. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.

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5. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.
6. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Second Edition” CRC Press, Taylor & Francis Group, Third Edition 2021.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	-	-	-	-	1	-	3	-	3	3	-	1
CO2	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3
CO3	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3
CO4	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3
CO5	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3
Avg	3	3	3	3	3	-	-	1	-	3	-	3	3	3	3

24EE3029 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM L T P C
2 0 2 3

COURSE OBJECTIVES:

- To gain awareness of various EV charging stations and their standards
- To study the role and operation of power converters in EV charging systems
- To analyze renewable-energy-integrated EV charging methods
- To illustrate the working principle of wireless power transfer for EV charging
- To develop and simulate circuits for power factor correction.

UNIT I CHARGING STATIONS AND STANDARDS 6

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations

UNIT II POWER ELECTRONICS FOR EV CHARGING 6

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT III EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS 6

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

UNIT IV WIRELESS POWER TRANSFER 6

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

UNIT V POWER FACTOR CORRECTION IN CHARGING SYSTEM 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Simulation and analysis for bi-directional charging V2G and G2V.
2. Design and demonstrate solar PV based EV charging stations.
3. Simulate and infer wireless power charging station for EV charging.
4. Simulation of boost converter based power factor correction

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Explain different EV charging techniques and understand the related standards and

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regulations.

CO2: Demonstrate the operation and principles of DC–DC converters used in EV charging systems.

CO3: Highlight the benefits of renewable-energy-based EV charging systems.

CO4: Demonstrate the working principles of wireless power transfer and interpret standards associated with wireless charging.

CO5: Simulate DC–DC converters and analyze gain margin and phase margin.

TEXT BOOKS:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.

REFERENCES:

1. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher 1st Edition. 2020.

2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles, Modern Technologies and Trends. Springer Publisher 1st Edition, 2021.

3. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1st Edition.

4. Electric and Hybrid Electric Vehicles, James D Halderman, Pearson, 2022, 1st Edition.

5. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	2	2	-	3	-	3	3	--	-
CO2	3	3	3	3	-	-	2	2	-	3	-	3	3	3	3
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	-	-	2	2	-	2	-	1	3	3	3
CO5	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
Avg	3	3	3	3	3	-	2	2	-	3	-	2	3	3	3

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24EE3030 TESTING OF ELECTRIC VEHICLES

		L T P C
		2 0 2 3

COURSE OBJECTIVES:

- To understand the different standardization procedures
- To learn the testing procedures for EV and HEV components
- To gain knowledge of functional safety and EMC
- To examine the impact of EMC on electric vehicles
- To study the influence of EMI on motor drives and DC–DC converter systems.

UNIT I EV STANDARDIZATION 6

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

UNIT II TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 6

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT III FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 6

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

UNIT IV EMC IN ELECTRIC VEHICLES 6

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

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UNIT V EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 6

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

TOTAL: 30 PERIODS

LAB COMPONENT:

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

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the current status and key aspects of EV standardization.

CO2: Outline and demonstrate the testing procedures for EV and HEV components.

CO3: Examine the safety lifecycle and the importance of functional safety in EVs.

CO4: Analyze EMC-related challenges in EV components.

CO5: Assess the impact of EMI on motor drives and DC–DC converter systems.

TEXT BOOKS:

1. Electromagnetic Compatibility of Electric Vehicles, Li Zhai, Springer 2021, 1st Edition.

REFERENCES:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.

2. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.

3. EMI/EMC Computational Modeling Handbook, Druce Archam beault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.

4. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.

5. Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

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MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	-	2	2	-	3	-	3	3	--	2
CO2	3	1	1	-	-	-	1	2	-	3	-	3	3	3	2
CO3	3	1	1	-	-	-	2	-	-	-	-	-	3	3	2
CO4	3	1	1	-	-	-	1	2	-	3	-	1	3	3	2
CO5	3	1	1	-	-	-	2	-	-	-	-	-	3	3	3
Avg	**3**	**1**	**1**	-	-	-	**2**	**2**	-	**3**	-	**2**	**3**	**3**	**2**

24EE3031 MODELING, SIMULATION AND CONTROL OF ELECTRIC VEHICLES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To study modeling of electrical and mechanical systems.
- To understand modeling of electric motors and drives.
- To learn modeling of power converters and batteries.
- To study control techniques for electric drives.
- To understand energy management strategies in HEVs and EVs.

UNIT I SYSTEM MODELLING AND REPRESENTATION 9

System concepts- Transfer function Modeling of Electrical systems, Mechanical systems (Translational & Rotational systems)- Electrical Analogy of Mechanical Systems – Park and Clark transformation.

Activities: Prepare a table comparison between electrical and mechanical system modelling

UNIT II MODELLING OF ELECTRIC MOTORS 9

Modelling of DC motor- Modelling of Induction motor- Modelling of PMSM- Modelling of BLDC motor

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Activities: Prepare a PPT explaining the modelling of any one motor

UNIT III MODELLING OF POWER CONVERTERS AND BATTERY 9

Modelling of Buck converter- Modelling of Boost converter- Modelling of Inverter-Modelling of Bidirectional DC- DC converter- Battery Parameters-Modelling of Lithium ion battery
Activities: Draw a mind Map for Battery Parameters and its Characteristics

UNIT IV CONTROL OF ELECTRIC DRIVES 9

Scalar control-Field oriented control technique- Direct Torque based control technique-Speed Control of BLDC Motor

Activities: Any one control Strategy Implementation using MATLAB/Simulink

UNIT V CONTROL SYSTEM FOR HYBRID AND ELECTRIC VEHICLE 9

Function of the Control System in HEVs and EVs-Energy Management Strategies-Rule and Optimization based Energy management Strategies-EMS based on deterministic Rules
Activities: Prepare a case study of EMS used in Toyota Prius / Tesla / Hybrid buses

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Develop mathematical models of electrical and mechanical systems
CO2: Explain the Modelling of Electric Motors used in Hybrid and Electric vehicle.
CO3: Explicate the Modelling of Power Converters and Battery used in Hybrid and Electric vehicle
CO4: Narrate on controlling of Electric Drives
CO5: Develop Energy Management rules to control Hybrid and Electric vehicle

TEXT BOOK:
1. SerefSoylu, "Electric Vehicles: Modelling and Simulations" , InTech Publications, 2011
2. Wei Liu, "Hybrid Electric Vehicle System Modelling and Control", Second Edition, Wiley Publications, 2017
3. Gopal M, "Control Systems – Principles and Design, Tata McGraw-Hill, New Delhi, 2013

REFERENCES:
1. Krishnan R., " Electric Motor & Drives: Modelling, Analysis and Control", Pearson Education, 2015

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MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	–	–	–	–	–	–	1	2	3	1
CO2	3	3	2	2	2	–	–	–	–	–	–	1	3	2	1
CO3	3	3	3	2	3	–	1	–	–	–	–	1	3	3	2
CO4	2	3	3	2	3	–	–	–	–	–	–	2	3	2	2
CO5	2	3	3	2	2	1	3	–	1	1	1	2	3	2	3
Avg	3	3	3	2	2	1	2	–	1	1	1	1	3	2	2

24EE3032 GRID INTEGRATION OF ELECTRIC VEHICLES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts and current status of Vehicle-to-Grid (V2G).
- To study the benefits and applications of V2G in power and energy markets.
- To analyze the technical, economic, and regulatory challenges of V2G systems.
- To learn the impact of EVs and V2G on smart grids and renewable energy integration.
- To understand grid integration, communication, and management of electric vehicles.

UNIT I DEFINITION And STATUS Of V2G **9**

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice , V2G - Power Markets and Applications. Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G.

Activities: Prepare a Comprehensive Mind Map of V2G Concepts

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UNIT II BENEFITS AND CHALLENGES OF V2G 9

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.
Activities: Simulation of Battery Charging–Discharging for V2G Operation

UNIT III CHALLENGES TO V2G 9

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues , EV Costs and Benefits , Adding V2G Costs and Benefits , Additional V2G Costs , The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G , V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges.
Activities: Comparison analysis of Technical, Economic, and Regulatory Challenges in Vehicle-to-Grid (V2G) Systems

UNIT IV IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS 9

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.
Activities: Prepare a flowchart illustrating the evolution of electric vehicles.

UNIT V GRID INTEGRATION AND MANAGEMENT OF EVS 9

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

Activities: Prepare a powerpoint presentation on Machine-to-Machine (M2M) communication for electric vehicles and distributed energy management.

TOTAL: 45 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

COURSE OUTCOMES:

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

CO1: Explain the concepts related with V2G

CO2: Study the grid connection of 3 phase Q inverter

CO3: Explain the Technical, Economic, and Regulatory Challenges of Vehicle-to-Grid (V2G)

CO4: Demonstrate the impact of EV and V2G on smart grid and renewable energy system

CO5: Explain the concept of grid integration and management of EVs.

TEXT BOOK:

1.Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.

2.Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnia and Arindam Ghosh,Springer,2015, 1st Edition.

REFERENCES:

1. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor [1;] Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
2. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
3. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicle-to-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	–	–	–	–	–	2	1	–	2	–	–	3	3	1
CO2	3	3	–	–	3	–	2	1	–	3	–	–	3	–	–
CO3	3	–	–	–	–	–	2	1	–	2	–	–	3	–	–
CO4	3	–	–	–	–	–	2	1	–	2	–	–	3	–	2
CO5	3	–	–	–	–	–	2	1	–	2	–	–	3	–	3
Avg	3	3	–	–	3	–	2	1	–	2	–	–	3	3	1

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

VERTICAL V - CONTROL SYSTEMS & SENSORS TECHNOLOGY

24EE3033 DIGITAL MEASUREMENTS AND INSTRUMENTATION **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Digital methods of measurements – Current, Voltage and Time measurements.
- Working principle of signal generators.
- Working principle of various signal analyzers.
- Concepts of digital display units and recording devices.
- Concepts of PC based data acquisition system

UNIT I DIGITAL METHODS OF MEASUREMENTS 9

Digital voltmeters and multimeters – Automation and accuracy of digital voltmeters and multimeters – Digital phase meters – Digital tachometers – Digital frequency, period and time measurements – Low frequency measurements – Automatic time and frequency scaling.
Activities: Visually recognize and match instrument types with the physical quantity they measure.

UNIT II SIGNAL GENERATORS 9

Signal Generators: AF, RF Signal Generators, Sweep Frequency Generators, Pulse and Square wave Generators, Function Generators, Arbitrary Waveform Generator and Specifications.
Activities: Characterize different complex signals required for testing electronic systems.

UNIT III SIGNAL ANALYZERS 9

AF, HF Wave Analyzers, Harmonic Distortion, Heterodyne wave Analyzers, Spectrum Analyzers, Power Analyzers, Capacitance-Voltage Meters, Oscillators.
Activities: Demonstrating harmonic distortion analysis with any one example.

UNIT IV DIGITAL TRANSDUCERS, DISPLAY & RECORDING DEVICES 9

Digital Transducers: Shaft Encoders- Optical encoder- Sliding contact encoder- Magnetic encoder- Proximity sensor encoder- Incremental Optical Encoders- Absolute Optical Encoders-Digital storage oscilloscopes – Digital printers and plotters –LCD and LED display.
Activities: Implementation of LED/LCD display.

UNIT V DIGITAL DATA ACQUISITION SYSTEM 9

Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE-488 GPIB Bus.

Activities: Basic computer-controlled system and understand the data flow chain.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understands working of various digital meters for measurements of current, voltage and time.

CO2: Explicate the working of various signal and wave generators.

CO3: Explain the working of various signal and wave analyzers.

CO4: Choose suitable digital transducers, display and recording devices for modern electronic systems.

CO5: Design a suitable PC based data acquisition system for accurate measurement of physical quantities.

TEXT BOOKS:

1. Doebelin, 'Measurement System, Application & Design', IV Ed, McGraw-Hill, Fifth Edition, 2018.
2. Modern Electronics Instrumentation & Measurement Techniques, by Albert D.Helstrick and William D.Cooper, Pearson Education, 2016.
3. Bouwens, A.J., "Digital Instrumentation", McGraw Hill, 1997

REFERENCES:

1. Sawhney A K, "A Course in Electrical and Electronic Measurement and Instrumentation", Dhanpat Rai& Sons, New Delhi, 18th Edition, 2012.
2. Gupta J.B., "A Course in Electronic and Electrical Measurements", S. K. Kataria & Sons, Delhi, 2009
3. Kalsi H.S, "Electronic Instrumentation", McGraw Hill Education India, 3rd Edition, 2010

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	-	1	1	1	-	-	2	2	3	2
CO2	3	3	2	2	1	-	1	1	1	-	-	2	2	3	2
CO3	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
CO4	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
CO5	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
Avg	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3034 **INDUSTRIAL INSTRUMENTATION** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Measuring techniques for acceleration, vibration, force, pressure, temperature, level and flow.
- Methods of acceleration, vibration, force and pressure measurement practiced in industries.
- Different temperature measurement techniques and its selection.
- Different electrical methods of level and flow measurement practiced in industries and to select appropriate sensors.
- Different methods of viscosity, humidity and moisture measurement practiced in industries.

UNIT I MOTION AND VIBRATION MEASUREMENT 9

Accelerometers: LVDT, Piezoelectric and Strain gauge type accelerometers - Seismic instruments as accelerometer - Vibration sensor. Different types of load cells: Hydraulic, Pneumatic, Strain gauge and Piezoelectric load cells.
Activities: Experimenting with any one of the motion sensors.

UNIT II PRESSURE MEASUREMENT 9

Units of pressure – Elastic type pressure gauges: Bourdon tube, bellows and diaphragms - Capacitive type pressure gauge – Piezo-resistive pressure sensor- Thermal conductivity gauges – Ionization gauge - calibration of pressure gauges. Dead weight tester.
Activities: Experimenting with any one of the pressure sensors.

UNIT III TEMPERATURE MEASUREMENT 9

Different types of filled in system thermometers - Bimetallic thermometers-Calibration of thermometers - RTD - characteristics and signal conditioning- 3 lead and 4 lead RTDs – Thermistors. Thermocouples and their compensation techniques -Radiation methods of temperature measurement - Total radiation pyrometers – Optical pyrometers.
Activities: Experimenting with any one of the temperature sensors.

UNIT IV ELECTRICAL TYPE LEVEL AND FLOW MEASUREMENT 9

Electrical types of level measurement:– Principle and constructional details of Conductivity sensors – Capacitive Sensors – Ultrasonic gauge -Differential pressure transmitter-Principle and constructional details of Electromagnetic flow meter – Ultrasonic flow meters – Target flow meter.

Activities: Experimenting with any one of the flow/level sensors.

UNIT V VISCOSITY, HUMIDITY AND MOISTURE MEASUREMENT 9

Viscosity: Saybolt viscometer – Rotameter type and Torque type viscometers. Humidity: Dry and wet bulb psychrometers – Resistive and capacitive type hygrometers – Dew cell – Commercial type dew meter. Moisture: Different methods of moisture measurements – Thermal, Conductivity and Capacitive sensors, Microwave, IR and NMR sensors, Application of moisture measurement – Moisture measurement in solids.

Activities: Experimenting with any one of the humidity/moisture/viscosity sensors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Analysing the instruments used for the measurement of motion and vibration.
CO2: Describes the working of various pressure measuring instruments.
CO3: Outlines the working of various temperature measuring instruments.
CO4: Explains the instruments used for measurement of flow and level.
CO5: Illustrates the instruments used for measurement of viscosity, moisture and humidity.

TEXT BOOKS:

1. Doebellin, E.O. and Manik D.N., “Measurement systems Application and Design”, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd, 2018.
2. Jones. B.E," Instrument Technology”, Vol.2, Butterworth-Heinemann, International Edition, 2003.
3. A. K. Sawhney, Puneet Sawhney, “Course in Mechanical Measurements and Instrumentation and Control”, Dhanpat Rai & Sons, New Delhi, 2013

REFERENCES:

1. Liptak, B.G., “Instrumentation Engineers Handbook (Measurement)”, CRC Press, 2005
2. Patranabis,D., “Principles of Industrial Instrumentation”, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
3. Eckman D.P., “Industrial Instrumentation”, Wiley Eastern Limited, 2003.
4. S.K.Singh., “Industrial Instrumentation and Control”, 3rd Edition, Tata McGraw - Hill Education, 2008.
5. Jain, R.K., “Mechanical and Industrial Measurements”, Khanna Publishers, Delhi, 1999.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO2	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO3	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO4	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO5	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
Avg	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2

24EE3035 **PROCESS CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Dynamics of various processes.
- Effect of various control actions.
- Selection of control elements used in process control.
- Evaluation criteria and tuning techniques of controllers.
- Concept of multi loop control techniques.

UNIT I PROCESS DYNAMICS 9

Need for process control – Introduction to Process variables, Signs & Symbols used in Process industries – Mathematical model of Flow, Level, and Thermal processes – Interacting and non interacting systems – Continuous and batch processes – Servo and regulatory operations.
Activities: Modeling a flow/level/thermal system using process variables, signs and symbols

UNIT II CONTROL ACTIONS 9

Characteristic of on-off, proportional, single speed floating, integral and derivative controllers – PI, PD and PID Control modes –Electronic PID controller – Auto transfer - Reset windup.
Activities: Analysing the performance of PI, PD and PID controller for any transfer function model in MATLAB.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT III FINAL CONTROL ELEMENTS 9

I/P converter – Pneumatic, hydraulic and electric actuators – Heat exchanger –Valve Positioner – Control Valves – Characteristic of Control Valves: - Inherent and Installed characteristics.
Activities: Experimenting flow rate control in the laboratory.

UNIT IV CONTROLLER TUNING 9

PID Tuning – Process reaction curve method – Continuous-cycling method – Damped oscillation method, Introduction to Auto tuning of PID controllers.
Activities: Analysis of PID tuning methods in MATLAB for flow/level/thermal system.

UNIT V MULTILOOP CONTROL 9

Methods of process control – Feed-forward control – Ratio control – Cascade control – Inferential control, Introduction to multivariable control– Model Predictive Control.
Activities: Modeling a tank and heater system and analysing the control variables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Build the mathematical model of simple systems.
CO2: Select the suitable control methods for a particular process.
CO3: Choose the Final control elements for process control.
CO4: Develop a simple tuning algorithm for PID controllers.
CO5: Relate the simple control methods with multi-loop control.

TEXT BOOKS:
1. R. P. Vyas, "Process Control and Instrumentation", Denett & Co., 7th edition,2015
2. Myke King, "Process Control: A Practical Approach", John Wiley & Sons, 2016, Second Edition.
3. D. Patranabis, "Principles of Process Control," Tata McGraw Hill Education, 2012.
4. Dale Patrick, Stephen Fardo ,"Industrial Process Control system", Delmar Cengage Learning, Second edition 1997.

REFERENCES:
1. Bela G. Liptak, "Instrument Engineers' Handbook, Volume Two: Process Control and Optimization", CRC
2. Bequette, B.W., "Process Control Modeling, Design and Simulation", Prentice Hall of India, 2004.
3. Sudheer S. Bhagade, Govind Das Nageshwar, "Process Dynamics and Control", PHI Learning Pvt. Ltd., 2011.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

4. Seborg, D.E., Edgar, T.F. and Mellichamp, D.A., “Process Dynamics and Control”, Wiley John andSons, second Edition, 2003.
5. S. Sundaram, "Process Dynamics and Control", Cengage, 1st edition, 2012.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO2	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO3	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO4	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO5	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
Avg	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2

24EE3036 **ROBOTICS AND CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Develop knowledge in the basics of robotics.
- Understand the basic homogeneous transformation matrices.
- Study the forward and inverse kinematics.
- Identify the various sensors and actuators.
- Know the velocity and force feedback

UNIT I ROBOT FUNDAMENTALS 9

Classification of Robots - History of Robotics - Robot Components - Robot Joints and Degrees of Freedom – Coordinates and Reference Frames - Robot Workspace – Applications - Social Issues.

Activities: Robot teardown and classification

UNIT II RIGID MOTIONS AND HOMOGENEOUS TRANSFORMATIONS 9

Representation of Positions and rotations in matrix form - Rotational Transformations - Rotation with respect to the current coordinate frame - Rotation with respect to a fixed frame - Parameterizations of Rotations - Euler Angles - Roll, Pitch, Yaw Angles - Axis/Angle Representation - Homogeneous Transformations.

Activities: Physical manipulation of coordinate frames using a 3D model and marker

UNIT III FORWARD AND INVERSE KINEMATICS 9

Forward Kinematics - Kinematic Chains - Denavit Hartenberg Representation - Assigning the coordinate frames Inverse Kinematics - Kinematic Decoupling - Inverse Position - Inverse Orientation - Degeneracy and Dexterity.

Activities: Implementation of forward and inverse kinematics with two degrees of freedom.

UNIT IV ROBOTIC SENSORS AND ACTUATORS 9

Sensor Characteristics – Position, Velocity, Acceleration Sensors - Force and Pressure Sensors - Torque Sensors - Visible Light and Infrared Sensors - Touch and Tactile Sensors - Proximity Sensors - Range Finders – other sensors Characteristics of Actuating Systems - Comparison of Actuating Systems - Hydraulic Actuators - Pneumatic Devices - Electric Motors and their types - Control of Electric Motors (PWM control and direction control with H bridge) - Magnetostrictive Actuators - Shape-Memory Type Metals – MEMS based actuators.

Activities: Recognition of sensors and actuators used in robots.

UNIT V MOTIONS AND VELOCITIES 9

Differential Motions and Velocities - Differential Relationships – Jacobian - Differential Motions of a Frame Calculation of the Jacobian - Inverse Jacobian – Force feedback (elementary)– case study.

Activities: Calculating and visualizing the Jacobian for a 2D robot arm

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the fundamentals of robotics.

CO2: Explains about rigid body transformations.

CO3: Describes the forward and inverse kinematics.

CO4: Explain about various robotic sensors and actuators.

CO5: Illustrate end effector motion with an example.

TEXT BOOKS:

1. Saeed Benjamin Niku," Introduction To Robotics: Analysis, Control, Applications", John Wiley & Sons, 2011

2. Mark W. Spong," Robot Dynamics and Control", Wiley,2005.

3. R.K.Mittal and I.J.Nagrath, "Robotics and Control" Tata McGraw-Hill, 2003.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

REFERENCES:

1. Paul Sandin ,"Robot mechanisms and mechanical devices illustrated", McGraw-Hill, 2003
2. Jorge Angeles, "Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms", Springer International, 2014.
3. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, "ROBOTICS: Control, Sensing, Vision, and Intelligence", McGraw-Hill, 1987.
4. Reza N. Jazar, "Theory of Applied Robotics- Kinematics, Dynamics, and Control ", Springer International, 2007.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO2	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO3	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO4	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
CO5	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2
Avg	3	3	3	3	3	-	1	1	1	-	-	2	2	3	2

24EE3037 ADVANCED CONTROL SYSTEMS L T P C
2 0 2 3

COURSE OBJECTIVES:

To impart knowledge on

- P, PI & PID controllers design.
- Various models, analysis and design using state variable techniques.
- Phase plane analysis, describing function analysis and stability analysis of linear systems.
- Phase plane analysis, describing function analysis and stability analysis of non-linear systems.
- Basic concepts of optimal control.

UNIT I CONTROLLER DESIGN 9

P, PI, PID Controllers - Transfer function – Design in frequency domain - Ziegler-Nichols tuning of PID Controller, Cohen Coon tuning Method.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT II STATE VARIABLE ANALYSIS 9

Concept of state and State variable - State models for LTIV continuous-time systems (Physical, Phase Variable and Canonical) – Transfer function from State model – Diagonalisation - Solution of state equations- State Transition Matrix.

UNIT III ANALYSIS AND DESIGN OF IN STATE SPACE 9

Eigen values and vectors – Controllability and Observability- Kalman's and Gilbert's tests – Effect of pole–zero cancellation in TF on Controllability and Observability - Pole Placement by state feedback – Full order Observer Design.

UNIT IV NON-LINEAR SYSTEMS 9

Introduction – Properties of Non-Linear systems-Phase plane method: Basic Concept – Phase trajectory and phase portraits – Singular points – Construction of phase trajectories: Isocline methods. Describing function: Basic concepts-Describing functions for common nonlinearities: dead zone, saturation and relay with hysteresis.

UNIT V STABILITY ANALYSIS 9

Introduction – Concept of stability – Equilibrium points- Lyapunov's stability theorems -Lyapunov's direct method for LTIV systems – Lyapunov's method for non-linear systems – Determination of Lyapunov function using Krasovskii's and Variable Gradient methods.

TOTAL: 30 PERIODS

LAB COMPONENT:

Using electromagnetic software

1) Design and Simulate P, PI, and PID controllers for a second order system.
2) Derive and simulate the state-space models of mechanical or electrical systems in different canonical forms.
3) Simulate and analyze the controllability and observability of a given system using Kalman's and Gilbert's tests.
4) Design and simulate a state-feedback controller using the pole-placement technique.
5) Implement common non-linearities such as dead-zone, saturation, and relay with hysteresis in a simulation environment.
6) Implement specific methods like Krasovskii's or the Variable Gradient method within the simulation environment to construct a suitable Lyapunov function.

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

COURSE OUTCOMES:

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

CO1: Design P, PI & PID controllers.

CO2: Derive models and analyze State Variables for LTIV continuous systems.

CO3: Design the controller through State Variable approach for LTIV continuous systems.

CO4: Evaluate the performance and stability analysis of non-linear systems by Phase plane and Describing Function methods respectively.

CO5: Analyze the stability of linear and non-linear systems using various concepts.

TEXT BOOKS:

1. Gopal M., "Modern Control System Theory", New Age International Publishers, 2011.
2. Ogata K, "Modern Control Engineering, Prentice-Hall of India, New Delhi, 2010.
3. Khalil H. K, Nonlinear Systems, 3rd Edition, Prentice Hall, 2002.
4. Gopal M., Control Systems Principles and Design, 4/e, Tata McGraw Hill, 2012.

REFERENCES:

1. Constantine H. Houpis, Stuart N. Sheldon, Linear Control System Analysis and Design with MATLAB®, CRC Press, USA, 2013.
2. Nagrath I J and Gopal M, ―Control System Engineering, New Age International Publishers, New Delhi, 2014.
3. Norman S. Nise, ―Control system Engineering, John Wiley & Sons, New York, 2011.
4. Gopal M, ―Digital Control and State Variable Methods, Tata McGraw-Hill, New Delhi, 2008.

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	-	1	1	1	-	-	2	2	3	2
CO2	3	3	2	2	1	-	1	1	1	-	-	2	2	3	2
CO3	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
CO4	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
CO5	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2
Avg	3	2	2	2	1	-	1	1	1	-	-	2	2	3	2

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

24EE3038 MEMS SENSORS AND ACTUATORS L T P C
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Properties of materials ,microstructure and fabrication methods.
- Modeling of Electrostatic sensors and actuators.
- The characterizing thermal sensors and actuators through design and modeling.
- The fundamentals of piezoelectric sensors and actuators.
- Different MEMS and NEMS devices.

UNIT I MICRO-FABRICATION, MATERIALS AND ELECTROMECHANICAL CONCEPTS 9

Overview of Micro-fabrication Silicon and other material based fabrication processes-conductivity of semiconductors-crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress-resonant frequency and quality factor-photolithography.

Activities: Develop a microchip with art and craft materials to mimic fabrication steps.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION 9

Principle-material-design and fabrication of parallel plate capacitors as electrostatic sensors-capacitive pressure sensor- comb drive -micro motors- actuators-.Applications.

Activities: Understanding the electrostatic effects through various examples.

UNIT III THERMAL SENSING AND ACTUATION 9

Principle-material-design and fabrication of thermocouples- thermal bimorph sensors- thermal resistor sensors- actuators- Applications.

Activities: Experimenting bimorph sensor analogy

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9

Piezo-electric effect - cantilever piezo electric actuator model - properties of piezo-electric materials- Applications.

Activities: Experimenting with piezoelectric sensor.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V CASE STUDIES 9

Acceleration sensors - gyroscopes-piezo-resistive sensors-magnetic actuation-micro fluids applications-medical applications- optical MEMS.
Activities: Sorting micro-device applications

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Explain the concept of MEMS technology and MEMS materials.
CO2: Express the different fabrication methods used of MEMS technology and issues related to packaging and reliability.
CO3: Differentiate MEMS sensors and actuators based on electrostatic and thermal principles.
CO4: Find suitable applications of MEMS sensors and actuators working based on thermal principles.
CO5: Explicate the design of new MEMS devices based on various principles.

TEXT BOOKS:
1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2012.
2. Tai-Ran Hsu, “MEMS and Microsystems Design and Manufacture”, McGraw Hill, 2002.

REFERENCES:
1. Stephen Senturia, “Microsystems Design”, Springer, 2006.
2. Marc Madou, “Fundamentals of micro fabrication”, CRC Press, 1997.
3. Boston, “Micro machined Transducers Sourcebook”, WCB McGraw Hill, 1998.
4. M.H.Bao, “Micromechanical Transducers: Pressure sensors, accelerometers and gyroscopes”, Elsevier, New York, 2000
5. Mohamed Gad-el-Hak, editor, “The MEMS Handbook”, CRC press Baco Raton, 2001.
6. NadimMaluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO2	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO3	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO4	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
CO5	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2
Avg	3	2	2	2	2	-	1	1	1	-	-	2	3	2	2

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3039 **MODEL BASED CONTROL** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Multivariable and Multiloop systems.
- Model predictive control schemes and its elements.
- State space MPC and various constrained MPC along with case studies.
- Principles of STR, MRAC and Gain scheduling.
- Design simple adaptive controllers for linear systems.

UNIT I INTRODUCTION TO MIMO CONTROL 9

Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC-IMCPIDCase studies.

Activities: Explore various MIMO controllers presently used in industries.

UNIT II MODEL PREDICTIVE CONTROL SCHEMES 9

Introduction to Model Predictive Control - Model Predictive Control Elements - Generalized Predictive Control Scheme – Multivariable Generalized Predictive Control Scheme – Multiple Model based Model Predictive Control Scheme Case Studies.

Activities: Develop MPC, Adaptive and MIMO controllers for industrial processes.

UNIT III STATE SPACE BASED MODEL PREDICTIVE CONTROL SCHEME 9

State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies

Activities: Implement the controllers for MIMO systems.

UNIT IV CONSTRAINED MODEL PREDICTIVE CONTROL SCHEME 9

Constraints Handling: Amplitude Constraints and Rate Constraints –Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies.

Activities: Using software tools for practical exposures to the controllers used in industries by undergoing training.

UNIT V ADAPTIVE CONTROL SCHEME 9

Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators–MARS-Adaptive Model Predictive Control Scheme –Case Studies.

Activities: Realisation of various optimization techniques for economical operation of process.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Ability to apply engineering knowledge to understand the control schemes on MIMO systems.

CO2: Ability to design controllers for MIMO systems.

CO3: Ability to analyze the control schemes available in industries.

CO4: Ability to design MPC, Adaptive controllers for practical engineering problems.

CO5: Ability to choose suitable controllers for the given problems.

TEXT BOOKS:

1. Coleman Brosilow, Babu Joseph, "Techniques of Model-Based Control", Prentice Hall PTR Pub 2002, 1st Edition.
2. E. F. Camacho, C. Bordons ,"Model Predictive Control",Springer-Verlag London Limited 2007, 2nd Edition.
3. K.J. Astrom and B. J. Wittenmark, "Adaptive Control", Second Edition, Pearson Education Inc., second Edition 2013.

REFERENCES:

1. Paul Serban Agachi, Zoltan K. Nagy, Mircea Vasile Cristea, and Arpad Imre-Lucaci Model Based Control Case Studies in Process Engineering,WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2007.1st Edition.
2. Ridong Zhang, Anke Xue Furong Gao,"Model Predictive Control Approaches Based on the Extended State Space Model and Extended Non-minimal State Space Model",Springer Nature Singapore Pte Ltd. 2019, 1st Edition.
3. J.A. ROSSITER "Model-Based Predictive Control A Practical Approach"Taylor & Francis eLibrary, 2005, 1st edition.
4. Open Source Software/ Learning website:
a. https://nptel.ac.in/courses/103103037
b. https://nptel.ac.in/courses/108103007
c. https://onlinecourses.nptel.ac.in/noc21_ge01/preview
d. https://nptel.ac.in/courses/127106225

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	1	1	1	1	2	2	2
CO2	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

CO3	3	3	3	2	1	1	1	1	1	1	1	1	2	2	2
CO4	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
CO5	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2
Avg	3	3	3	3	1	1	1	1	1	1	1	1	2	2	2

24EE3040 ENERGY BASED CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Basic matrix operations and properties.
- Bazier's Polynomials.
- Modelling and passivity control of buck converter.
- Modelling and passivity control of boost converter.
- Modelling and passivity control of buck-boost converter.

UNIT I INTRODUCTION TO MATRICES 4

Introduction to matrix operations - properties - Types of matrices.
Activities: Simulation of matrix operations and properties with examples.

UNIT II POLYNOMIALS 5

Need for polynomial realization - Bezier's polynomial - Gabriel Polynomial
Activities: Simulate a polynomial trajectory block

UNIT III PASSIVITY BASED CONTROL FOR BUCK CONVERTER 12

Buck converter operation - State-Space Modelling, Normalization, Equilibrium points, Linearization - energy shaping and damping - Passivity control for buck converter.
Activities: Simulation of passivity control of buck converter.

UNIT IV PASSIVITY BASED CONTROL FOR BOOST CONVERTER 12

Boost converter operation - State-Space Modelling, Normalization, Equilibrium points, Linearization - energy shaping and damping - Passivity control for boost converter.
Activities: Simulation of passivity control of boost converter.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT V PASSIVITY BASED CONTROL FOR BUCK-BOOST CONVERTER 12

Buck-Boost converter operation - State-Space Modelling, Normalization, Equilibrium points, Linearization - energy shaping and damping - Passivity control for buck-boost converter.
Activities: Simulation of passivity control of buck-boost converter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:
CO1: Analyze Converter Stability using Matrix Definiteness.
CO2: Develop Mathematical Models for buck, boost and buck-boost converters.
CO3: Implement Energy-Based Control Strategies.
CO4: Utilize Polynomial Dynamics for Trajectory Tracking.
CO5: Validate Control Laws through Simulation.

TEXT BOOKS:
1. H. Sira-Ramírez and R. Silva-Ortigoza, Control Design Techniques in Power Electronics Devices. London: Springer-Verlag, 2006.
2. R. Ortega, A. Loría, P. J. Nicklasson, and H. Sira-Ramírez, Passivity-based Control of Euler-Lagrange Systems: Mechanical, Electrical and Electromechanical Applications. London: Springer, 2014.
3. H. Bai, M. Arcak, and J. Wen, Cooperative Control Design: A Systematic, Passivity-Based Approach. Springer, 2011.

REFERENCES:
1. Ganesh Kumar, Marco Rivera Abarca, and S. K. Pattanaik, “Power Converters, Drives and Controls for Sustainable Operations”, Scrivener Publishing LLC, 2023.
2. M. H. Rashid, Power Electronics: Devices, Circuits, and Applications, 4th edition. Pearson, 2018.
3. R. Ortega et al., PID Passivity-Based Control of Nonlinear Systems with Applications, 1st ed. Wiley-IEEE Press, 2021.
4. Open Source Software/ Learning website:
a. https://matlabacademy.mathworks.com/details/matlab-onramp
b. https://matlabacademy.mathworks.com/details/calculations-with-vectors-and-matrices
c. https://matlabacademy.mathworks.com/details/curve-fitting-onramp
d. https://matlabacademy.mathworks.com/details/control-system-modeling-essentials
e.https://matlabacademy.mathworks.com/details/power-electronics-simulation-onramp/powerelectronics

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

MAPPING OF COs with POs and PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	3	1	3	1	1	2	2	2
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CO3	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
CO4	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
CO5	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2
Avg	3	3	3	3	1	1	1	3	1	3	1	1	2	2	2

ANNA University Nominee | **Subject Expert 1** | **Subject Expert 2** | **Industrial Expert** | **Alumni**

VERTICAL VI: DIVERSIFIED COURSES

24EE3041 ENERGY MANAGEMENT AND AUDITING L T P C
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Economic analysis and Load management.
- Basics of materials and energy balance.
- Energy efficiency in thermal utilities.
- Concept of a compressed air system.
- Lighting systems and co generation.

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT 9

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit - Energy management /audit approach-understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments - Case study.

Activities: Prepare a report on Energy use data from their homes(Electricity)

UNIT II MATERIAL AND ENERGY BALANCE 9

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager–employees training and planning-Financial Management: financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return–Case Study.

Activities: Create a process flow diagram of Water Purification or Milk Pasteurization

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 9

Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers - Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings - Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery –Refractory : types, selection and application of refractories, heat loss - Cogeneration: classification and saving potentials -Case Study.

Activities: Prepare a comparison chart on coal,diesel,LPG,Biomass,Kerosene based on Sources and Typical uses.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 9

Compressed Air System: Types of air compressors - efficient compressor operation - Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle –refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities - Vapour absorption refrigeration system: working principle - types and comparison with vapour compression system -saving potential - Cooling Tower: Types and performance evaluation, efficient system operation - flow control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues - Case Study.
Activities: Prepare a chart comparing Reciprocating compressor,screw compressor,Reciprocating compressor,Scroll compressor.

UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES 9

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver - variable speed drives –Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System :Types - system operation – flow control methods - Lighting System: Light source, choice of lighting, luminance requirements –ballast - occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.
Activities: Prepare an lighting audit to replace lamps,improve reflectors,use task lightings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the completion of the course, students will be able to:
CO1: Acquire knowledge in the field of energy management and auditing process.
CO2: Learn about the basic concepts of economic analysis and load management.
CO3: Design an effective thermal utility system.

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CO4: Improve the efficiency in a compressed air system.
CO5: Acquire the design concepts in the field of lighting systems, light sources and various forms of cogeneration..

TEXT BOOKS:
1. Mehmet Kanoglu, Yunus A Cengel,"Energy Efficiency and Management for Engineers", McGraw-Hill Education, First Edition, 2020.
2. Moncef Krati, 'Energy Audit of Building Systems: An Engineering Approach', Third Edition, CRC Press, Dec.2020.
3. Michael P.Deru,Jim Kelsey,'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.

REFERENCES:
1. Sonal Desai,'Hand book of Energy Audit', Mc Graw Hill Education(India) Private Limited, 2015.
2. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990, 1st Edition.
3. 'Energy Managers and Energy Auditors Guide book', Bureau of Energy Efficiency,2006.
4. Larry C.Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

List of Open Source Software/Learning website:

1. https://lab.fs.uni-lj.si/kes/erasmus/Energy%20Management%20Handbook.pdf
2. https://www.sciencedirect.com/science/article/pii/S2212827114004491
3. http://knowledgeplatform.in/wp-content/uploads/2017/03/1.3-Energy-management-Audit.pdf

MAPPING OF COs WITH Pos AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	2	-	-	-	1	-	-	-	2	3	2	3
CO2	3	-	-	-	-	-	2	1	3	-	1	2	3	2	3
CO3	3	-	1	2	3	-	-	1	-	-	-	2	3	2	3
CO4	3	3	-	-	-	-	-	1	3	-	-	2	3	2	3
CO5	3	-	1	2	-	-	-	1	-	-	2	2	3	2	3
Avg	3	1	1	1	1	-	1	1	1	-	1	2	3	2	3

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

24EE3042 **PLC PROGRAMMING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- Fundamentals of PLC and Automation
- PLC programs using IEC 61131-3 languages
- Architecture and operation of SCADA systems
- Industrial communication protocols,
- Implementation of real-time industrial automation applications.

UNIT I INTRODUCTION 9

Programmable Logic Controller (PLC)- Block diagram of PLC- Programming languages of PLC- Basic instruction sets- Design of alarm and interlocks- Networking of PLC- Overview of safety of PLC with case studies- Process Safety Automation: Levels of process safety through use of PLCs- IEC 61131-3 Standard - Application of international standards in process safety control.

Activities: Draw a labeled diagram and describe the function of CPU,input module,output module,communication port,power supply.

UNIT II IEC 61131-3 9

Rails- Rungs- Relay Logic- Latch switch- Timers- Counters- Boolean logics- Math Instructions-Data manipulation Instructions- Requirement of communication networks for PLC, PLC to PC Communication to computer- FBD equivalent to LL- FBD Programming- IL- SFC-ST.

Activities: Create a simple ladder diagram with left and right rails at least three rungs controlling, Lamp ON/OFF,motor start,Buzzer.

Activities: Create a simple ON/OFF control such as Valve on when tank low,pump on when tank is full.

UNIT III SCADA 9

Elements of SCADA system- History of SCADA, Remote Terminal Unit- Discrete control-Analog control, Master Terminal Unit- Operator interface.

Activities: Create a simple ON/OFF control such as Valve on when tank low,pump on when tank is full.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT IV HART and Field Bus 9

Introduction- Evolution of signal standards- HART communication protocol- communication modes- HART networks- HART commands- HART and OSI model- Field bus- Architecture- Basic requirements of field Bus standard- Field bus Topology- Interoperability- Interchangeability.

Activities: Draw and Explain the architecture showing H1,HSE,Field devices,Control system,Power conditioners,Segment Protectors

UNIT V PLC PROGRAMMING 9

Exercise in Programming Languages from IEC 61131-3: Traffic Light Control- Two way- Four way – Water Level Control- Automatic Material Sorting System- Automatic Bottle Filling System, Code Converters- DC motor Control- Alarm Circuit.

Activities: Prepare a ladder diagram for conveyor Material sorting based on color,size and shape.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the completion of the course, students will be able to:

CO1: Understand the basics and need for Automation in industries

CO2: Explain the logic and flow of any particular programming written for a process

CO3: Apply the knowledge to design or improve an existing program to increase productivity of any process

CO4: Break down SCADA architecture and communication protocols.

CO5: Build and logic in any of the programming languages from IEC- 61131- 3 standard.

TEXT BOOKS:

1.Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2019.

2.Stuart Boyer A, "SCADA: Supervisory control and data Acquisition", Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society,2010.

3.John W. Webb & Ronald A. Reis," Programmable Logic Controllers: Principles and Applications" 6th Edition, Prentice Hall,2019.

REFERENCE:

1.Bolton. W, "Programmable Logic Controllers", Elsevier Newnes, 6th Edition 2015.

2.Madhuchhanda Mitra & Samarjit Sen," Programmable Logic Controllers and Industrial Automation" 2nd Edition, Oxford University Press, 2022

3.Mikell P. Groover," Automation, Production Systems and Computer-Integrated Manufacturing", 5th Edition, Pearson, 2021.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

List of Open Source Software/Learning website:

1. https://nptel.ac.in/courses/108105062
2. https://nptel.ac.in/courses/108105088
3. http://www.nitttrc.edu.in/nptel/courses/video/105105201/lec56.pdf
4 https://nptel.ac.in/courses/108106022

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	-	-	-	1	-	1	-	-	-	-	-
CO2	2	2	3	2	-	-	-	1	-	1	-	-	-	-	-
CO3	3	2	3	2	-	-	-	1	-	1	-	-	-	-	-
CO4	3	3	2	2	-	-	-	1	-	1	-	-	-	-	-
CO5	3	2	2	2	-	-	-	1	-	1	-	-	-	-	-
Avg	3	2	2	2	-	-	-	1	-	1	-	-	-	-	-

24EE3043 **IOT FOR SMART GRIDS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

To impart knowledge on

- The fundamentals of Smart Grid and Internet of Things (IoT).
- IoT technologies, communication networks, and standardization frameworks.
- IoT concepts to Smart Grid applications.
- IoT-aided Smart Grid architectures.
- Prototype solutions for IoT-based Smart Grid systems.

UNIT I INTRODUCTION TO SMART GRID AND IOT **9**

Internet of Things-Smart Grid-Importance of Smart Grid in Smart Cities-Integration of the Internet of Things into a Smart Grid.

Activities: Map how Iot sensor communicates with smart Grid(select three iot devices,smart meter,Voltage sensor,load controller.

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

UNIT II IOT TECHNOLOGIES, COMMUNICATION TECHNOLOGIES AND STANDARDIZATION 9

IoT Technologies–Communication Technologies: Home Area Network (HAN)-Neighborhood Area Network (NAN)-Wide Area Network(WAN)-Standardization: Activities in IoT, Smart Grid and IoT aided Smart grid systems.
Activities: Prepare a list of network types:HAN,NAN,WAN coverage devices,protocols.

UNIT III APPLICATIONS OF IOT IN SMART GRID SYSTEMS 9

HAN applications: Smart Home–Electric vehicle–AMI–Integration of DERs–Power demand management-NAN applications: Smart Distribution – smart patrol – WAN applications: Transmission tower protection – monitoring of power transmission lines.
Activities: Prepare HAN based energy management in smart homes using arduino,monitor and display

UNIT IV ARCHITECTURES FOR IOT AIDED SMART GRID SYSTEMS 9

Smart Grid Architecture Model–Three layered architecture–Four layered architecture–Cloud based architecture–Web enabled smart grid architecture–Last meter smart grid architecture.
Activities: Draw a block diagram showing flow of Electricity and information on power layer,communication layer,application layer.

UNIT V PROTO TYPES FOR IOT AIDED SMART GRID SYSTEMS 9

A Simple Proto type for Energy Efficiency-Integration of Renewable and Non Renewable Energy Sources at Home-In Home Appliance Monitoring Implementation-Real time Monitoring of Medium Voltage Grid–Open issues & challenges.
Activities: Group presentation/report summarizing on Energy storage limitations,Reliability and fault detection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the completion of the course, students will be able to:
CO1: Describe the concepts of Internet of Things.
CO2: Explain the IoT communication technologies.
CO3: Explicate the applications IoT in Smart Grid.
CO4: Spell out the suitable architectures for IoT aided Smart grid systems.
CO5: Apply existing prototypes of IoT in smart grid.

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

TEXT BOOKS:

1. P.Waher, Learning Internet of Things.Packt Publishing, 2015.
2. N.Ramesh Babu, Smart Grid Systems: Modeling and Control, CRC Press, 2018.
3. F.P.Sioshansi,Smart Grid: Integrating Renewable, Distributed and Efficient Energy, Academic Press, 2011.

REFERENCES:

1. D.Kellmereit, The Silent Intelligence: The Internet of Things.Dn D Ventures, 2013.
2. A.Mc Ewen and H.Cassimally, Designing the Internet of Things. John Wiley & Sons, 2013.
3. S.Borlase, Smart Grids: Advanced Technologies and Solutions, Second Edition.CRC Press, 2017.
4. .J.A.Momoh, Smart Grid: Fundamentals of Design and Analysis. John Wiley & Sons, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
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CO1	3	2	1	-	2	-	-	-	-	2	-	-	2	2	1
CO2	2	2	2	-	3	-	-	-	-	2	-	-	2	3	1
CO3	2	3	2	2	2	2	3	-	-	2	-	-	2	3	3
CO4	2	2	3	2	3		2	-	-	2	-	-	3	3	2
CO5	2	2	3	3	3		2	-	2	2	2	3	3	3	3
Avg	2	2	2	2	3	1	2	-	1	2	1	1	2	3	2

24EE3044 ENERGY STORAGE SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

Students will be able to:

- Understand the various types of energy storage Technologies.
- Analyze thermal storage systems.
- Analyze different battery storage technologies
- Analyze the thermo dynamics of Fuel Cell
- Study the various applications of energy storage systems.

UNIT I INTRODUCTION 9

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

Activities: Analyze a real world application of Energy storage-case study(Tesla power wall,Hornsdale Power Reserve)

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UNIT II THERMAL STORAGE SYSTEM 9

Thermal storage–Types–Modeling 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.

Activities: Prepare a Thermal Energy storage systems classification chart with Examples.

UNIT III ELECTRICAL ENERGY STORAGE 9

Fundamental concept of batteries – measuring of battery performance, charging and discharging, power density, energy density, and safety issues. Types of batteries–Lead Acid, Nickel–Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries –Flow Batteries.

Activities: Create a table summarizing Battery Types,voltage,Energy/power density and safety notes.

UNIT IV FUEL CELL 9

Fuel Cell–History of Fuel cell,Principles of Electro chemical storage–Types–Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

Activities: Create a Detailed chart of Alkaline fuel cell advantages and limitations.

UNIT V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

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

Activities: Understand energy storage in super capacitors by connecting small capacitors to a low-voltage led.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the completion of the course, students will be able to:

CO1: Understand different types storage technologies

CO2: Design a thermal storage system

CO3: Model battery storage system

CO4: Analyze the thermodynamics of fuel cell

CO5: Analyze the appropriate storage technologies for different applications and explore the alternate energy storage technologies

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TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, ‘Thermal Energy Storage Systems and Applications’, John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliang sun, ‘Electrochemical technologies for energy storage and conversion’, Wiley publications, 2nd Volume set, 2012.
3. James Larminie and Andrew Dicks,‘Fuel cell systems Explained’,Wiley publications,3rd Edition, 2018.

REFERENCES:

1. Lunardini.V.J, ‘Heat Transfer in Cold Climates’, John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J., ‘Thermal Energy Storage and Regeneration’, Hemisphere Publishing Corporation, 1981, 1st Edition.

List of Open Source Software/Learning website:

1. Prof. Subhasish BasuMajumder, “Electrochemical Energy Storage”,NPTEL Course, https://nptel.ac.in/courses/113105102.
2. Prof. PK Das, “Energy conservation and waste heat recovery”, NPTEL Course, https://nptel.ac.in/courses/112105221.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-	3
CO2	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO3	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO4	3	-	2	-	-	-	-	-	-	-	-	-	2	-	3
CO5	3	3	2	-	-	2	-	-	-	-	-	-	2	-	3
Avg	3	1	2	-	-	1	-	-	-	-	-	-	2	-	3

24EE3045 HYBRID ENERGY TECHNOLOGY L T P C
2 0 2 3

COURSE OBJECTIVES:

Students will be able to:

- Provide knowledge about different types of hybrid energy systems
- Analyze the various electrical Generators used for the Wind Energy Conversion Systems
- Design the power converters used in SPV Systems
- Analyze the various power converters used in hybrid energy systems and to understand the importance of standalone and grid-connected operation in Hybrid renewable energy systems.
- Analyze the performance of the various hybrid energy systems

UNIT I INTRODUCTION TO HYBRID ENERGY SYSTEMS 7

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind- Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems – Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy - Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics.

UNIT II ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 5

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT III POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 6

Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck- boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems - Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems.

UNIT IV ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS 6

Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter – Merits and Limitations.

UNIT V CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS 6

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis - Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

TOTAL: 30 PERIODS

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LIST OF EXPERIMENTS:

1.Simulation of Wind energy conversion system

2. Simulation of power converters

3.Simulations of AC-DC-AC converters.

4. Simulations of PWM inverters

5.Simulations of Matrix Converters with Resistive and dynamic loads

Software Requirements:

MATLAB/Simulink

TOTAL: 30 PERIODS

TOTAL: 30 + 30 PERIODS

COURSE OUTCOMES:

At the completion of the course, students will be able to:

CO1: Analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power

CO2: Select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system

CO3: Design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems.

CO4: Analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems.

CO5: Interpret the hybrid renewable energy systems

TEXT BOOKS:

1. Bahman Zohuri, “Hybrid Energy Systems”, Springer, First Edition, 2018.

2. S.M. Muyeen, “Wind Energy Conversion Systems”, Springer First Edition, 2012

3. Md. Rabiul Islam, Md. Rakibuzzaman Shah, Mohd Hasan Ali, "Emerging Power Converters for Renewable Energy and Electric Vehicles", CRC Press, First Edison, 2021.

REFERENCES:

1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3^{rd} Edition.

2. S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electrical Systems”, Oxford University Press, 7^{th} Impression, 2005.

3. Rashid.M. H “Power electronics Hand book”, Academic press,4^{th} Edition, 2018.

4.Rai. G.D, “Non-conventional energy sources”, Khanna publishers, 6^{th} Edition, 2017.

. 5. Rai. G.D, “Solar energy utilization”, Khanna publishers, 3^{rd} Edition, 1987.

6. Gray, L. Johnson, “Wind energy system”, Prentice Hall of India, 2^{nd} Edition, 2006.

7. B.H.Khan "Non-conventional Energy sources", Tata McGraw hill Publishing

ANNA University Nominee	Subject Expert 1	Subject Expert 2	Industrial Expert	Alumni

Company, New Delhi, 2017, 3rd Edition.

List of Open Source Software/Learning website:

1. https://www.sciencedirect.com/topics/engineering/hybrid-energy-system
2. https://www.sciencedirect.com/topics/engineering/wind-energy-conversion-system
3. https://www.academia.edu/35619294/Modeling_and_Performance_Analysis_of_Solar_PV_S
4. System_and_DC_DC_Converters
5. https://www.mdpi.com/journal/energies/special_issues/Power_Converter_Electric_Machines
6. Renewable_Energy_Systems_Transportation

MAPPING OF COs WITH POs AND PSOs

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CO2	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO4	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO5	3	3	3	2	-	-	-	-	-	3	-	3	3	3	3
Avg	3	3	3	2	2	-	-	-	-	3	-	3	3	3	3

24EE3046 DESIGN AND MODELLING OF RENEWABLE ENERGY SYSTEMS **L T P C**
2 0 2 3

COURSE OBJECTIVES:

Students will be able to:

- Review the renewable energy systems and technology
- Learn the Single phase grid-connected photovoltaic systems
- Three phase photovoltaic systems
- Illustrate the small wind energy systems
- Simulate the Doubly-fed induction generator based WECS

UNIT I RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES **5**

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends.

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UNIT II SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS 7

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single- Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters, Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems.

UNIT III THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES 6

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

UNIT IV SMALL WIND ENERGY SYSTEMS 6

Introduction-Generator Selection for Small-Scale Wind Energy Systems- Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications-Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems-Magnus Turbine–Based Wind Energy System.

UNIT V DOUBLY-FED INDUCTION GENERATOR-BASED WECS 6

Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS:

1.Simulation of inverter for PV systems
2.Simulation of Doubly-Fed Wind Energy Conversion System with Doubly-Fed Induction Generator.
3.Simulation of a Small PMSG-Based Wind Turbine
4.Modeling of a Single-Phase Grid-Connected PV System
5.Performance Analysis of Solar, Wind and Hybrid Systems

Software Requirements:

MATLAB/Simulink

TOTAL: 30 PERIODS

TOTAL:30 +30 PERIODS

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

COURSE OUTCOMES:
At the completion of the course, students will be able to:
CO1: Review the perspectives of renewable energy systems
CO2: Integrate photovoltaic systems with grid
CO3: Study inverter for PV systems
CO4: Elaborate the working of small wind power systems
CO5: Study the features of induction machines and doubly fed induction machines.

TEXT BOOKS:

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021
3. Nabil Derbel, Quanmin ZhuModeling, "Identification and Control Methods in Renewable Energy Systems" , Springer, First Edition, 2019

REFERENCES:

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

List of Open Source Software/Learning website:

1. https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy
2. https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html
3 https://www.sciencedirect.com/topics/engineering/three-phase-inverter
4. academia.edu/32704493/Wind_Power_Lecture_Notes
5. https://www.syscop.de/files/2018ss/WES/handouts/script.pdf
6. https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator

MAPPING OF COs WITH POs AND PSOs

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CO2	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
CO3	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

CO4	3	2	3	3	-	-	-	-	-	-	-	-	3	3	3
CO5	3	2	3	3	2	-	-	-	-	-	-	-	3	3	3
Avg	3	2	3	3	1	-	-	-	-	-	-	-	3	3	3

24EE3047 GRID INTEGRATING TECHNIQUES AND CHALLENGES **L T P C**
2 0 2 3

COURSE OBJECTIVES:

Students will be able to:

- Learn the present power Scenario
- Model a micro grid system
- Model power converter for grid interconnection
- Integrate wind energy conversion system with grid
- Simulate power converters like three phase inverters and DC-DC converters.

UNIT I PRESENT POWER SCENARIO IN INDIA 6

Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal Power Plants in India- Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy – Power plants India

UNIT II POWER GRIDS 6

Introduction -Electric Power, Background, The Construction of a Power Grid System , Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a Microgrid System.

UNIT III MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS 6

Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, Pulse Width Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse Width Modulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation, The Sizing of DC/DC Converters for Micro grid.

UNIT IV WIND ENERGY SYSTEM GRID INTEGRATION **6**

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

UNIT V GRID INTER CONNECTION **6**

Grid Code requirements-Grid integration of WECS-Grid Integration of PV systems.

TOTAL: 30 PERIODS

LAB COMPONENT:

1. Develop a model for the control of DC micro grid for non linear load.

2. Simulation study of three phase inverters with fixed and sine PWM techniques,

3.Simulation and Design of buck/boost converters.

4. Simulate a Grid Connected Wind Energy System with STATCOM and investigate the improvement in power quality.

TOTAL: 30 PERIODS

TOTAL: 30+30 = 60 PERIODS

COURSE OUTCOMES:
At the completion of the course, students will be able to:
CO1: Review the power sector scenario in India
CO2: Model a microgrid system
CO3: Model a converter for power grid distributed system.
CO4: Integrate wind energy system
CO5: Simulate three phase inverter with fixed and sine PWM.

TEXT BOOKS:

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.

2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications", Springer, 1st Edition 2022.

3. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems", John Wiley & Sons, Ltd, 2014, 3rd Edition.

REFERENCES:

1. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani, and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition.

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2. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.

3. Design of smart power grid renewable energy systems, Third Edition, Ali Keyhani, Wiley 2019.

4. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, Wiley 2017, 1st Edition.

5. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st Edition.

List of Open Source Software/Learning website:

1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India
2. https://energyeducation.ca/encyclopedia/Electrical_grid
3. https://dnv.com/services/wind-farm-control-and-grid-integration
4. https://www.wind-energy-the-facts.org/images/chapter2.pdf

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	3	-	3	3	3	3
CO2	3	-	2	-	3	-	-	-	-	3	-	3	3	3	3
CO3	3	3	3	2	3	-	-	-	-	3	-	3	3	3	3
CO4	3	3	1	3	3	-	-	-	-	3	-	3	3	3	3
CO5	3	3	2	3	-	-	-	-	-	3	-	3	3	3	3
Avg	3	2	2	2	2	-	-	-	-	3	-	3	3	3	3

24EE3048 SUSTAINABLE AND ENVIRONMENTAL FRIENDLY HV INSULATION SYSTEM .

L T P C
3 0 0 3

COURSE OBJECTIVES:

Students will be able to:

- Understand sustainability concepts in energy and product design.
- Analyze the environmental impact of conventional gaseous insulating materials.
- Evaluate alternative green liquid insulating materials,
- Assess conventional and eco-friendly solid insulating materials
- Interpret evolving standards and best practices for green insulation systems

UNIT I SUSTAINABLE AND ENVIRONMENTAL ENERGY AND PRODUCTS 9

Carbon print, global warming potential, environment requirement for any product and system.
Activities: Comparative analysis of Carbon foot print for different Energy Sources(Coal,Solar,Wind,Hydro)

UNIT II ALTERNATE GREEN GASEOUS INSULATORS 9

SF6 gas and its hazardous environmental effects, alternate gases, gaseous mixtures and other sources and its properties.
Activities: Analysis of the role of SF6 in High voltage Equipment(circuit breakers,switch gear)

UNIT III ALTERNATE GREEN LIQUID INSULATORS 9

Hazardous effects of existing liquid dielectric materials (such as organic oil), alternate sources of environmental friendly liquid such as ester oil, vegetable oils dielectric and its properties.
Activities: Study of Common Liquid Dielectrics(Mineral/organic oils)and their applications in Electrical equipment.

UNIT IV ALTERNATE GREEN SOLID INSULATORS 9

Hazardous effects of existing solid dielectric materials, alternate sources of environmental friendly solid dielectric and its properties.
Activities: Analysis of physical,chemical and Electrical properties of conventional solid Dielectrics.

UNIT V EVOLVING STANDARDS FOR GREEN INSULATION SYSTEMS 9

Requirements, evolving standards of management, testing, usage and disposal of alternate insulation systems, Major applications and standards.
Activities: Analysis of safe Disposal practices and Recycling of alternate insulation Materials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the completion of the course, students will be able to:
CO1: Know about sustainable and environmental energy and products.
CO2: Describe the alternate green gaseous insulators.

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CO3: Describe the alternate green liquid insulators

CO4: Describe the alternate green solid insulators

CO5: Elaborate the standards for Green insulation systems.

TEXT BOOKS:

1. E. Kuffel, W.S. Zaengl, J. Kuffel,'High Voltage Engineering Fundamentals',E. Kuffel, W.S. Zaengl, J. Kuffel Elsevier / Newnes
2. M.S. Naidu & V. Kamaraju,". High Voltage Engineering",McGraw Hill Education
3. "Eco-Friendly High-Voltage Insulation Systems"A suitable course-oriented compiled text / lecture material

REFERENCES:

1. S. Chakraborty, M. J. B. Reddy.'Green and Sustainable Electric Power Technologies'CRC Press
2. Edited by Hermann Koch,'SF_6 Alternatives and High-Voltage Gas-Insulated Systems,Wiley-IEEE Press
3. J. Aubin, O. Lesaint, A. Beroual,'Vegetable Oils and Bio-based Insulation Liquids in Power Transformers'Springer
4. A. Bradwell,'Dielectric Materials for Electrical Engineering',Wiley

List of Open Source Software/Learning website:

1. https://www.iso.org/standard/79064.html
2. https://www.ictfootprint.eu/en/iec-tr-627252013-factsheet
3. https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1275,25

4..https://www.iec.ch/ords/f?p=103:41:628762356646470::::FSP_ORG_ID,FSP_LANG_ID:3237

5 https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1299,25

6. https://www.iec.ch/sdgs/sdg13

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO2	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO3	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO4	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
CO5	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3
Avg	3	-	3	-	-	-	3	-	-	-	-	-	3	-	3

ANNA University Nominee	**Subject Expert 1**	**Subject Expert 2**	**Industrial Expert**	**Alumni**

MANDATORY COURSES I

SYLLABUS

CODE: 24MX3081	INTRODUCTION TO WOMEN AND GENDER STUDIES	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To understand what gender means and why it is important.
2	To learn about the problems and challenges faced by women.
3	To know how society, family, school, and media shape gender roles.
4	To become aware of gender inequality and discrimination.
5	To develop respect, fairness, and equality towards all genders.

UNIT: I — GROWTH OF WOMEN'S STUDIES / GENDER STUDIES — 9

Objectives and scope of Women's Studies – Need for Women's Studies Introducing Women's Studies in Higher Education - Role of Women's Studies Centre – Women Studies Programme in India – UGC initiatives – Women's Studies in Tamil Nadu – Case Studies

UNIT: II — GENDER SOCIALIZATION — 9

Stages – Agencies of socialization – Social Construction of Gender Sex and Gender – Gender Discrimination Gender Stereotyping – Gender Sensitivity - Gender Roles – Gender Perspective – Gender Analysis – Gender Auditing – Gender Budgeting Gender Equity – Gender Equality - Gender Mainstreaming – Role Play

UNIT: III — ISSUES RELATED TO FEMALE CHILDREN — 9

Female feticide – Female infanticide – Child Marriage – Prostitution – Transgender and juvenile Girls HIV positive children – Differently abled Children – COVID19 Pandemic and girl child

UNIT: IV WOMEN AND INSTITUTIONS OF SOCIAL SYSTEM 9

Family – types – Marriage – types of marriage – Multiple roles of women – Caste – Class- Culture Religion and Social system – Initiatives for minorities empowerment – Evaluation

UNIT: V STATUS OF WOMEN 9

Status – Concept – Meaning – Definition – Types of status – Achieved and Ascribed status – factors and indicators of status of women-Status of women in Indian Society – Emerging trends in Women's Studies-Women Empowerment

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1 To understand the need and significance of Gender Studies.

CO2 To gain knowledge of key concepts and theories related to gender.

CO3 To develop awareness of issues concerning female children.

CO4 To evaluate the role of social institutions in shaping and perpetuating gender discrimination.

CO5 To understand the contemporary status and challenges faced by women in the present scenario.

REFERENCES

1 L. Ayu Saraswati, Barbara L. Shaw, and Heather Rellihan 2020 "Introduction to Women's, Gender and Sexuality Studies" ISBN: 9780190084806

2 Melissa J. Gillis, Andrew T. Jacobs 2019 "Introduction to Women's and Gender Studies: An Interdisciplinary Approach"

3 Eliza Long, 2022 “Introduction to Gender Studies” Social Sciences, ISBN9781641726917, Larsen and Keller Education

4 Maithreyi Krishna Raj, 1986, Women Studies in India – Some Perspectives, Popular Prakasham, Bombay

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	-	-	-	-	1	1	1	3	3	-	3	3	2	2
CO2	-	-	-	-	-	1	1	1	3	3	-	3	3	3	2
CO3	-	-	-	-	-	1	1	1	3	3	-	3	3	3	2
CO4	-	-	-	-	-	1	1	1	3	3	-	3	2	2	3
CO5	-	-	-	-	-	1	1	1	3	3	-	3	2	2	3

3 – High, 2 – Medium, 1- Low

CODE: 24MX3082	INDIAN KNOWLEDGE SYSTEMS	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	The course introduces India's traditional knowledge systems and shows their importance in today's world.
2	It explains how knowledge was created and used in fields like philosophy, science, medicine, arts, agriculture, and architecture.
3	Students learn the basic principles of IKS, focusing on holistic thinking, sustainability, and harmony between humans, society, and nature.
4	The course compares classical texts and indigenous practices with modern scientific ideas to encourage critical understanding.
5	It highlights how IKS can help solve current issues such as environmental protection, health, community welfare, and sustainable development.

UNIT: I	INTRODUCTION TO IKS	9

Definition and characteristics of Indian Knowledge Systems - Historical evolution from ancient times to the 18th century CE - Impact of colonial education policies and the need for revisiting traditional Knowledge - Traditional educational institutions: Gurukuls, Pathshalas, Takshashila, and Nalanda - Local heritage sites and their relevance.

UNIT: II	INTRODUCTION TO ANCIENT INDIAN MATHEMATICS AND ASTRONOMY	9

Mathematics: Ancient numeral systems and mathematical concepts - Logic: Indian logic systems and epistemology - Overview of Indian astronomy; celestial coordinate systems and calendar systems - Astronomical Instruments (Yantras)- Application of Physics and Chemistry

UNIT: III INTRODUCTION TO HEALTH AND MEDICINE 9

In-depth study of Ayurveda, its diagnostic methods, and therapeutic practices - Understanding the holistic approach to health encompassing physical, mental, and spiritual well-being - Application of Ayurveda principles in contemporary healthcare systems - Ayurvedic perspectives on health, including dietary regimes, disease management, elements of wellness—and their intersections with botany and medical science

UNIT: IV INTRODUCTION TO ANCIENT GOVERNANCE AND PUBLIC ADMINISTRATION 9

Analysis of ancient Indian governance models and administrative structures - Insights from texts like Arthashastra on statecraft and economics - Relevance of traditional governance principles in modern administrative Practices - Concept of Kingship; duties and responsibilities of a monarch - Three-tier political system: Dharmadanda, Rajdanda, Nyāyadanda - Law & administration, crime suppression, defence systems, foreign policy - Concept of wealth, ownership, and distribution - Kautilya's "Saptanga" model (seven sources of income) - Taxation, savings, and expenditure in ancient Indian economy

UNIT: V INTRODUCTION TO ANCIENT ARTS AND CULTURE 9

Study of traditional Indian art forms, including sculpture, dance, and music - Understanding the cultural significance and philosophical underpinnings of these art forms - Promotion of cultural heritage through education and practice - Temple architecture overview - Cave and monolithic architecture - Architectural styles: Chalukya, Pallava, Chola, Hoysala, Mauryan, Vijayanagara. Buddhist and Jain art & architectural heritage

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1 Understand what Indian Knowledge Systems are and how they developed.

CO2 Learn basic ideas of ancient Indian mathematics and astronomy.

CO3 Understand the principles of Ayurveda and holistic health.

CO4 Learn how ancient Indian governance and administration worked.

CO5 Understand traditional Indian art, architecture, and cultural heritage.

REFERENCES

1. Introduction to Indian Knowledge System: Concepts and Applications by B. Mahadevan .
2. Indian Knowledge System by Kapil Kapoor and Avadhesh Kumar Singh
3. Traditional Knowledge System in India by Amit Jha.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	-	-	-	-	-	1	-	-	2	2	-	-
CO2	3	3	2	2	-	-	-	-	1	-	-	2	3	-	-
CO3	2	2	1	-	-	-	-	-	1	-	-	3	2	2	-
CO4	2	3	2	1	-	-	-	-	2	-	-	2	-	-	-
CO5	1	2	1	-	-	-	-	-	1	-	-	2	2	2	-

3 – High, 2 – Medium, 1- Low

CODE: 24MX3083	PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To know the basic concept and function of Production and Operation Management for entrepreneurship.
2	To understand the Production process and planning.
3	To understand the Production and Operations Management Control for business owners.
4	To understand the Production and Management process
5	To understand the process of Controlling Productions.

UNIT : I **INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT** **9**

Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organization of production function, recent trends in production /operations management - production as an organizational function, decision making in production Operations research

UNIT: II **PRODUCTION & OPERATION SYSTEMS** **9**

Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry

UNIT: III **PRODUCTION & OPERATIONS PLANNING** **9**

Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning

UNIT: IV PRODUCTION & OPERATIONS MANAGEMENT PROCESS 9

Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters –- Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation -Forecasting methods.

UNIT: V CONTROLING PRODUCTION & OPERATIONS MANAGEMENT 9

Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	To understand the basics and functions of Production and Operation Management for business owners.
CO2	To learn about the Production & Operation Systems.
CO3	To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.
CO4	To known about the Production & Operations Management Processes in organisations.
CO5	To comprehend the techniques of controlling , Production and Operations in industries.

REFERENCES

1 Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.

2 Amitabh Raturi, Production and Inventory Management, , 2008.

3 Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.

4 Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.

5 Chary S.N, Production and Operations Management, TMH Publications, 2010.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	2	3	-	-	-	-	2	2	-	-	3	2	2
CO2	3	2	2	3	-	-	-	-	2	1	-	-	3	3	2
CO3	2	3	2	3	-	-	-	-	2	2	-	-	2	3	2
CO4	2	2	2	3	-	-	-	-	2	1	-	-	2	2	3
CO5	3	3	3	3	-	-	-	-	2	2	-	-	3	3	3

3 – High, 2 – Medium, 1- Low

CODE: 24MX3084	DISASTER RISK REDUCTION AND MANAGEMENT	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
2	To acquaint with the skills for planning and organizing disaster response
3	To understand the types, causes, and impacts of natural and man-made disasters.
4	To develop the skills to plan, respond to, and manage disaster situations effectively.
5	To learn strategies and methods for disaster prevention, preparedness, and mitigation.

UNIT: I HAZRADS, VULNERABILITY AND DISASTER RISKS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

UNIT: II DISASTER RISK REDUCTION (DRR) 9

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT: III **DISASTER MANAGEMENT** **9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT: IV **TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT** **9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development – Standard operation Procedure for disaster response – Financial planning for disaster Management

UNIT: V **DISASTER MANAGEMENT: CASE STUDIES** **9**

Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)
CO2	To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment

	prevention and risk reduction
CO3	To develop disaster response skills by adopting relevant tools and technology
CO4	Enhance awareness of institutional processes for Disaster response in the country
CO5	Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity

TEXT BOOKS

1	Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2	Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3	Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN- 13: 978-9380386423
4	Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

REFERENCES

1	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2	Government of India, National Disaster Management Policy, 2009.
3	Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2	3	-	-	1	1	2	2	-	-	2	-	1
CO2	3	3	3	3	-	-	1	1	2	1	-	-	2	-	1
CO3	3	3	3	3	-	-	1	1	2	2	-	-	2	-	1
CO4	3	3	2	3	-	-	1	1	2	1	-	-	2	-	1
CO5	3	3	2	3	-	-	1	1	2	2	-	-	3	-	1

3 – High, 2 – Medium, 1- Low

CODE: 24MX3085	WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To enjoy life happily with fun filled new style activities that help to maintain health also
2	To adapt a few lifestyle changes that will prevent many health disorders
3	To be cool and handbill every emotion very smoothly in every walk of life
4	To learn to eat cost effective but healthy foods that are rich in essential nutrients
5	To develop immunity naturally that will improve resistance against many health disorders

UNIT: I	HEALTH AND ITS IMPORTANCE	9

Health: Definition - Importance of maintaining health - More importance on prevention than treatment -Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath.

Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

UNIT: II	DIET	9

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet -Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes- Different cooking methods, merits and demerits of each method

UNIT: III	ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH	9

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.

Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Pancheekarana Theory / **(**Five Element Theory) 96 fundamental Principles - Uyir Thathukkal **(**Tri-Dosha Theory) - Udal Thathukkal

Prevention of illness with our traditional system of medicine

Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

UNIT: IV MENTAL WELLNESS 9

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

Sleep - Sleep and its importance for mental wellness - Sleep and digestion.

Immunity - Types and importance - Ways to develop immunity

UNIT: V YOGA 9

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	Learn the importance of different components of health
CO2	Gain confidence to lead a healthy life
CO3	Learn new techniques to prevent lifestyle health disorders
CO4	Understand the importance of diet and workouts in maintaining health
CO5	Understand the importance of yoga and physical fitness.

TEXT BOOKS

1	Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2	Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

REFERENCES

1	What we know about emotional intelligence How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts
2	A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	-	-	-	-	-	-	1	-	1	-	-	-
CO2	3	2	2	-	-	-	-	-	-	1	-	1	-	-	-
CO3	2	1	2	-	-	-	-	-	-	2	1	1	-	-	-
CO4	1	-	2	-	-	-	-	-	-	2	1	2	-	-	-
CO5	2	1	1	-	-	-	-	-	-	1	1	2	-	-	-

3 – High, 2 – Medium, 1- Low

MANDATORY COURSES II

SYLLABUS

CODE: 24MX3086	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
2	To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
3	To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
4	To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
5	To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT: I	ENVIRONMENT AND BIODIVERSITY	9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT: II **ENVIRONMENTAL POLLUTION** **9**

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts .

UNIT: III **RENEWABLE SOURCES OF ENERGY** **9**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT: IV **SUSTAINABILITY AND MANAGEMENT** **9**

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT: V **SUSTAINABILITY PRACTICES** **9**

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio economical and technological change.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
CO2	To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
CO3	To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
CO4	To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
CO5	To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.

TEXT BOOKS

1	Anubha Kaushik and C. P. Kaushik’s “Perspectives in Environmental Studies”, 6th Edition, New Age International Publishers ,2018.
2	Benny Joseph, ‘Environmental Science and Engineering’, Tata McGraw-Hill, New Delhi, 2016.
3	Gilbert M.Masters, ‘Introduction to Environmental Engineering and Science’, 2nd edition, Pearson Education, 2004.

REFERENCES

1	R.K. Trivedi, ‘Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards’, Vol. I and II, Enviro Media. 38 . edition 2010.

2 Cunningham, W.P. Cooper, T.H. Gorhani, ‘Environmental Encyclopedia’, Jaico Publ., House, Mumbai, 2001.

3 Dharmendra S. Sengar, ‘Environmental law’, Prentice hall of India PVT. LTD, New Delhi, 2007.

4 Rajagopalan, R, ‘Environmental Studies-From Crisis to Cure’, Oxford University Press, Third Edition, 2015.

5 ErachBharucha “Textbook of Environmental Studies for Undergraduate Courses” Orient Blackswan Pvt. Ltd. 2013.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	-	-	-	2	3	-	-	-	-	2	-	-	-
CO2	3	2	-	-	-	3	3	-	-	-	-	2	-	-	-
CO3	3	-	1	-	-	2	2	-	-	-	-	2	-	-	-
CO4	3	2	1	1	-	2	2	-	-	-	-	2	-	-	-
CO5	3	2	1	-	-	2	2	-	-	-	-	1	-	-	-

3 – High, 2 – Medium, 1- Low

CODE: 24MX3087	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To understand the basic concepts of history and science in India.
2	To learn about important historians of science and technology.
3	To study science and technology in ancient India.
4	To study science and technology in medieval India.
5	To learn about science and technology in colonial and modern India.

UNIT: I **CONCEPTS AND PERSPECTIVES** **9**

Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT: II **HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA** **9**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

UNIT: III **SCIENCE AND TECHNOLOGY IN ANCIENT INDIA** **9**

Technology in pre-historic period Beginning of agriculture and its impact on technology Science and

Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200.

UNIT: IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA 9

Legacy of technology in Medieval India, Interactions with Arabs Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences Science and Technology on the eve of British conquest

UNIT: V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA AND POST-INDEPENDENT INDIA 9

Science and the Empire Indian response to Western Science Growth of techno-scientific institutions-Science, Technology and Development discourse Shaping of the Science and Technology Policy Developments in the field of Science and Technology Science and technology in globalizing India Social implications of new technologies like the Information Technology and Biotechnology

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	Understand the relationship between history, science, and society in India.
CO2	Recognize contributions of major historians of science.
CO3	Explain scientific and technological developments in ancient India.
CO4	Describe science and technology during medieval India.
CO5	Understand modern science and technology and their social impact in India.

REFERENCES

1 History of Science and Technology in India by Dr. Binod Bihari Satpathy

2 R. Parthasarathy, Paths of Innovators In Science, Engineering and Technology, EastWest Books (Madras) Pvt. Ltd, 2000.

3 Glimpses of India‘s Statistical Heritage, Edited by: J.K. Ghosh, S.K. Mitra, K.R. Parthasarathy, Wiley Eastern Limited, 1992.

4 Jagjit Singh, Some Eminent Indian Scientists, Publications Division, Ministry of Information and Broadcasting, Government of India, 1991.

5 B.C. Berndt and R.A. Rankin, Ramanujan: Essays and Surveys, Hindustan Book Agency, 2003.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	-	-	-	-	-	3	2	2	-	2	1	3	-	-	-
CO2	-	-	-	-	-	3	2	2	-	2	1	3	-	-	-
CO3	-	-	-	-	-	3	2	2	-	2	1	3	-	-	-
CO4	-	-	-	-	-	3	2	2	-	2	1	3	-	-	-
CO5	-	-	-	-	-	3	2	3	-	2	1	3	-	-	-

3 – High, 2 – Medium, 1- Low

CODE: 24MX3088	POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To introduce students to human needs, desires, and the evolution of political and economic systems aimed at fulfilling them.
2	To examine and critically analyse major political and economic systems, including capitalism, communism, fascism, welfare state, and liberal democracy.
3	To explore Gandhian thought and Indian civilisational perspectives as models for a humane and just society.
4	To understand the role of technology, education, and social transformation in shaping human welfare and societal progress.
5	To enable students to evaluate and propose alternative political-economic frameworks that promote equity, sustainability, and human well-being.

UNIT: I	FOUNDATIONS OF A HUMANE SOCIETY	9

Considerations for a humane society – Holistic thought – Human being's desires – Harmony in the self – Harmony in human relationships – Harmony in society and nature – Introduction to societal systems.

UNIT: II	CAPITALISM, FASCISM & TOTALITARIAN SYSTEMS	9

Capitalism: Free Markets, Demand–Supply, Perfect Competition, Laissez-Faire, Monopolies, Imperialism – Liberal Democracy. Fascism & Totalitarianism – World War I & II – Cold War.

UNIT: III	COMMUNISM & WELFARE STATE	9

Communism: Mode of production – Theory of labour – Surplus value – Class struggle – Dialectical materialism – Historical materialism – Russian and Chinese models. Welfare State: relation with human desires – Empowered human beings – Satisfaction and well-being.

UNIT: IV GANDHIAN THOUGHT & INDIAN CIVILISATION 9

Gandhian thought: Swaraj – Decentralized economy and polity – Community life – Control over one's life – Relationship with nature. Essential elements of Indian civilisation – Cultural, ethical and social foundations.

UNIT: V TECHNOLOGY, EDUCATION & FUTURE DIRECTIONS 9

Technology as a driver of society – Technology and human relationships – Role of education in shaping society – Social transformation – Future directions for a humane society – Conclusion.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	Understand the relationship between human needs, desires, and the evolution of political and economic systems.
CO2	Analyse and compare different political-economic systems, including capitalism, communism, fascism, welfare state, and liberal democracy, in terms of human welfare and social justice.
CO3	Evaluate Gandhian thought and Indian civilisational perspectives as approaches to building a humane and equitable society.
CO4	Assess the role of technology, education, and social transformation in shaping society and promoting human well-being.
CO5	Apply political-economic theories and perspectives to contemporary issues and propose pathways for a sustainable and humane society.

REFERENCES

1. M.K. Gandhi, Hind Swaraj, Navajivan Publishing House
2. Adam Smith, The Wealth of Nations, Oxford University Press
3. Karl Marx, Selected Writings, Oxford University Press
4. E.F. Schumacher, Small Is Beautiful: Economics as if People Mattered, Harper & Row

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	1	-	-	-	-	-	-	-	-	1	-	-	-
CO2	3	3	2	2	-	-	-	-	1	-	-	2	-	-	-
CO3	3	2	2	1	-	-	-	-	2	1	-	2	-	-	-
CO4	2	2	2	3	2	-	-	-	2	1	1	2	-	-	-
CO5	3	3	2	2	2	-	-	-	3	2	1	2	-	-	-

3 – High, 2 – Medium, 1- Low

CODE: 24MX3089	STATE, NATION BUILDING AND POLITICS IN INDIA	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To provide an understanding of the State, its functions, and the working of its main organs.
2	To explain the primacy of politics, political processes, and the concept of sovereignty, including its changing nature in a globalized world.
3	To acquaint students with the major developments and legacies of the Indian national movement and constitutional evolution.
4	To analyse the rationale for adopting a Parliamentary–Federal system in India and understand the broad philosophy underlying the Indian Constitution.
5	To examine the challenges of national integration and nation-building, and to encourage students to envision future pathways for a more inclusive and better India.

UNIT: I **STATE, SOVEREIGNTY AND POLITICAL SYSTEM** **9**

Understanding the Need and Role of the State – Meaning and Scope of Politics – Development of the Nation-State – Concept of Sovereignty – Types and Features of Sovereignty – Sovereignty in a Globalized World – Organs of the State: Executive, Legislature, Judiciary – Functions of Each Organ – Separation of Powers – Forms of Government: Unitary and Federal; Presidential and Parliamentary Systems.

UNIT: II **IDEA OF INDIA AND THE NATIONAL MOVEMENT** **9**

The Idea of India – 1857 and the National Awakening – Emergence of National Consciousness – Formation of the Indian National Congress (1885) – Phases of the National Movement – Legacies of the Freedom Struggle – Constitution Making Process – Constituent Assembly Debates – Goals, Objectives and Philosophy of the Indian Constitution.

UNIT: III FEDERALISM, NATIONAL INTEGRATION AND NATION-BUILDING 9

Why a Federal System? – Features of Indian Federalism – Centre–State Relations – National Integration: Meaning, Need and Challenges – Nation-Building: Issues of Identity, Diversity and Unity – Challenges of Nation-Building – Rajni Kothari's "State Against Democracy" – Democracy, Pluralism and Integration.

UNIT: IV SOCIAL MOVEMENTS AND POLITICAL TRANSFORMATION 9

New Social Movements – Women's Movements – Farmers' Movements – Dalit Movements – Environmental Movements – Human Rights Movements – Civil Society and People's Initiatives – Role of Social Mobilization in Nation-Building – Political Participation and Citizenship.

UNIT: V CONTEMPORARY INDIAN POLITICAL SYSTEM AND FUTURE DIRECTIONS 9

The Changing Nature of the Indian Political System – Shifts in Party Systems – Electoral Behaviour – Governance Challenges – Role of Media and Public Opinion – Political Reforms – Future Scenario of Indian Democracy – What Can We Do? – Strengthening Participation, Accountability and Democratic Governance.

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	Explain the theoretical foundations of the State, its organs, and their functioning within the political system.
CO2	Describe the historical background, philosophy and evolution of the Indian political system and constitutional framework.
CO3	Analyse the major streams, issues and challenges related to national integration and nation-building in India.

CO4	Evaluate the functioning of India’s political processes and governance mechanisms from an informed and critical perspective.
CO5	Propose constructive ways for effective citizen participation aimed at strengthening governance, democratic delivery systems, and societal well-being.

REFERENCES

1 Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.

2 Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.

3 Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.

4 Sumantra Bose, Transforming India: Challenges to the World’s Largest Democracy, Picador India, 2013.

5 AtulKohli, Democracy and Discontent: India’s Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.

6 M. P. Singh and RekhaSaxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.

7 Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	-	2	-	3	2	2	2	2	-	3	3	-	-
CO2	2	2	-	2	-	2	2	2	1	2	-	3	3	-	-
CO3	2	3	-	3	-	3	3	2	2	2	-	3	3	2	2
CO4	2	3	2	3	-	3	3	2	2	3	-	3	3	2	2
CO5	2	2	2	3	-	3	3	2	3	3	2	3	3	3	3

3 – High, 2 – Medium, 1- Low

CODE: 24MX3090	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	0

COURSE OBJECTIVES:

1	To Understand the Introduction and basic Terminologies safety.
2	To enable the students to learn about the Important Statutory Regulations and standards.
3	To enable students to Conduct and participate the various Safety activities in the Industry.
4	To have knowledge about Workplace Exposures and Hazards.
5	To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT: I SAFETY TERMINOLOGIES 9

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects-Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

UNIT: II STANDARDS AND REGULATIONS 9

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT: III SAFETY ACTIVITIES 9

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan-Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT: IV	**WORKPLACE HEALTH AND SAFETY**	**9**

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT: V	**HAZARD IDENTIFICATION TECHNIQUES**	**9**

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

TOTAL: 45 PERIODS

COURSE OUTCOMES :

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

CO1	Understand the basic concept of safety.
CO2	Obtain knowledge of Statutory Regulations and standards.
CO3	Know about the safety Activities of the Working Place.
CO4	Analyze on the impact of Occupational Exposures and their Remedies
CO5	Obtain knowledge of Risk Assessment Techniques.

TEXT BOOKS

1	R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
2	L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCES

1 Frank Lees (2012) ‘Lees’ Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.

2 John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.

3 Dan Petersen (2003) Techniques of Safety Management: A System Approach.

4 Alan Waring.(1996).Safety management system: Chapman &Hall,England

5 Society of Safety Engineers, USA

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	3	1	1	3	2	2	3	3	1	3	3	3	3
CO2	2	3	2	2	1	3	2	3	3	2	1	3	3	3	3
CO3	2	2	2	2	1	2	2	2	3	2	1	2	3	3	3
CO4	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	3	2	3	2	2	3	2	2	3	2	2	3	3	3	3

3 – High, 2 – Medium, 1- Low

OPEN ELECTIVE I

SYLLABUS

CODE: 24OEEE01	SEMICONDUCTOR MEMORIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Different types of semiconductor memories.
2	Architectures of Static, Random Access, and Non-volatile memories.
3	Fault modelling and testing procedures for memory circuits.

UNIT: I	RANDOM ACCESS MEMORY TECHNOLOGIES	9

Static Random Access Memories (SRAMs): SRAM Cell Structures – MOS SRAM Architecture – MOS SRAM Cell and Peripheral Circuit Operation – Bipolar SRAM Technologies – Silicon On Insulator (SOI) Technology – Advanced SRAM Architectures and Technologies – Application Specific SRAMs. **Dynamic Random Access Memories (DRAMs):** DRAM Technology Development – CMOS DRAMs – DRAM Cell Theory and Advanced Cell Structures – BiCMOS DRAMs – Soft Error Failures in DRAMs – Advanced DRAM Designs and Architectures.

UNIT: II	NON-VOLATILE MEMORIES	9

Masked Read-Only Memories (ROMs) – High Density ROMs – Programmable Read-Only Memories (PROMs) – Bipolar PROMs – CMOS PROMs – Erasable (UV) PROMs (EPROMs) – Floating-Gate EPROM Cell – One-Time Programmable (OTP) EPROM – Electrically Erasable PROMs (EEPROMs) – EEPROM Technology and Architecture – Non-volatile SRAM – Flash Memories (EPROMs/EEPROMs) – Advanced Flash Memory Architecture.

UNIT: III	MEMORY FAULT MODELLING & TESTING	9

RAM Fault Modelling – Electrical Testing – Pseudo Random Testing – Megabit DRAM Testing – Non-volatile Memory Modelling and Testing – IDDQ Fault Modelling and Testing – Application-Specific Memory Testing.

UNIT: IV SEMICONDUCTOR MEMORY RELIABILITY 9

General Reliability Issues – RAM Failure Modes and Mechanisms – Non-volatile Memory Reliability – Reliability Modelling and Failure Rate Prediction – Design for Reliability – Reliability Test Structures – Reliability Screening and Qualification.

UNIT: V SEMICONDUCTOR MEMORY RADIATION EFFECTS 9

Radiation Effects – Space Radiation Environments – Total Dose Effects – Single Event Phenomena – Non-volatile Memory Radiation Characteristics – Radiation Hardening Techniques – Process and Design Issues – Radiation Hardness Assurance and Testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Synthesize Static and Dynamic Memory structures.
CO2	Decide the type of memory suitable for a specific application.
CO3	Analyze modelling for memory faults and testing procedures.
CO4	Examine reliability issues of semiconductor memory.
CO5	Understand the effects of radiation on memory.

TEXT BOOKS:

1	Andrea Redaelli & Fabio Pellizzer, *Semiconductor Memories and Systems*, Elsevier, Woodhead Publishing, 2022.
2	Ashok K. Sharma, *Advanced Semiconductor Memories: Architecture, Designs and Applications*, Wiley Interscience, IEEE Press, 2009.

REFERENCES:

1 Kiyoo Itoh, *VLSI Memory Chip Design*, Springer, 2013.

2 Chenming C. Hu, *Modern Semiconductor Devices for Integrated Circuits*, Pearson/Prentice Hall, New Jersey, 2010.

3 Andrea Redaelli & Fabio Pellizzer, *Semiconductor Memories and Systems*, Elsevier, Woodhead Publishing, 2022.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	1	1	-	-	-	-	-	-	2	3	2	3
CO2	3	2	2	2	1	-	-	-	-	-	-	2	3	2	3
CO3	2	3	2	3	1	-	-	-	-	-	-	3	3	2	2
CO4	2	2	3	3	1	-	-	-	-	-	-	3	3	3	2
CO5	1	2	1	2	1	-	-	-	-	-	-	2	2	3	1
Avg.	**2**	**2**	**2**	**2**	**1**	-	-	-	-	-	-	**2**	**3**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEE02	ELECTRICAL SAFETY AND SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Basics of electrical fire and statutory requirements for electrical safety.
2	The causes of accidents due to electrical hazards.
3	The various protection systems in Industries from electrical hazards.
4	The importance of earthing.
5	The various hazardous zones and applicable fire proof electrical devices.

UNIT: I	INTRODUCTION ABOUT ELECTRICAL SAFETY AND SAFETY MANAGEMENT	9

Introduction – electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference–Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety – first aid-cardio pulmonary resuscitation (CPR)

UNIT: II	ELECTRICAL HAZARDS	9

Primary and secondary hazards - shocks, burns, scalds, falls - Human safety in the use of electricity - Classes of insulation-voltage classifications -current surges- over current and short circuit current-heating effects of current-electrical causes of fire and explosion. Lightning hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

UNIT: III	PROTECTION SYSTEMS	9

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines - overload and short circuit protection. Earth leakage circuit breaker (ELCB)- use of low voltage-electrical guards-Personal protective equipment.

UNIT: IV SELECTION, INSTALLATION, OPERATION AND MAINTENANCE 9

Role of environment in selection- protection and interlock self diagnostic features and fail safe concepts-lock out and work permit system - safety in the use of portable tools-cabling and cable joints-preventive maintenance.

UNIT: V HAZARDOUS ZONES 9

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification- use of barriers and isolators.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Clarify the statutory requirements related to electrical safety
CO2	Elucidate the basic concepts in electrical circuit and hazards involved in it.
CO3	Explicate the electrical hazards in Industries.
CO4	Expound the operation of various protection systems from electrical hazards.
CO5	Recognize different hazardous zones in Industries

TEXT BOOK:

1 Rao.S,”Electrical Safety Fire Safety Engineering and Safety Management”, Khanna Publications, 2nd Edition, 2012.

REFERENCES:

1 Fordham Cooper, W., “Electrical Safety Engineering” Butterworth and Company, London, 2006.

2 Indian Electricity Act and Rules, Government of India.

3 Power Engineers – Handbook of TNEB, Chennai, 2009.

4	Martin Glov, 'Electrostatic Hazards in powder handling', Research Studies Pvt.Ltd., England, 2008.
5	Dr.Massim A.G.Mitolo, 'Electrical safety of Low voltage systems', Mc Graw Hill 2009
6	John Cadick et al., 'Electrical safety Handbook', Third Edition, Mc Graw Hill 2006

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	**-**	1	2	3	2	**-**	1	**-**	2	3	1	1
CO2	3	2	1	**-**	1	2	3	1	**-**	1	**-**	2	3	1	1
CO3	3	2	2	**-**	1	2	3	1	**-**	1	**-**	2	3	1	1
CO4	3	2	2	**-**	2	2	3	1	**-**	1	**-**	2	3	1	2
CO5	3	2	1	**-**	1	2	3	2	**-**	1	**-**	2	3	1	2
Avg.	**3**	**2**	**1**	**-**	**1**	**2**	**3**	**1**	**-**	**1**	**-**	**2**	**3**	**1**	**1**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC01	IOT CONCEPTS AND APPLICATIONS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1	To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
2	To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
3	To introduce the technologies behind Internet of Things(IoT).
4	To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
5	To apply the concept of Internet of Things in real world scenario.

UNIT: I INTRODUCTION TO INTERNET OF THINGS 5

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

UNIT: II COMPONENTS IN INTERNET OF THINGS 5

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

UNIT: III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT: IV OPEN PLATFORMS AND PROGRAMMING 7

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT: V **IOT APPLICATIONS** **7**

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

TOTAL: 30 PERIODS

PRACTICAL EXERCISES:

1	Introduction to Arduino platform and programming
2	Interfacing Arduino to Zigbee module
3	Interfacing Arduino to GSM module
4	Interfacing Arduino to Bluetooth Module
5	Introduction to RaspberryPI platform and python programming
6	Interfacing sensors to RaspberryPI
7	Communicate between Arduino and RaspberryPI using any wireless medium
8	Setup ac loud platform to log the data
9	Log Data using RaspberryPI and upload to the cloud platform
10	Design an IOT based system

TOTAL: 30 PERIODS

TOTAL :30+30= 60 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the concept of IoT.

CO2 Understand the communication models and various protocols for IoT.

CO3 Design portable IoT using Arduino/Raspberry Pi /open platform

CO4 Apply data analytics and use cloud offerings related to IoT.

CO5 Analyze applications of IoT in real time scenario.

TEXT BOOKS:

1 Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017

2 Samuel Green gard, The Internet of Things, The MIT Press, 2015

REFERENCES:

1 PerryLea,"Internetofthingsforarchitects",Packt,2018

2 Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applicationsandProtocols",Wiley,2012

3 IOT(InternetofThings)Programming:ASimpleandFastWayofLearning,IOTKindleEdition

4 DieterUckelmann,MarkHarrison,Michahelles,Florian(Eds),"ArchitectingtheInternetof Things", Springer, 2011.

5 ArshdeepBahga,VijayMadisetti,"InternetofThings—Ahands-onapproach",UniversitiesPress, 2015

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	-	-	1	-	-	-	-	2	-	2	3	1	-
CO2	3	2	1	-	2	-	-	-	-	2	-	1	3	2	-
CO3	2	2	3	1	3	1	-	-	-	2	1	2	3	2	1
CO4	2	1	3	3	3	-	-	-	2	3	2	2	3	3	2
CO5	1	2	2	-	2	1	3	2	2	3	-	2	2	3	2
Avg.	**3**	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC02	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To understand the basics of drone concepts
2	To learn and understand the fundaments of design, fabrication and programming of drone
3	To impart the knowledge ofa flying and operation of drone
4	To know about the various applications of drone
5	To understand the safety risks and guidelines of fly safely

UNIT: I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept- Vocabulary Terminology-History of drone-Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship -Opportunities/applications for entrepreneurship and employability

UNIT: II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT: III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications

UNIT: IV	DRONE COMMERCIAL APPLICATIONS	9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT: V	FUTURE DRONES AND SAFETY	9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Know about a various type of drone technology, drone fabrication and programming.
CO2	Execute the suitable operating procedures for functioning a drone
CO3	Select appropriate sensors and actuators for Drones
CO4	Develop a drone mechanism for specific applications
CO5	Create the programs for various drones

TEXT BOOKS:

1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2	TerryKilby and Belinda Kilby, “Make: Getting Started with Drones“,Maker Media, Inc, 2016

REFERENCES:

1. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016
2. Zavrsnik, “Drones and Unmanned Aerial Systems: Legaland Social Implications for Security and Surveillance”, Springer, 2018

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
Avg.	**1**	**2**	**3**	**1**	**3**	**2**	-	-	-	-	-	**1**	**2**	**1**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE01	PLASTIC AND E-WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To know various sources of plastics waste generation and the segregation methods for recycling the plastics and recycling codes of commodity and engineering plastics.
2	To learn about primary recycling techniques with examples/case studies.
3	To understand the recycling of various commodity and engineering plastics.

UNIT: I SOURCES AND CHARACTERIZATION 9

Plastic and environment value additions, global policy, regulations, waste energy management. Waste treatment of various plastic plants, estimations of power requirement &efficiency of sizereductionoperationofplastics,environmentpollutionaspects.Needfor recycling – Sorting and segregation of waste – Plastics identification- Plastics Production and composition—Plasticswaste—Composition,quantitiesanddisposalalternatives.

UNIT: II PRIMARY RECYCLING OF PLASTIC WASTES 9

Primary recycling – Equipment's for primary recycling. Specific recycling techniques – PE films, PP battery case – Crushing and separation – PET films.

UNIT: III SECONDARY RECYCLING OF PLASTIC WASTES 9

Recycling of plastics from urban waste – rheology, density, mechanical behavior. Secondary recycling Plastics wastes containing paper – hydrolytic treatment – processing methods – processingofmixedplasticswaste—householdwaste—industrialsector—TPObased materials.

UNIT: IV TERTIARY RECYCLING OF PLASTIC WASTES 9

Use of recyclable plastics in motor vehicles – recoverable materials – disposal of residuals – recyclable plastic components – virgin and recycled HDPE – Fluorinated and unfluorinated HDPE –fueltanks. Tertiary recycling –Reactors used – Advantages – Dry method wet method -use of recyclable plastics in automobiles.

UNIT: V **EWASTE MANAGEMENT** **9**

E-waste;compositionandgeneration.Globalcontextine-waste;E-wastepollutants,Ewaste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management, Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials- mechanical processing, technologies for recovery of materials, occupational and environmental health perspectives of recycling e-waste in India

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Sources of plastics waste generation and the segregation methods for recycling the plastics
CO2	Understand the various equipment for recycling of plastics
CO3	Understand the process involved in secondary recycling of plastics
CO4	Comprehend the tertiary recycling of plastics
CO5	Understand the process involved in Ewaste management

TEXT BOOKS:

1	Polymer recycling, Science, Technology and Applications, John Scheirs, John Wiley and Sons, England, 1988.
2	Recycling of Plastic Materials(Ed), Francesco Paolo LaMantia, ChemTecPublishing,1993
3	Plastics Waste Management(Ed),Nabil Mustafa, Marcel Dekker,NewYork,1995.

REFERENCES:

1. Degradable polymers, Recycling and Plastic Waste Management (Eds) Ann Christine Albertson and Samuel J. Huang, Marcel Dekker, New York.
2. Recycling and Plastics Waste Management, Edited by Dr.J.S. Anand, CIPET,1 997.
3. Degradable polymers, Recycling and Plastic Waste Management (Eds) Ann Christine Albertson and Samuel J. Huang, Marcel Dekker, New York.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO2	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO3	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO4	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
CO5	1	2	3	1	3	2	-	-	-	-	-	1	2	1	3
Avg.	**1**	**2**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE02	REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To educate the students on aspects of Remote Sensing
2	Develop the different remote sensing technique
3	To educate the students on aspects of GIS and data management
4	Develop the GIS Applications for monitoring and management of environment

UNIT: I — ELEMENTS OF REMOTE SENSING — 9

Historical Perspective, Principles of remote sensing, components of Remote Sensing, Energy source and electromagnetic radiation, Electromagnetic spectrum, Energy interaction, Spectral response pattern of earth surface features, Energy recording technology

UNIT: II — REMOTE SENSING TECHNOLOGY — 9

Classification of Remote Sensing Systems, Aerial photographs, Photographic systems — Across track and along track scanning, Multispectral remote sensing, Thermal remote sensing, Microwave remote sensing—Active and passive sensors, RADAR, LIDAR

UNIT: III — SATELLITE REMOTE SENSING — 9

Satellites and their sensors, satellite orbits, Indian space programme - Research and development - ISRO satellites, LANDSAT, ERS, SPOT, TERRA and NOOA satellite series, Characteristics of Remote Sensing data, Satellite data Products

UNIT: IV — REMOTE SENSING APPLICATIONS AND CASESTUDIES — 9

Visual image interpretation, Digital image processing—Image rectification, Enhancement, transformation, Classification, Data merging – Remote sensing applications in Monitoring and management of environment-Conservation of resources, Disaster management, Sustainable urban land use, Agriculture, EIA, Marine and Coastal zone management—Case studies

UNIT: V GEOGRAPHICAL INFORMATION SYSTEM CASESTUDIES 9

GIS - Concepts and components, Spatial and non-spatial data, Vector and raster data structures, Data analysis, Data base management—RS—GIS Integration, Image processing software, GIS software GIS applications in Monitoring and management of environment-Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Know the remote sensing principle and the different stages of remote sensing
CO2	Understand the various type remote sensing technology.
CO3	Apply the knowledge of satellite sensing system for different environmental issues.
CO4	Apply the knowledge of GIS and image analysis for environmental applications.
CO5	Develop the GIS database. And work with multi-disciplinary team.

REFERENCES:

1 Lillesand, T.M. and Kiefer, R.W, "Remote sensing and image interpretation", John Wileyand sons, New York, 2018.

2 Golfried Konechy, Geo information: "Remote sensing, Photogrammetry and Geographical Information Systems", CRC press, 1st Edition, 2017.

3 Burrough,P.A.and McDonnell,R.A.,"PrinciplesofGeographicInformationsystems" Oxford University Press, New York, 2017.

4 "Pmaplerand Applications of Imaging RADAR", Manual of Remote Sensing, Vol.2, ASPR, 2011.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	-	-	-	-	2	-	-	-	-	-	3	-	-	-
CO2	-	2	-	-	-	-	-	2	2	-	-	-	-	-	-
CO3	-	2	-	-	3	-	-	2	3	-	-	3	-	-	3
CO4	2	-	3	2	3	2	2	-	-	2	3	-	3	2	3
CO5	-	-	2	2	-	-	3	-	3	2	3	2	2	2	2
Avg.	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS01	ADVANCED JAVA TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Gain knowledge in server-side development using Java Servlets, JSP, and EJB technologies.
2	Explore and apply software design patterns and enterprise frameworks in real-time applications.
3	Understand database creation concepts and perform essential database operations using Java.
4	Acquire familiarity with Java Mail and Java Message Service (JMS) for enterprise communication and messaging.
5	Learn to implement and utilize J2EE web services for distributed web applications.

UNIT: I — JSP AND ENTERPRISE JAVA BEANS — 9

J2EE and J2SE– Java and XML – Java Servlets - JSP: Java Server Pages - JSP Tags – Tomcat – Request String - User Session – Cookies – Session Objects. EJB: Container – Classes – Interfaces - Deployment Descriptors – Session Java Bean – Entity Java Bean – Message Driven Bean – JAR File.

UNIT: II — ENTERPRISE JAVA DESIGN PATTERNS AND FRAMEWORKS — 9

J2EE Multi-Tier Architecture - J2EE Best Practices -Enterprise Application Strategy – The Enterprise Application – Clients - Sessions Management - Web Tier and JSP – EJB Tier –MVC - Struts framework: overview – architecture – Struts Action class– Using Struts HTML tags – Struts validation framework – Developing application with Struts. Introduction to Spring – Introduction to Hibernate.

UNIT: III — ENTERPRISE DATABASE CONCEPTS — 9

Database Concepts – Database Schema – Creating Tables – Indexing – Inserting Data – Selecting Data – Metadata – Updating Data – Deleting Data – Joining Tables – Calculating Data – Grouping and Ordering Data – Sub Queries - View

UNIT: IV **ENTERPRISE JAVA INTERCONNECTIVITY** **9**

Java Mail API - Java Activation Framework - Protocols - Send Email Message - Retrieving Email Messages - Deleting Email Messages - Replying to and Forwarding an Email Message – Sending/Receiving - Searching an Email Folder. Java Message service: Components of a JMS Program - Message Selector – Sending/ Receiving Messages to/from a Queue - Creating a Publisher/Subscriber - Creating a Message Listener - Compiling and Running the Publisher and Subscriber.

UNIT: V **ENTERPRISE JAVA WEB SERVICES** **9**

SOAP: Basics - Java API for XML Messaging - Create, Send, and Receive a Point-to-Point SOAP Message - Using a Messaging Provider - Creating a SOAP Attachment–UDDI: UDDI API – Inquiry API – Publishing API - Electronic Business XML - Java API for XML Registries - Web Services Description Language (WSDL)

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Build dynamic web applications using Java Servlets, Java Server Pages, and Enterprise JavaBeans.
CO2	Implement suitable enterprise design patterns and frameworks to develop scalable Java solutions.
CO3	Develop database-driven enterprise applications using Enterprise Java technologies.
CO4	Design and integrate GUI-based Enterprise Java applications with communication services such as JavaMail and JMS.
CO5	Implement and deploy Enterprise Java web services to support real-time application needs.

TEXT BOOK:

1 Jim Keogh, “J2EE The Complete Reference”, McGraw Hill, 2017.

REFERENCES:

1. Antonio Goncalves, “Beginning Java™ EE 6 Platform with GlassFish™ 3”, Second Edition, Apress, 2009.

2. Jeffrey C. Jackson, "Web Technologies – A Computer Science Perspective", Pearson Education, 2011.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	3	2	3	-	-	1	2	2	1	1	3	3	2
CO2	2	3	3	2	3	-	-	1	2	2	1	1	3	3	2
CO3	2	3	3	2	3	-	-	1	2	2	2	1	3	3	2
CO4	1	2	3	1	3	-	-	1	3	3	2	1	3	3	2
CO5	2	3	3	2	3	-	-	1	2	3	2	2	3	3	3
Avg.	**2**	**3**	**3**	**2**	**3**	-	-	**1**	**2**	**2**	**2**	**1**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS02	MACHINE LEARNING PARADIGMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Gain foundational understanding of machine learning principles and core algorithms.
2	Study the structure and working of multilayer neural networks and support vector machines.
3	Analyze and choose appropriate tree-based and ensemble learning models for various tasks.
4	Apply graphical models and clustering techniques for pattern discovery and inference.
5	Investigate advanced machine learning paradigms for complex real-world applications.

UNIT: I	**INTRODUCTION**	**9**

Machine Learning–Types of Machine Learning –Machine Learning process- Weight Space- Curse of Dimensionality- Testing machine learning algorithms - Turning data into probabilities- Basic statistics- Bais and variance trade off- Neural networks- Perceptron- Linear separability -Linear regression

UNIT: II	**MULTILAYER NEURAL NETWORK AND SVM**	**9**

Forward propagation-Back propagation of error- Multi-layer perceptron networks- Examples of using MLP-Deriving Back propagation-Support Vector Machines-Optimal Separation-Kernels-Support Vector Machine algorithm-Extensions to SVM

UNIT: III	**DECISION TREE AND ENSEMBLE LEARNING**	**9**

Structure of decision tree-Decision tree induction algorithms-Validating and pruning of decision trees- Ensemble techniques – Parallel ensemble models- Incremental ensemble models – Sequential ensemble models

UNIT: IV GRAPHICAL MODELS AND CLUSTERING METHODS 9

Bayesian belief network – Markov chain methods – Hidden Markov model- Clustering approaches – Proximity measures- Hierarchical clustering methods – Partitioning clustering methods – Density based methods – Grid and Probability based approaches – Cluster evaluation methods

UNIT: V ADVANCED MACHINE LEARNING PARADIGMS 9

Interpretable and Explainable Machine Learning- Introduction to Deep Learning Networks-Convolutional neural networks- Transfer learning – Recurrent neural networks – LSTM – Applications of Deep learning

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Understand and apply fundamental mathematical and logical concepts used in machine learning techniques.
CO2	Utilize multilayer neural networks and support vector machines to solve real-time problems.
CO3	Design and implement decision tree and ensemble learning models for diverse applications.
CO4	Develop solutions using probabilistic graphical models and clustering algorithms.
CO5	Employ deep learning approaches to address complex, real-world scenarios.

TEXT BOOKS:

1	Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, Second Edition, 2014.
2	S Sridhar, M Vijayalakshmi, Machine Learning, Oxford University Press, First Edition, 2021.

REFERENCES:

1 Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.

2 Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.

3 Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer, 2009.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	1	2	2	-	-	1	1	1	-	2	3	2	2
CO2	2	3	2	2	3	-	-	1	1	2	1	2	3	3	3
CO3	2	3	3	2	3	-	-	1	1	2	1	2	3	3	3
CO4	2	3	2	3	3	-	-	1	1	2	1	2	3	3	3
CO5	2	3	3	3	3	-	-	1	2	3	1	3	3	3	3
Avg.	**2**	**3**	**2**	**2**	**3**	**-**	**-**	**1**	**1**	**2**	**1**	**2**	**3**	**3**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OEME01	FUNDAMENTALS OF AERONAUTICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To learn the different component systems and functions
2	To know the concepts of basic properties and principles behind the flight
3	To learn the basics of different structures & construction
4	To learn the basics of different structures & construction
5	To learn the various types of power plants used in aircrafts

UNIT: I — HISTORY OF FLIGHT — 9

Balloon flight-ornithopter -Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT: II — AIRCRAFT CONFIGURATIONS AND ITS CONTROLS — 9

Different types of flight vehicles, classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation.

UNIT: III — BASICS OF AERODYNAMICS — 9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers.

UNIT: IV — BASICS OF AIRCRAFT STRUCTURES — 9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.

UNIT: V **BASICS OF PROPULSION** **9**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Illustrate the history of aircraft & developments over the years.
CO2	Ability to identify the types & classifications of components and control systems.
CO3	Explain the basic concepts of flight & Physical properties of Atmosphere.
CO4	Identify the types of fuselage and constructions
CO5	Distinguish the types of Engines and explain the principles of Rocket.

TEXT BOOKS:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

REFERENCES:

1. Sadhu Singh, "Internal Combustion Engines and Gas Turbine"-, SS Kataraia& Sons, 2015.
2. Kermode, "Flight without Formulae", -, Pitman; 4th revised edition 1989

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	-	-	-	-	-	1	-	2	3	2	3
CO2	3	2	1	1	-	-	-	-	-	1	-	2	3	2	3
CO3	3	2	1	2	-	-	-	-	-	1	-	2	3	2	3
CO4	3	2	1	2	-	-	-	-	-	2	-	3	3	2	3
CO5	3	2	1	2	-	-	-	-	-	1	-	3	3	2	3
Avg.	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**3**	**2**	**3**

3 – High ,2 – Medium, 1- Low

CODE: 24OEME02	ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To understand fundamental energy concepts, global/Indian resources, consumption patterns, and the importance of renewable energy prospects.
2	To evaluate the operation, efficiency, merits, and demerits of conventional power generation systems including thermal, hydro, and nuclear plants.
3	To learn about various non-conventional energy technologies such as solar, wind, ocean, tidal, and geothermal systems and their applications.
4	To explore biomass conversion methods, the principles of different fuel cells, magneto hydrodynamic power generation, and energy storage technologies.
5	To apply energy conservation principles and conduct energy audits in industrial settings, particularly within chemical process plants

UNIT 1 INTRODUCTION 9

Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources.

UNIT 2 CONVENTIONAL ENERGY 9

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

UNIT 3 NON-CONVENTIONAL ENERGY 9

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

UNIT 4	BIOMASS ENERGY	9

Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.

UNIT 5	ENERGY CONSERVATION	9

Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.
CO2	Students will excel as professionals in the various fields of energy engineering.
CO3	Compare different renewable energy technologies and choose the most appropriate based on local conditions.
CO4	Explain the technological basis for harnessing renewable energy sources.
CO5	Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.

TEXT BOOKS:

1	Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2	Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi,1984.
3	Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, TataMcGraw Hill, 1990.

REFERENCES:

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	1	2	1	1	1	2	3	3	3	2
CO2	3	3	3	2	2	1	2	1	2	2	2	2	3	3	2
CO3	3	3	3	2	2	1	2	1	2	2	3	3	3	3	2
CO4	3	3	3	2	2	1	2	1	2	2	3	3	3	3	2
CO5	3	3	3	2	2	1	2	1	2	2	3	3	3	3	2
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEAD01	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Introduce the basic concepts, history, and scope of Artificial Intelligence.
2	Develop understanding of knowledge representation and reasoning techniques.
3	Familiarize students with fundamental Machine Learning concepts and workflows.
4	Enable students to apply supervised and unsupervised learning algorithms to simple datasets.
5	Provide basic understanding of neural networks and exposure to modern AI/ML applications.

UNIT: I FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE 9

Introduction to AI – History, Evolution-Applications of AI across domains- Intelligent Agents – Types and Structure-Problem Solving – Search Problems-Uninformed Search: BFS, DFS-Informed Search: Greedy, A*-Real-life examples of AI systems

UNIT: II KNOWLEDGE REPRESENTATION & REASONING 9

Knowledge-Based Systems-Propositional Logic – Predicate Logic-Inference: Forward & Backward Chaining-Resolution-Reasoning under Uncertainty – Probability Basics-Bayesian Networks – Simple examples-Fuzzy Logic Concepts

UNIT: III BASICS OF MACHINE LEARNING 9

What is Machine Learning?-Types of Learning: Supervised, Unsupervised, Reinforcement-ML Lifecycle – Data Collection, Preprocessing-Feature Engineering Basics-Splitting Data – Train/Test-Performance Metrics: Accuracy, Precision, Recall, F1 Score, RMSE

UNIT: IV SUPERVISED & UNSUPERVISED ALGORITHMS 9

Supervised Learning-Linear Regression-Logistic Regression-Decision Trees-Random Forest-K-Nearest Neighbour (KNN)-Support Vector Machines (SVM)-Naïve Bayes-Unsupervised Learning-Clustering – K-Means, Hierarchical- Dimensionality Reduction – PCA

UNIT: V INTRODUCTION TO NEURAL NETWORKS & APPLICATIONS 9

Biological Neuron vs Artificial Neuron-Perceptron – Multilayer Perceptron-Activation Functions-Backpropagation Basics-Introduction to Deep Learning-Overview of CNN & RNN-General Applications of AI/ML-Ethical Issues and Future of AI

TOTAL: 45 PERIODS

COURSE OUTCOMES:	
At the end of the course, the students will be able to:	
CO1	Explainthe fundamentals, search strategies, and applications of Artificial Intelligence.
CO2	Applyknowledge representation methods and reasoning techniques for solving simple problems.
CO3	Describethe Machine Learning concepts, data preprocessing steps, and evaluation metrics.
CO4	Implementbasic supervised and unsupervised learning algorithms using datasets.
CO5	Analyzethe working principles of neural networks and identify real-world AI/ML applications.
TEXT BOOKS:	
1.	Stuart Russell & Peter Norvig – *Artificial Intelligence: A Modern Approach*, Pearson.
2	Tom M. Mitchell – Machine Learning, *McGraw Hill.*

REFERENCES:	
1.	Ethem Alpaydin – *Introduction to Machine Learning*, *MIT Press*
2.	Ian Goodfellow, Yoshua Bengio – *Deep Learning*, *MIT Press*
3.	Elaine Rich, Kevin Knight – *Artificial Intelligence*, *TMH*

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	-	-	-	-	-	1	-	2	3	2	3
CO2	3	2	1	1	-	-	-	-	-	1	-	2	3	2	3
CO3	3	2	1	2	-	-	-	-	-	1	-	2	3	2	3
CO4	3	2	1	2	-	-	-	-	-	2	-	3	3	2	3
CO5	3	2	1	2	-	-	-	-	-	1	-	3	3	2	3
Avg.	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**3**	**2**	**3**

3 – High ,2 – Medium, 1- Low

CODE: 24OEAD02	BUSINESS INTELLIGENCE AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Provide fundamental knowledge of Business Intelligence (BI), its architecture, and components.
2	Enable students to understand data warehousing, ETL processes, and data preparation for BI.
3	Equip students with skills in BI tools for reporting, dashboards, and data visualization.
4	Provide analytical capabilities using OLAP, data mining, and predictive analytics.
5	Expose students to modern BI applications across various domains.

UNIT: I — INTRODUCTION TO BUSINESS INTELLIGENCE — 9

Definition and Scope of BI – Evolution of Business Intelligence – BI Architecture – BI Components – BI Lifecycle – Role of BI in Decision Support Systems – Types of BI (Strategic, Tactical, Operational) – Key Performance Indicators (KPIs) & Metrics – Data-driven Decision-Making – Challenges and Trends in BI – Introduction to Self-Service BI.

UNIT: II — DATA WAREHOUSING AND ETL PROCESSES — 9

Data Warehousing Concepts – Data Mart vs Data Warehouse – Data Warehouse Architecture (Kimball & Inmon Approaches) – Dimensional Modeling: Star Schema, Snowflake Schema, Fact and Dimension Tables – ETL Concepts – Data Extraction, Data Transformation, Data Loading – Data Preprocessing: Cleaning, Integration, Reduction – Data Staging – Metadata Management – OLTP vs OLAP.

UNIT: III — BUSINESS ANALYTICS & DATA VISUALIZATION — 9

Introduction to Business Analytics – Descriptive, Diagnostic, Predictive, Prescriptive Analytics – Reporting Tools – Dashboard Design Principles – Data Visualization Concepts – Storytelling with Data – Visualization Tools: Power BI, Tableau, Google Data Studio – Interactive Visualizations – BI Reporting: Scorecards, Drill-down/Drill-through, Filters, Slicers – BI for Performance Monitoring

UNIT: IV OLAP, DATA MINING & PREDICTIVE ANALYTICS 9

OLAP: MOLAP, ROLAP, HOLAP – OLAP Operations (Slice, Dice, Pivot, Roll-up, Drill-down) – Data Mining Concepts – Classification, Clustering, Association Rule Mining – Regression Models – Predictive Analytics Workflow – Text Analytics – Forecasting Techniques – Introduction to R/Python for BI & Analytics – Model Evaluation Metrics.

UNIT: V BI APPLICATIONS & EMERGING TRENDS 9

Enterprise BI solutions – BI in Finance, Retail, Healthcare, Manufacturing, Banking, Telecom, E-commerce – Marketing Analytics – Web Analytics – BI in Supply Chain – Cloud BI – Mobile BI – Real-time BI – Big Data Analytics & BI Integration – BI Tools: QlikView, SAS BI, MicroStrategy, SAP BusinessObjects – Future of BI (AI-driven BI, Augmented Analytics, Automated Insights).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain BI concepts, architecture, and components.

CO2 Apply data preprocessing, ETL, and warehousing techniques for BI.

CO3 Use BI tools to create dashboards, visualizations, and reports.

CO4 Analyze business data using OLAP and data mining techniques.

CO5 Evaluate BI applications and frameworks used in real-world industries.

TEXT BOOKS:

1 Ramesh Sharda, Dursun Delen, Efraim Turban, “Business Intelligence and Analytics: Systems for Decision Support.” Pearson

2 Larissa T. Moss, “Business Intelligence Roadmap: The Complete Project Lifecycle for Decision-Support Applications”, Addison-Wesley.

3 Michael Corey, “Data Warehousing: Architecture and Implementation”, Morgan Kaufmann.

REFERENCES:

1. Anil Maheshwari, “Data Analytics Made Accessible.”
2. Thomas Connolly, Carolyn Begg, “Database Systems: A Practical Approach to Design, Implementation, and Management.”
3. Cindi Howson, “Successful Business Intelligence”, McGraw-Hill.
4. Jiawei Han, Micheline Kamber, “Data Mining: Concepts and Techniques.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	-	-	-		2		2	2	2	2
CO2	3	3	2	2	3	-	-	-	1	2		2	3	3	2
CO3	2	2	3	2	3	-	-	-	1	3		2	3	2	3
CO4	3	3	3	2	3	-	-	-	1	2		3	2	3	3
CO5	2	3	2	2	2	-	-	-	1	3	1	3	2	2	3
Avg.						-	-	-							

3 – High ,2 – Medium, 1- Low

OPEN ELECTIVE II

SYLLABUS

CODE: 24OEEE03	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Basic concepts on different energy storage systems
2	Hydrogen storage methods
3	Energy storage using batteries
4	Power Production using fuel-cell

UNIT: I ENERGY STORAGE METHODS 9

Need for Energy storage-Different energy storage Methods- Mechanical energy storage: Pumped storage, Compressed air storage - Electromagnetic storage-Electrostatic storage-Thermal energy storage: Sensible heat storage, Latent heat storage-Different methods of chemical Energy storage-Reversible Chemical Storage

UNIT: II HYDROGEN ENERGY STORAGE SYSTEMS 9

Block diagram of Hydrogen energy systems - Properties of Hydrogen - Extraction methods of Hydrogen: Thermo-chemical methods - Electrolysis of water- Thermolysis of water- Biophotolysis - Hydrogen storage techniques-Delivery of Hydrogen-Conversion of Hydrogen - Applications-Safety Issues

UNIT: III ENERGY STORAGE USING BATTERIES 9

Batteries - Construction and working - Elements of Electrochemical cell-operation of Electrochemical cell-Theoretical cell voltage and capacity-Losses in a cell-Batteryclassification-Constructions and working principle of Lead Acid battery-Nickel Cadmium batteries-Lithium-ion batteries-Battery parameters: Battery capacity, Battery Voltage, Depth of discharge-Battery life cycle-Discharge/charge rate, Self discharge-Ragone Plots

UNIT: IV BATTERY CHARGING AND CHARGE CONTROLLERS 9

Factors affecting battery performance: Battery voltage level, Battery Discharge current, Battery Temperature during discharge-Factors affecting Choice of a battery-Battery charging and discharging methods-Charge controllers for stand-alone PV system-Types of charge controllers for stand-alone PV system: Shunt type, Series type, DC-DC converter type, MPPT charge controller –Power stage and control scheme for battery charging using DC-DC converter-Flow chart for battery charging

UNIT: V MECHANICAL, THERMAL AND OTHER ENERGY STORAGE DEVICES 9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel –Thermal storage system-heat pumps, hot water storage tank, solar thermal collector – Superconducting Magnetic Energy Storage (SMES) – Super capacitors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Demonstrate the concepts of different energy storage systems.
CO2	Comprehend different Hydrogen extraction schemes
CO3	Describe about different battery technologies
CO4	Analyze the performance of battery charge controllers and their application
CO5	Conceptualize the operation of different Fuel cell

TEXT BOOKS:

1	Khan B.H.,"Non-Conventional Energy Resources", Tata McGraw Hill Publication, 2nd Edition, 2009.
2	Sandeep Dhameja, "Electric Vehicle Battery Systems", Elsevier Science,2001
3	Thomas B. Reddy,"Linden's Handbook of Batteries", Fourth Edition,McGrawHill,2011

REFERENCES:

1 Robert A. Huggins, "Energy Storage", Springer Science & Business Media, 2010.

2 Ralph Zito, "Energy storage: A new approach", Wiley, 2010.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	-	1	-	-	-	-	1	-	2	3	1	1
CO2	3	2	1	-	1	-	-	-	-	1	-	2	3	1	2
CO3	3	2	2	-	1	-	-	-	-	1	-	2	3	1	1
CO4	3	2	3	-	2	-	-	-	-	1	-	2	3	1	2
CO5	3	2	2	-	1	-	-	-	-	1	-	2	3	1	2
Avg.	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**3**	**1**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEE04	ENERGY MANAGEMENT AND AUDITING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Electrical energy management and energy auditing.
2	Principle and design of illumination systems and methods of managing energy.
3	The various systems in industries for optimal energy consumption & energy saving potentials.

UNIT: I ENERGY SCENARIO 9

Introduction – Primary and Secondary Energy – Commercial and Non Commercial Energy – Renewable and NonRenewable Energy – Energy needs of Growing Economy – Energy and Environment – Energy Security – Energy Conservation and its Importance - BEE Star ratings.

UNIT: II ENERGY MANAGEMENT IN ELECTRIC MOTORS 9

Losses in electric motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors - Motor Efficiency Management, Energy Management in Pumps, Compressors.

UNIT: III ENERGY MANAGEMENT IN LIGHTING 9

Light source, Choice of lighting, Luminance requirements, Energy conservation methods –Lighting Energy Management Steps – Day lighting - Maintenance - Energy Efficiency in Lighting – Case studies.

UNIT: IV ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS 9

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology.

UNIT: V **ENERGY AUDIT** **9**

Definition, Energy audit - need, Types of energy audit, Methodology of Energy Audit - Energy costs, Bench marking and Energy performance, Maximizing system efficiencies, Energy Audit Instruments – Energy Monitoring and Targeting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Deliver the impact of energy conservation on current energy scenario
CO2	Demonstrate the effects of energy management in electric motors
CO3	Demonstrate the effects of energy management in lighting
CO4	Illustrate the Energy Efficient Technologies in Electrical Systems.
CO5	Get familiarized with the theoretical aspects of energy audit.

TEXT BOOKS:

1	Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, “Guide to Energy Management”, Fifth Edition, The Fairmont Press, Inc., 2006.
2	Amit K. Tyagi, “Handbook on Energy Audits and Management”, The Energy and Resources Institute, 2003.

REFERENCES:

1	Sonal Desai, Handbook of Energy Audit, McGraw-Hill Education, 2017.
2	Wayne C. Turner, Energy Management Handbook, The Fairmont Press, Inc., 2007.
3	Larry C. Witte, Philip S. Schmidt & David R. Brown, “Industrial Energy Management & Utilization”,Hemisphere Pub. Corp., 1988.

4 D P Kothari, I J Nagrath, “Power System Engineering” 2nd Edition, McGraw-Hill Co., 2008.

5 National Productivity Council of India, Energy Audit Manual and Reports.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	-	1	-	2	2	-	1	-	2	3	1	1
CO2	3	2	2	-	2	-	2	1	-	1	-	2	3	1	1
CO3	3	2	2	-	2	-	2	1	-	1	-	2	3	1	1
CO4	3	2	2	-	2	-	2	1	-	1	-	2	3	1	2
CO5	3	2	1	-	1	-	2	2	-	1	-	2	3	1	2
Avg.	**3**	**2**	**2**	-	**2**	-	**2**	**1**	-	**1**	-	**2**	**3**	**1**	**1**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC03	ROBOTIC PROCESS AUTOMATION	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1	To understand the basic concepts of Robotic Process Automation.
2	To expose to the key RPA design and development strategies and methodologies.
3	To learn the fundamental RPA logic and structure.
4	To explore the Exception Handling, Debugging and Logging operations in RPA.
5	To learn to deploy and maintain the software bot.

UNIT: I — INTRODUCTION TO ROBOTIC PROCESS AUTOMATION — 6

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files

UNIT: II — AUTOMATION PROCESS ACTIVITIES — 6

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, Ui Explorer, Handling Events

UNIT: III — APP INTEGRATION, RECORDING AND SCRAPING — 6

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

UNIT: IV EXCEPTION HANDLING AND CODE MANAGEMENT 6

Exception handling, Common exceptions, Logging- Debugging techniques, collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

UNIT: V DEPLOYMENT ANDMAINTENANCE 6

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates.RPA Vendors-OpenSource RPA, Future of RPA

TOTAL: 30 PERIODS

PRACTICAL EXERCISES:

1	Create a Sequence to obtain user inputs display the musing a message box
2	Create a Flowchart to navigate to a desired page based on a condition
3	Create a State Machine workflow to compare user input with a random number
4	Build a process in the RPA platform using UI Automation Activities.
5	Create an automation process using key System Activities, Variables and Arguments
6	Also implement Automation using System Trigger
7	Automate login to(web) Email account
8	Recording mouse and keyboard actions.
9	Scraping data from website and writing to CSV
10	Implement Error Handling in RPA platform
11	Web Scraping
12	Email Query Processing

TOTAL: 30 PERIODS

TOTAL: 30+30=60 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the various satellite orbits and launching.

CO2 Describe the various earth and space segments in satellite communication.

CO3 Outline the satellite link design and interference analysis.

CO4 Identify the various satellite access and services.

CO5 Interpret the satellite systems for direct broadcasting.

TEXT BOOKS:

1 Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool- Ui Path by Alok Mani Tripathi, Packt Publishing,2018.

2 Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", A press publications, 2020.

REFERENCES:

1 Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018

2 Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018

3 AGerardusBlokdyk,"RoboticProcessAutomationRpaACompleteGuide",2020

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	1	3	-	-	-	1	3	3	2	2	2	1
CO2	1	1	2	3	3	-	-	-	1	2	3	1	3	2	1
CO3	2	3	2	3	3	-	-	-	2	3	1	1	3	3	3
CO4	1	2	1	2	2	-	-	-	1	2	1	3	3	3	2
CO5	3	3	3	3	3	-	-	-	3	1	1	1	3	2	1
Avg.	**2**	**2**	**2**	**2**	**3**	**-**	**-**	**-**	**2**	**2**	**2**	**2**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC04	FUNDAMENTALS OF EMBEDDED AND IOT	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

1	To understand the concepts of 8086 microprocessor and 8051microcontroller.
2	To interface microprocessors with supporting chips
3	To learn the concepts of Embedded system design.
4	To learn the architecture of IoT
5	To learn design flow of IoT

UNIT: I INTRODUCTION TO MICROCONTROLLER 6

Introduction to 8086 microprocessor - Architecture, Introduction to 8051 microcontroller – Architecture,addressing modes, instruction set, Assembly language programming

UNIT: II I/O INTERFACING 6

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface, I2C– Interrupt controller – Programming and applications Case studies: TrafficLight control, LED display and LCD display

UNIT: III INTRODUCTION TO EMBEDDED SYSTEM DESIGN 6

Embedded system design process –Design example: Model train controller- ARM Processor – Instruction Set– CPU – Programming Input and Output, Models for programs – Assembly, Linking and Loading

UNIT: IV FUNDAMENTALS OF IoT 6

Introduction to IoT& Devices – Characteristics – Physical Design, Logical Design – IoT Enabling

Technologies – Domain Specific IoTs – IoT and M2M – IoT System Management with NETCONF–YAN

UNIT: V **IoT PROTOCOLS AND DESIGN FLOW** **6**

Protocols - MQTT, XMPP, Modbus, CANBUS and BACNet. IoT Platform Design – Methodology – IoT Reference Model – Domain Model - Communication Model.

TOTAL: 30 PERIODS

PRACTICAL EXERCISES:

1 Basic arithmetic and Logical operations using 8086 and 8051.

2 Interfacing using peripherals such as keyboard and stepper Motor

3 Traffic light controller

4 Blinking of LEDs and LCD

5 Interfacing using peripherals such as ADC and DAC

6 Interfacing sensors with Raspberry pi

TOTAL: 30 PERIODS

TOTAL: 30 +30=60 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basics of consumer electronics components.

CO2 Explain principles of entertainment electronics systems.

CO3 Demonstrate the function of smart home sensors and assistants

CO4 Describe automation and control in home appliances.

CO5 Comprehend the role of smart OS and communication technologies in personal devices.

TEXT BOOKS:

1 Nick Vandome, Smart homes in easy steps-Master smart technology for your home 2018.

2 ThomasM.Coughlin,"DigitalStorageinConsumerElectronics",ElsevierandNewness2012

REFERENCES:

1 Thomas LFloyd"ElectronicDevices",TenthEdition,PearsonEducationAsia,2018.

2 Jordan Frith, "Smart phones as Locative Media", Wiley. 2014.

3 R.G.Gupta, *"AudioandVideoSystems:*Principles,MaintenanceandTroubleshooting*",*SecondEdition, Tata Mc Graw Hill Publisher, 2010.

4 Bali S.P., "Consumer Electronics",PearsonEducation,2017.

5 Vijay Garg,"Wireless Communications & Networking",Elsevier Science &Technology Books, 2019.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO2	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO3	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO4	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO5	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
Avg.	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE03	GREEN BUILDING DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1	To understand the environmental impact of buildings, learn about energy use, building technologies, thermal comfort, solar applications, and gain knowledge of green materials, waste management, and sustainable urban practices.

UNIT: I — ENVIRONMENTAL IMPLICATIONS OF BUILDINGS — 9

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

UNIT: II — IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS — 9

Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings

UNIT: III — COMFORTS IN BUILDING — 9

Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.

UNIT: IV — UTILITY OF SOLAR ENERGY IN BUILDING — 9

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings

UNIT: V — GREEN COMPOSITES FOR BUILDINGS — 9

Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain the environmental implications of building materials, energy use, and waste disposal.
CO2	Analyze the embodied energy and environmental impacts of different building technologies
CO3	Assess the thermal comfort and heat transfer characteristics of various building materials.
CO4	Apply solar passive techniques for cooling and heating buildings effectively.
CO5	Design sustainable solutions using green composites, waste and water management systems in buildings.

TEXT BOOKS:

1	Yanniotis, S. Energy Efficiency in Buildings. CRC Press, 2019.
2	Jagadish, K.S., Venkatarama Reddy, B.V., and Nanjunda Rao, K.S. Alternative Building Materials and Technologies. New Age International, 2017.
3	Givoni, B. Climate Considerations in Building and Urban Design. Van Nostrand Reinhold, 1998.

REFERENCES:

1	Kibert, Charles J. Sustainable Construction: Green Building Design and Delivery. John Wiley & Sons, 2021.
2	Hall, M.R. et al. Materials for Energy Efficiency and Thermal Comfort in Buildings. Woodhead Publishing, 2010.
3	Edwards, Brian. Green Buildings Pay. Taylor & Francis, 2014.
4	IS 3792:1978 — Thermal Insulation of Buildings — Code of Practice.
5	Ganesan, S.Sustainable Building Design and Construction.PHI Learning, 2018.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO2	3	2	1	1	1	2	3	2	1	2	1	2	2	1	1
CO3	3	3	3	2	2	3	3	2	1	2	1	3	3	2	2
CO4	3	2	3	3	2	2	3	2	2	2	2	3	3	3	2
CO5	2	2	3	2	3	2	3	2	2	3	2	3	2	3	3
Avg.	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE04	WEB USER INTERFACE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Create aesthetically appealing and structured web pages using HTML5.
2	Understand and apply Cascading Style Sheets (CSS) for effective webpage styling and layout.
3	Validate and manipulate webpage content using JavaScript and Document Object Model (DOM).
4	Learn and utilize fundamental features of jQuery to enhance web interactivity.
5	Gain practical knowledge of Bootstrap for developing responsive and mobile-friendly web designs.

UNIT: I	HTML5	9

Review of HTML - Lists - Tables - Forms - Internal linking - Meta elements - New HTML5 Form input types - Input and datalist elements and auto complete attribute – Page Structure Elements

UNIT: II	CSS3	9

Types of CSS – Inline Styles- Embedded Stylesheets - Conflicting style sheets – Linking External Style sheets- Positioning Elements - Element Dimension - Box model and Text Flow – Media Types and Media Queries- Drop down menus – Text Shadows –Rounded Corners – Box Shadows.

UNIT: III	JAVASCRIPT AND DOM	9

JavaScript - Syntax - Variables and data types - JavaScript Control Statements - Operators - Literals - Functions - Objects - Arrays - Built in objects - JavaScript Event Handling - Form processing with focus, blur, submit, reset - Event Bubbling - Document Object Model - The Document Tree - DOM Collections – Dynamic Style - Using Timer and Dynamic Styles to Create Animated Effects.

UNIT: IV	JQUERY	9

Jquery Fundamentals - Selecting elements for manipulation - managing the wrapped element set - Manipulating Element Properties and attributes - Changing element Styling - Setting Element Content - Dealing with form element value

UNIT: V	BOOTSTRAP	9

Bootstrap Scaffolding - Bootstrap file Structure – Global styles – Default grid system – Container layout - Typography – Tables – Forms – Buttons –Images –Icons – Dropdown menu – Button groups – Button with dropdown – Navigation elements – Labels – Badges – Thumbnail- Progress bar

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Develop visually rich and structured web pages using HTML5 elements and features.
CO2	Apply CSS3 to create attractive layouts, visual effects, and stylistic variations in web pages.
CO3	Build valid, dynamic, and interactive web content using JavaScript and DOM manipulation.
CO4	Develop real-time interactive features using jQuery functions and plugins.
CO5	Design responsive and user-friendly interfaces using Bootstrap components and utilities.

TEXT BOOKS:

1	P.J. Deitel, H.M. Deitel, “Internet and World Wide Web – How to program”, Fifth Edition, Pearson Education Publishers, 2011 (Unit 1 to 3)
2	Bibeault, Bear, Aurelio De Rosa, and Yehuda Katz, “jQuery in Action”, Manning Publisher, 2015. (Unit 4)
3	Spurlock, Jake,”Bootstrap: responsive web development, “O'Reilly Media, Inc.", 2013. (Unit 5)

REFERENCES:

1	Jeffrey C. Jackson, "Web Technologies - A Computer Science Perspective", Pearson Education, 2011
2	Shenoy, Aravind, and Ulrich Sossou. Learning Bootstrap. Packt Publishing Ltd, 2014.
3	Chernick, Michael R., and Robert A. LaBudde. An introduction to bootstrap methods with applications to R. John Wiley & Sons, 2014.
4	Chaffer, Jonathan, and Karl Swedberg. Learning jQuery. Packt Publishing Ltd, 2011.
5	Chaffer, Jonathan, and Karl Swedberg. Learning jQuery 1.3. Packt publishing, 2009.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2	3	1	2	-	-	1	1	2	1	1	2	2	1
CO2	1	2	3	1	2	-	-	1	1	2	1	1	2	2	1
CO3	2	2	3	2	3	-	-	1	2	2	2	2	3	3	2
CO4	2	2	3	2	3	-	-	1	2	2	2	2	3	3	2
CO5	2	2	3	1	3	-	-	1	2	3	2	2	3	3	2
Avg.	**2**	**2**	**3**	**1**	**3**	**-**	**-**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS03	IOT AND EDGE COMPUTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Understand the foundational concepts and architecture of the Internet of Things (IoT).
2	Explore sensors, their working principles, and IoT communication technologies.
3	Develop programming skills for microcontrollers used in IoT applications.
4	Examine edge computing architecture and edge-to-cloud communication protocols.
5	Study techniques for edge data acquisition, storage, and analytics in IoT systems.

UNIT: I **INTRODUCTION TO IOT** **9**

Definitions and functional requirements –IoT conceptual framework – IoT architectural view – Technology behind IoT – Sources of IoT – M2M communication – Examples of IoT. Internet connectivity principles: Internet connectivity – Internet-based communication – IP addressing in the IoT – Application layer protocols.

UNIT: II **IOT COMPONENTS** **9**

Components of Internet of Things: Control units – Sensors – Communication modules – Power sources. Sensor technology – Actuator - participatory sensing, industrial IoT and automotive IoT - Communication technologies: RFID – Bluetooth – ZigBee – WiFi – RF Links – Mobile Internet – Wired Communication - Sensor data communication protocols – Radio frequency identification technology (RFID) – Wireless sensor networks (WSN) technology.

UNIT: III **PROGRAMMING THE MICROCONTROLLER FOR IOT** **9**

Arduino and Raspberry PI Microcontroller platform - Development environment – Arduino and Raspberry PI Interfaces– Reading from sensors - Programming microcontroller for IoT - Connecting microcontroller using Bluetooth, Ethernet and WiFi - Communicate to COSM cloud using Ethernet / WiFi shield – Web Application Framework

UNIT: IV EDGE COMPUTING AND EDGE TO CLOUD PROTOCOLS 9

Edge purpose and definition – Edge hardware architecture – Edge Operating Systems – Edge Platforms - Edge use cases: Ambient Computing – Synthetic Sensing – MQTT – MQTT-SN – COAP – STOMP - AMQP

UNIT: V EDGE DATA COLLECTION, STORAGE AND ANALYTICS 9

Cloud computing paradigm for data collection, storage and computing – IoT cloud-based services using the Xively, Nimbits and other platforms - Basic data analytics in IoT – Top level cloud pipeline – Rules engines – Ingestion – Complex event processing – Lambda architecture - Data acquiring and storage – organizing the data – transactions, business processes, integration and enterprise systems - analytics – knowledge acquiring, managing and storing processes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Understand the IoT conceptual framework and principles of internet connectivity.
CO2	Identify and apply suitable IoT components and communication technologies for specific applications.
CO3	Design and develop portable IoT solutions using appropriate microcontrollers.
CO4	Implement edge-to-cloud data communication using suitable protocols.
CO5	Store, manage, and analyze data at the edge using edge analytics techniques.

TEXT BOOKS:

1	Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw-Hill Education Pvt. Ltd., First Edition, 2018.
2	Perry Lea, "IoT and Edge Computing for Architects", Packet Publisher, Second Edition, 2020.

REFERENCES:

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-On Approach”, VPT Publisher, First Edition, 2015.
2. Charalampos Doukas, “Building Internet of Things with the Arduino”, Create space, 2012.
3. Derek Molloy, “Exploring Raspberry PI”, Wiley, First Edition, 2016.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	1	2	-	1	-	-	1	-	1	2	1	1
CO2	2	2	1	1	2	-	1	-	-	1	-	1	2	2	1
CO3	1	2	3	2	2	-	1	-	1	1	1	1	2	3	2
CO4	1	2	2	2	2	-	1	-	1	1	1	1	2	3	2
CO5	1	2	2	3	2	-	1	-	1	1	1	2	2	3	3
Avg.	**1**	**2**	**2**	**2**	**2**	**-**	**1**	**-**	**1**	**1**	**1**	**1**	**2**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS04	IT IN AGRICULTURAL SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To introduce the students to areas of agricultural systems in which IT and computers play a major role.
2	To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.

UNIT: I — PRECISION FARMING — 9

Precision agriculture and agricultural management – Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.

UNIT: II — ENVIRONMENT CONTROL SYSTEMS — 9

Artificial light systems, management of crop growth in greenhouses, simulation of CO2 consumptionin greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture.

UNIT: III — AGRICULTURAL SYSTEMS MANAGEMENT — 9

Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems.

UNIT: IV — WEATHER PREDICTION MODELS — 9

Importance of climate variability and seasonal forecasting, Understanding and predicting world’s climate system, Global climatic models and their potential for seasonal climate forecasting, General systems approach to applying seasonal climate forecasts.

UNIT: V — E-GOVERNANCE IN AGRICULTURAL SYSTEMS — 9

Expert systems, decision support systems, Agricultural and biological databases, e-commerce, ebusiness systems & applications, Technology enhanced learning systems and solutions, e learning, Rural development and information society.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	The students shall be able to understand the applications of IT in remote sensing applications such as Drones etc.
CO2	The students will be able to get a clear understanding of how a greenhouse can be automated and its advantages
CO3	The students will be able to apply IT principles and concepts for management of field operations.
CO4	The students will get an understanding about weather models, their inputs and applications.
CO5	The students will get an understanding of how IT can be used for e-governance in agriculture

TEXT BOOKS:

1	National Research Council, “Precision Agriculture in the 21st Century”, National Academies Press, Canada, 1997.
2	H. Krug, Liebig, H.P. “International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation”, 1989.

REFERENCES:

1	Peart, R.M., and Shoup, W. D., “Agricultural Systems Management”, Marcel Dekker, New York, 2004.
2	Hammer, G.L., Nicholls, N., and Mitchell, C., “Applications of Seasonal Climate”, Springer, Germany, 2000.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	3	3	2	3	1	3	3	1	3	3	3	1	1	1
CO2	3	3	3	3	3	1	3	3	1	3	3	3	1	1	1
CO3	2	3	3	2	3	2	3	2	2	3	3	3	2	2	2
CO4	3	3	3	1	3	2	3	3	1	3	3	3	2	2	2
CO5	2	3	3	2	3	3	3	3	2	3	3	3	3	3	3
Avg.	2	3	3	2	3	2	3	3	1	3	3	3	2	2	2

3 – High, 2 – Medium, 1- Low

CODE: 24OEME03	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, global warming and eco-legislations.
2	To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation
3	To elaborate on the technologies available for generating energy from waste.
4	To study the solid and hazardous waste generation, characteristics, management strategies, disposal methods, and waste minimization.
5	To analyze various industrial pollution types, their impacts, control methods, and perform basic environmental impact assessments.

UNIT: I	**INTRODUCTION**	**9**

Global atmospheric change – greenhouse effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental.

UNIT: II	**AIR POLLUTION**	**9**

Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipment’s - issues in air pollution control – air sampling and measurement.

UNIT: III	**WATER POLLUTION**	**9**

Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

UNIT: IV	**WASTE MANAGEMENT**	**9**

Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.

UNIT: V OTHER TYPES OF POLLUTION FROM INDUSTRIES 9

Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control - water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies. Radiation pollution: types, sources, effects, control of radiation pollution.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain global environmental issues, natural cycles, and fundamental principles of environmental chemistry and biology.
CO2	Identify major air pollutants, analyze their effects, and apply suitable air pollution control and monitoring techniques.
CO3	Assess water quality, evaluate water and wastewater treatment processes, and ensure compliance with environmental standards.
CO4	Classify and manage solid and hazardous wastes using appropriate collection, processing, disposal, and minimization methods.
CO5	Evaluate various industrial pollution types, recommend control measures, and perform basic environmental impact assessments.

TEXT BOOKS:

1	Arcadio P Sincero and G.A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
2	Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore, 2000.

REFERENCES:

1. G. Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi, 2003.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 1998.
3. H. Ludwig, W. Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J. (1991).
4. H.S. Peavy, D.R. Rowe and G. Tchobanoglous, Environmental Engineering McGraw- Hill Book Company, New York, (1985).
5. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers, 2006.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	1	2	1	1	1	2	**3**	2	3	2
CO2	3	3	3	2	2	1	2	2	2	2	2	2	2	3	2
CO3	3	3	3	2	2	1	2	2	2	2	3	3	2	3	2
CO4	3	3	3	2	2	1	2	2	2	2	3	3	2	3	2
CO5	3	3	3	2	2	1	2	2	2	2	3	3	2	3	2
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEME04	ELEMENTS OF MARINE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To understand the role of Marine machinery systems.
2	To be familiar with Marine propulsion machinery system.
3	To acquaint with Marine Auxiliary machinery system.
4	To have acquired basics of Marine Auxiliary boiler system.
5	To be aware of ship propellers and steering system.

UNIT: I — ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS — 9

Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – PropulsionMachinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fueloil and Lubricating Oil Purifiers, Marine Boiler systems.

UNIT: II — MARINE PROPULSION MACHINERY SYSTEM — 9

Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting andreversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system

UNIT: III — MARINE AUXILIARY MACHINERY SYSTEM — 9

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine,Difference between slow speed and medium speed engines – advantages, limitations and applications.

UNIT: IV **MARINE BOILER SYSTEM** **9**

Types of Boilers – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships,Usesof steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance ofmountings, need for accessories.

UNIT: V **SHIP PROPELLERS AND STEERING MECHANISM** **9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitchpropellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Distinguish the role of various marine machinery systems.
CO2	Relate the components of marine propulsion machinery system.
CO3	Explain the importance of marine auxiliary machinery system.
CO4	Acquire knowledge of marine boiler system.
CO5	Understand the importance of ship propellors and steering system.

TEXT BOOKS:

1	Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London,2011.
2	.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011.
3	K.Ramaraj, “Text book on Marine Engineering”, Eswar Press, Chennai, 2018.

REFERENCES:

1 Alan L.Rowen, "Introduction to Practical Marine Engineering, Volume 1&2, The Institute of MarineEngineers (India), Mumbai, 2006.

2 A.S.Tambwekar, "Naval Architecture and Ship Construction", The Institute of Marine Engineers (India), Mumbai, 2015.

3 Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi,1981.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	1	2	1	1	1	2	3	1	2	2
CO2	3	3	3	2	2	1	2	1	2	2	2	2	1	2	2
CO3	3	3	3	2	2	1	2	1	2	2	3	3	1	2	2
CO4	3	3	3	2	2	1	2	1	2	2	3	3	1	2	2
CO5	3	3	3	2	2	1	2	1	2	2	3	3	1	2	2
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**3**	**3**	**1**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEAD03	AUGMENTED REALITY AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Utilize the foundations and trends of immersive technologies in relevant applications
2	Apply appropriate AR tools to highlight interactivity in applications.
3	Apply VR technologies in emerging applications
4	Apply rendering and modelling techniques in VR distributed architectures
5	Analyze various frameworks and development tools in the VR domain.

UNIT: I — INTRODUCTION TO AUGMENTED AND VIRTUAL REALITY — 9

Introduction to Immersive Technologies - Historical evolution of immersive technologies –AR, VR- Key characteristics and taxonomy -Technological Foundations - Current Trends and Future Directions

UNIT: II — FOUNDATIONS OF AUGMENTED REALITY: PRINCIPLES, TOOLS, AND DEVICES — 9

Augmented reality: Introduction – Types of AR targets –components – User experience - Field of view – visual perception – Degree Of Freedom (DOF) - 3D formats - applications of AR – AR concepts: sensors - processor – display- Ingredients of AR experience- SDK Tools: Vuforia – AR Toolkit – AR core - AR foundation – AR algorithm: SLAM - AR devices.

UNIT: III — VIRTUAL REALITY SYSTEMS: INTERACTION, PERCEPTION, AND HARDWARE COMPONENTS — 9

Virtual reality: Introduction-The Three I‘s of VR- Input devices - Trackers, Navigation, Gesture, Output devices – Graphic displays - Human vision System - Gaze interaction - Characteristics –technologies (LCD,LED,OLED,AMOLED),HMDs,3D sound, Haptic Displays-Human Auditory System- Emerging applications (e.g., metaverse, digital twins) – VR HMD devices.

UNIT: IV — GRAPHICS PIPELINE, MODELLING, AND RENDERING SYSTEMS — 9

Fundamentals of Computer Graphics-Rendering and graphics pipeline- Modern graphics and haptic rendering pipeline -Gaming desktop architecture -Distributed VR architectures-cloud rendering-Geometric modelling - 3D authoring software and scanners - scene illumination - Texture mapping - Transformation invarients - behaviour modelling – Level of detail management (LOD).

UNIT: V VR TOOLKITS, SDKS AND WEB-BASED DEVELOPMENT PLATFORMS 9

VR tools: XR interaction toolkit - OpenXR - Meta XR All-in-one SDK – HP VR launch kit - SteamVR plugin - Amazon Sumerian - Godot Engine - A Frame(webVR) – CoSpaces Edu - Three.JS – WebGL - Babylon.js.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Utilize the foundations, key characteristics, and trends of immersive technologies (AR & VR) in relevant applications
CO2	Apply appropriate Augmented Reality tools and techniques to enhance interactivity in real-time applications.
CO3	Apply Virtual Reality technologies—including input/output devices, display systems, and interaction techniques—in emerging VR applications.
CO4	Apply rendering, modeling, and graphics pipeline concepts in designing VR systems within distributed architectures.
CO5	Analyze various VR frameworks, SDKs, and development tools for building immersive applications.

TEXT BOOKS:

1.	Jonathan Linowes, ―Augmented Reality with unity AR foundation‖, 1st Edition, Packt publishing, 2021
2	OnathanLinowes and Krystian Babilinski, Augmented Reality for Developers,1st Edition, Packt publishing,2017.
3	Griore C.Burdea and Philippe Coiffet,Virtual Reality Technology,3rd edition, IEEE press wiley, 2024.
4	Steven M. LaValle, "Virtual Reality," 1st Edition, Cambridge University Press, 2017

REFERENCES:

1. Micheal Lanham. ―Learn ARCore – Fundamentals of Google ARCore‖, 1st Edition, Packt publishing, 2018.
2. Paul Mealy, John Carucci, "Virtual & Augmented Reality For Dummies," 1st Edition, For Dummies, 2017.
3. Tomas Akenine-Möller, Eric Haines, "Real-Time Rendering," 4th edition, A K Peters/CRC Press, 2018.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	1	2	-	-	-	-	1	-	2	2	3	2
CO2	3	2	2	1	3	-	-	-	1	2	-	2	3	3	2
CO3	2	2	3	1	3	-	-	-	1	1	-	2	2	3	3
CO4	3	3	3	2	3	-	-	-	1	2	1	3	3	2	3
CO5	2	3	2	2	3	-	-	-	1	3	1	3	3	2	3
Avg.	**3**	**2**	**2**	**1**	**3**	-	-	-	**1**	**2**	-	**2**	**3**	**3**	**3**

3 – High ,2 – Medium, 1- Low

CODE: 24OEAD04	DIGITAL FORENSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Identify digital forensics concepts and apply forensic procedures to manage digital evidence.
2	Analyze cybercrime laws and apply forensic readiness and legal methods to handle digital evidence.
3	Apply forensic methods to analyze digital, mobile, and embedded evidence
4	Apply internet and memory forensic techniques for evidence acquisition and analysis in investigations.
5	Apply legal and forensic practices to tackle digital investigation challenges.

UNIT: I **FOUNDATIONS OF DIGITAL FORENSICS** **9**

History of Forensic Science – Digital Forensics – Digital Evidence – The Digital Forensics Process: Identification Phase – Collection Phase – Examination Phase – Analysis Phase –Presentation Phase.

UNIT: II **CYBERCRIME LAWS AND FORENSIC READINESS** **9**

Introduction to Cybercrime Law – International Legal Framework of Cybercrime Law – Digital Crime – Substantive Criminal Law – Investigation Methods for Collecting Digital Evidence – International Cooperation in Order to Collect Digital Evidence – Digital Forensic Readiness – Law Enforcement vs. Enterprise Digital Forensic Readiness – Frameworks, Standards, and Methodologies – CERT–In Guidelines for Handling and Reporting Cyber Incidents.

UNIT: III **COMPUTER AND MOBILE FORENSICS** **9**

Introduction to Computer Forensics - Evidence Collection – Examination – Analysis – Mobile and Embedded Forensics: Collection Phase – Examination Phase – Reverse Engineering and Analysis of Applications – Data Recovery Techniques and Tools.

9

UNIT: IV INTERNET AND MEMORY FORENSICS

Internet Forensics: Layers of Network Abstraction – The Internet – Tracing Information on the Internet – Collection Phase: Local Acquisition – Network Acquisition – Remote Acquisition – Memory Forensics: Memory Management – Volatility – Memory Analysis in Criminal Investigations – Malware Analysis.

UNIT: V LEGAL & FUTURE FORENSIC CHALLENGES 9

Legal Challenges in Digital Forensic Investigations: Constitutional issues in digital investigations, Federal Rules of Evidence – The Future of Cybercrime, Terror, and Policy: Introduction – Considering the future of cybercrime – Social movements, technology, and social change – Challenges in Digital Forensics: Computational Forensics – Automation and Standardization – Reinforcement of CERT-In Policies in Future Cybercrime Contexts.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Understand the basics of digital forensics and follow proper steps to collect and handle digital evidence safely.
CO2	Know the main cybercrime laws and use correct legal methods while dealing with digital evidence.
CO3	Use suitable forensic techniques to examine computers, mobile devices, and embedded systems for evidence.
CO4	Apply internet and memory forensics methods to collect and analyze evidence from online sources and system memory.
CO5	Use correct legal, ethical, and forensic practices to solve challenges during digital investigations.

TEXT BOOKS:

1. Andre Arnes, Digital Forensic, John Wiley & Sons Ltd, 2019.
2. Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar, Cybercrime and Digital Forensics an Introduction, 2nd Edition, Routledge, 2023.

REFERENCES:

1. Joakim Kavrestad, Fundamentals of Digital Forensics: Theory, Methods and Real-Life Applications, Springer, 2020.
2. Keshav Kaushik, Rohit Tanwar, Susheela Dahiya, Komal Kumar Bhatia, Yulei Wu, ―Unleashing the Art of Digital Forensics, 1st Edition CRC Press, 2023.
3. Ahmed A. Abd El-Latif, Lo'aiTawalbeh, Manoranjan Mohanty, Brij B. Gupta, Konstantinos E. Psannis, Digital Forensics and Cyber Crime Investigation: Recent Advances and Future Directions, 1st Edition, CRC Press, 2024

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	3	3	2	1	2	1	2	1	2	1	3	2
CO2	2	3	1	2	2	3	1	3	1	2	1	2	1	2	3
CO3	3	3	2	3	3	1	1	1	1	1	1	2	2	3	2
CO4	3	3	2	3	3	1	1	1	1	2	1	2	1	3	2
CO5	2	3	1	2	2	3	1	3	2	3	1	2	1	2	3
Avg.	**3**	**3**	**2**	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**2**

3 – High ,2 – Medium, 1- Low

OPEN ELECTIVE III

SYLLABUS

CODE: 24OEEE05	ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1	To provide the fundamental concepts, principles, analysis and design of hybrid and electric vehicles.

UNIT: I INTRODUCTION TO HYBRID ELECTRIC VEHICLES 9

History of hybrid vehicles - social and environmental importance of hybrid vehicles- Architecture of Hybrid vehicle: Series hybrid, Parallel hybrid, Series-parallel hybrid, Complex Hybrid.

Introduction to Electric Vehicle- social and environmental importance - Advantages and Limitation of Electric Vehicle-Comparison of Energy efficiency, and energy density of EV and ICE vehicle-Classification of EVs-Different architecture of Electric Vehicle.

UNIT: II HYBRID ELECTRIC DRIVE-TRAINS 9

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.

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

UNIT: III ELECTRIC PROPULSION UNIT 9

Introduction to electric components used in hybrid and electric vehicles, Configuration and control- DC Motor Drives, Induction Motor drives, Permanent Magnet Drives, Switched Reluctance Drives.

UNIT: IV	ENERGY STORAGE AND SIZING	9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy Storage and Analysis- Battery Parameters: Capacity, Charging Rate, SoC and SoH-Battery pack design using series and parallel connection- Battery Swapping- Hybridization of different energy storage devices. Sizing-Propulsion motor, Power Converters, Energy Storage.

UNIT: V	CONTROL SYSTEM FOR ELECTRIC AND HYBRID VEHICLE	9

Overview of Control System-Control Variables- Function of the Control System in HEVs and EVs-Different Operational Modes- Battery Charging Technologies- Power Electronic Converter for Battery Charging - ECU Design-field-oriented control of high-power IM drives.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Identify the importance of hybrid electric vehicle
CO2	Explicate the different train topologies and power flow control in electric vehicles
CO3	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
CO4	Choose proper energy storage systems for vehicle applications
CO5	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.

TEXT BOOK:

1	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2 nd Edition, 2003

REFERENCES:

1 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

2 James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons, 2003

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	-	1	-	2	1	-	1	-	2	3	1	1
CO2	3	2	2	-	2	-	2	1	-	1	-	2	3	1	1
CO3	3	2	3	-	2	-	2	1	-	1	-	2	3	1	2
CO4	3	2	2	-	2	-	2	1	-	1	-	2	3	1	2
CO5	3	2	3	-	2	-	2	1	-	1	-	2	3	1	2
Avg.	**3**	**2**	**2**	**-**	**2**	**-**	**2**	**1**	**-**	**1**	**-**	**2**	**3**	**1**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEE06	GREEN ENERGY SOURCES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Understand various renewable energy sources.
2	Study stand-alone and grid-connected renewable systems.
3	Explore implementation of hybrid renewable systems.

UNIT: I	**INTRODUCTION & SOLAR ENERGY**	**9**

Renewable energy scenario – Importance – Environmental aspects – CO_2 emissions – Applications – Solar radiation characteristics – Solar room heating and cooling.

UNIT: II	**SOLAR COLLECTORS**	**9**

Angle of sunrays – Flat plate and concentrating collectors – Solarpond – Desalination – PV cell and modules – MPPT (P&O, I&C).

UNIT: III	**WIND ENERGY**	**9**

Wind power and coefficients – Site selection – Wind conversion devices – Horizontal/Vertical systems – Betz limit – Performance characteristics – Safety and environmental aspects.

UNIT: IV	**OTHER RENEWABLE ENERGY SOURCES**	**9**

Fuel cells – Biogas generation – Small hydro – Geothermal energy – Construction and issues.

UNIT: V	**OCEAN ENERGY & HYBRID SYSTEMS**	**9**

Wave, tidal, OTEC – Hybrid systems – Diesel-PV, Wind-PV studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Explain the environmental impacts associated with fossil fuel usage.
CO2	Describe various solar energy harvesting technologies and their applications.
CO3	Understand the principles of wind energy conversion systems and their impacts.
CO4	Explain different renewable energy harvesting methods other than solar and wind.
CO5	Describe the concepts and configurations of hybrid renewable energy systems.

TEXT BOOKS:

1	B.H. Khan, *Non-Conventional Energy Resources*, TMH Education, 3rd Ed., 2017.
2	G.S. Sawhney, *Non-Conventional Energy Sources*, PHI, 2012.
3	R.K. Rajput, *Non-Conventional Energy Sources and Utilisation*, S. Chand, 2nd Ed., 2019.

REFERENCES:

1	S.P. Sukhatme & J.K. Nayak, *Solar Energy: Principles of Solar Thermal Collection and Storage*, Tata McGraw Hill, 2008.
2	Godfrey Boyle, *Renewable Energy – Power for a Sustainable Future*, OUP, 1996.
3	D.P. Kothari et al., *Renewable Energy Sources and Emerging Technologies*, PHI, 2013.
4	G.D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers, 2014.
5	N.K. Giri, *Alternate Energy – Sources, Applications and Technologies*, Khanna Publishers, 2016.
6	John Twidell & Tony Weir, *Renewable Energy Resources*, Taylor & Francis, 2nd Ed., 2015.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	-	2	-	-	-	-	-	2	1	3	1	1
CO2	3	2	2	-	2	-	-	-	-	-	2	1	3	1	1
CO3	3	2	3	-	2	-	-	-	-	-	2	2	3	1	1
CO4	3	2	3	-	2	-	-	-	-	-	2	2	3	1	2
CO5	3	2	3	-	2	-	-	-	-	-	2	2	3	1	2
Avg.	3	2	3	-	2	-	-	-	-	-	2	2	3	1	1

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC05	CONSUMER ELECTRONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Tofamiliarizethestudentswith the fundamental concepts of electronicsIn consumer devices.
2	To know about the working principle of entertainment devices.
3	To understand the function of sensors in smart home technology.
4	To provide the knowledge on the basics of automation in home appliance.
5	To gain knowledge on smart OS and current communication technologies.

UNIT: I CONSUMERELECTRONICS FUNDAMENTALS 9

Overview of Electronics: Vacuum tubes, Transistors, Integrated circuits-Moore'sLaw, Semiconductor Components: Diodes, Rectifiers, Transistors, Microcontrollers in consumer electronics, energy management, Wiring and Safety instructions

UNIT: II ENTERTAINMENT ELECTRONICS 9

Audio systems: Construction and working principle of Microphone, Loudspeaker,Display systems: CRT, LCD, LED, Video Players: DVD and Blue RAY, Recording Systems: Digital Cameras and Camcorders

UNIT: III SMARTHOME –SENSORS 9

Technology involved in Smart home, Home Virtual Assistants: Alexa and Google Home. Home Security Systems: Intruder Detection, Motion Sensors, Thermal Sensors and Water Level Sensors.

UNIT: IV HOMEAPPLIANCESAND AUTOMATION 9

Home Enablement Systems: RFID Home, Lighting control, Automatic Cleaning Robots, Washing Machines, Kitchen Electronics: Microwave, Dishwasher, Induction Stoves.

UNIT: V SMARTOPERATINGSYSTEMSANDCOMMUNICATION TECHNOLOGY 9

Introduction to Smart OS- Android and iOS, Internet Enabled Systems:Wi-Fi,IoT,Li-FiandGPS,Personaldevices-Tablets,SmartPhonesandSmartWatches.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Understand the basics of consumer electronics components.
CO2	Explain principles of entertainment electronics systems.
CO3	Demonstrate the function of smart home sensors and assistants
CO4	Describe automation and control in home appliances
CO5	Comprehend the role of smart OS and communication technologies in personal devices**.**

TEXT BOOKS:

1	Nick Vandome, Smart homes in easy steps-Master smart technology for your home 2018.
2	Thomas M.Coughlin, "Digital Storage in Consumer Electronics", Elsevier and Newness 2012

REFERENCES:

1	Thomas L Floyd "Electronic Devices", Tenth Edition, Pearson Education Asia, 2018.
2	Jordan Frith, "Smart phones as Locative Media", Wiley. 2014.
3	R. G. Gupta*,"*Audio and Video Systems*:* Principles, Maintenance and Troubleshooting*",* Second Edition, Tata Mc Graw Hill Publisher, 2010.
4	Bali S.P., “Consumer Electronics”, Pearson Education, 2017.
5	Vijay Garg,”Wireless Communications & Networking”, Elsevier Science &Technology Books, 2019.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO2	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO3	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO4	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
CO5	2	1	1	-	-	1	-	-	-	-	-	2	2	1	1
Avg.	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

3 – High, 2 – Medium, 1- Low

CODE: 24OEEC06	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1	The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

UNIT: I INTRODUCTION TO MEASUREMENTS AND SENSORS 9

Sensors: Functions- Classifications- Main technical requirement and trends Units and standards- Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error- Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics- mathematical model of transducers- Zero, First and Second order transducers- Dynamic characteristics of first and second order transducers for standard test inputs.

UNIT: II VARIABLE RESISTANCE AND INDUTANCE SENSORS 9

Principle of operation- Construction details- Characteristics and applications of resistive potentiometer- Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer- Variable reluctance transducers- EI pickup and LVDT

UNIT: III VARIABLE AND OTHER SPECIAL SENSORS 9

Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, antiglare sensor.

UNIT: IV AUTOMOTIVE ACTUATORS 9

Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.

UNIT: V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9

Different types of actuators used in automatic temperature control-Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	List common types of sensor and actuators used in vehicles.
CO2	Design measuring equipment's for the measurement of pressure force, temperature and flow.
CO3	Generate new ideas in designing the sensors and actuators for automotive application
CO4	Understand the operation of the sensors, actuators and electronic control
CO5	Design temperature control actuators for vehicles.

TEXT BOOKS:

1	Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. DoebelinDhanesh N. Manik Mc Graw Hill Publishers, 2019.
2	Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001
3	William Kimberley, "Bosch Automotive Hand book", 6th Edition, Robert Bosch GmbH, 2004.
4	BoschAutomotiveElectrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.

REFERENCES:

1	James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013
2	Tom Denton, "Automotive Electrical and Electronics Systems, "Third Edition, 2004, SAE International.
3	Patranabis. D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003
4	William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth -Heinemann Publishers, 2012.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	1	-	-	-	-	2	-	2	3	1	-
CO2	3	2	2	1	2	-	-	-	-	2	-	1	3	2	-
CO3	2	2	2	1	3	-	1	-	-	2	-	2	3	2	1
CO4	2	1	3	2	3	-	1	-	2	3	2	2	3	3	2
CO5	2	1	3	3	3	1	2	1	2	3	2	2	3	3	2
Avg.	**3**	**2**	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**3**	**2**	**2**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE05	URBAN AGRICULTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways
2	To delineate the role of agricultural engineers in relation to various crop production practices

UNIT: I	**INTRODUCTION**	**9**

Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.

UNIT: II	**VERTICAL FARMING**	**9**

Vertical farming- types, green facade, living/green wall-modular green wall, vegetated mat wall-Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants

UNIT: III	**SOIL LESS CULTIVATION**	**9**

Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens-tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping

UNIT: IV	**MODERN CONCEPTS**	**9**

Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, poly house and shade net system of crop production on roof tops

UNIT: V	**WASTE MANAGEMENT**	**9**

Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops
CO2	Explain different methods of crop production on roof tops
CO3	Explain nutrient and pest management for crop production on roof tops
CO4	Illustrate crop water requirement and irrigation water management on roof tops
CO5	Explain the concept of waste management on roof tops

TEXT BOOKS:

1	Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.
2	Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.
3	Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.

REFERENCES:

1	Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.
2	Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri- urban agriculture: A case study. Environmental Pollution, 126 (3): 323–329.https://www.science direct.com/science/article/pii/S0269749103002458#aep-section-id24.
3	Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.Anil K Chopra, Dynamics of structures – Theory and applications to Earthquake Engineering, Prentice Hall Inc., 2007.
4	1. Moorthy.C.V.R., Earthquake Tips, NICEE, IIT Kanpur,2002.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1
CO2	2	1	2	1	2	2	2	1	1	2	1	2	2	1	2
CO3	1	1	1	2	1	1	1	1	2	1	1	1	1	2	1
CO4	1	1	1	2	1	2	1	1	1	1	1	1	1	1	2
CO5	2	1	3	1	1	1	2	2	1	2	1	3	2	1	1
Avg.	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	**1**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECE06	IRRIGATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	The student is exposed to different phases in irrigation practices and Planning and management of irrigation. Further they will be imparted required knowledge on Irrigation storage and distribution canal system and Irrigation management.

UNIT: I — CROP WATER REQUIREMENT — 9

Need and classification of irrigation- historical development and merits and demerits of irrigation types of crops-crop season-duty, delta and base period- consumptive use of crops- estimation of Evapotranspiration using experimental and theoretical methods

UNIT: II — IRRIGATION METHODS — 9

Tank irrigation – Well irrigation – Irrigation methods: Surface and Sub-Surface and Micro Irrigation – design of drip and sprinkler irrigation – ridge and furrow irrigation-Irrigation scheduling – Water distribution system- Irrigation efficiencies.

UNIT: III — DIVERSION AND IMPOUNDING STRUCTURES — 9

Types of Impounding structures - Gravity dam – Forces on a dam -Design of Gravity dams; Earth dams, Arch dams- Diversion Head works - Weirs and Barrages

UNIT: IV — CANAL IRRIGATION — 9

Canal regulations – direct sluice - Canal drop – Cross drainage works-Canal outlets – Design of prismatic canal-canal alignments-Canal lining - Kennedy's and Lacey's Regime theory-Design of unlined canal

UNIT: V — WATER MANAGEMENT IN IRRIGATION — 9

Modernization techniques- Rehabilitation – Optimization of water use-Minimizing water losses- On form development works-Participatory irrigation management- Water resources associations- Changing paradigms in water management-Performance evaluation-Economic aspects of irrigation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Have knowledge and skills on crop water requirements.
CO2	Understand the methods and management of irrigation.
CO3	Gain knowledge on types of Impounding structures
CO4	Understand methods of irrigation including canal irrigation.
CO5	Get knowledge on water management on optimization of water use.

TEXT BOOKS:

1	Dilip Kumar Majumdar, "Irrigation Water Management", Prentice-Hall of India, New Delhi, 2008.
2	Punmia B.C., et. al; Irrigation and water power Engineering, Laxmi Publications, 16th Edition, New Delhi, 2009
3	Garg S. K., "Irrigation Engineering and Hydraulic structures", Khanna Publishers, 23rd Revised Edition, New Delhi, 2009

REFERENCES:

1	Duggal, K.N. and Soni, J.P., "Elements of Water Resources Engineering", New Age International Publishers, 2005
2	Linsley R.K. and Franzini J.B, "Water Resources Engineering", McGraw-Hill Inc, 2000
3	Chaturvedi M.C., "Water Resources Systems Planning and Management", Tata McGraw-Hill Inc., New Delhi, 1997.
4	Sharma R.K.. "Irrigation Engineering", S.Chand& Co. 2007.
5	Michael A.M., Irrigation Theory and Practice, 2nd Edition, Vikas Publishing House Pvt. Ltd., Noida, Up, 2008

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	2	2	1	1	1	1	1	1	1	0	1	1	1	1	0
CO2	2	3	3	3	3	2	2	2	2	1	3	2	3	2	0
CO3	2	3	3	3	3	3	3	3	3	2	2	3	3	2	2
CO4	3	3	3	3	3	3	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	3	3	3	3	3	3	3	3	3	3	0
Avg.	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**1**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS05	DEEP LEARNING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Understand the fundamental concepts of machine learning and deep learning techniques.
2	Apply regularization and optimization strategies to train deep neural networks effectively.
3	Analyze the structure and applications of convolutional networks and sequence models.
4	Explore autoencoders and deep generative models for representation and data generation tasks.
5	Utilize deep learning techniques to develop solutions for real-time applications.

UNIT: I BASICS OF MACHINE LEARNING AND DEEP LEARNING 9

Machine Learning: Learning Algorithms, Supervised and Unsupervised learning - Capacity, Overfitting and Underfitting – Hyperparameters and Validation Sets. History of Deep Learning - Perceptrons - Perceptron Learning Algorithm - Multilayer Perceptrons (MLPs).Deep Feed forward Networks: Learning XOR – Gradient based learning – Hidden Units

UNIT: II REGULARIZATION AND OPTIMIZATION 9

Regularization: Parameter Norm Penalties - Dataset augmentation–Noise Robustness - Early stopping - Parameter tying and sharing –Bagging and Ensemble methods - Dropout. Optimization: Stochastic Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, AdaGrad, RMSProp, Adam.

UNIT: III CONVOLUTIONAL NETWORKS AND SEQUENCE MODELLING 9

Convolutional Networks – Convolution operation – Motivation Pooling – Basic Convolution function – Algorithms – Recurrent and recursive nets: Recurrent neural networks – Bidirectional RNN – The Long Short-Term Memory and Other GatedRNNs – Deep Dream - Deep Art - Fooling Convolutional Neural Networks.

UNIT: IV **AUTOENCODERS AND DEEP GENERATIVE MODELS** **9**

Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders. Deep Generative Models - Boltzmann Machines - Restricted Boltzmann Machines - Deep Belief Networks - Deep Boltzmann Machines - Generative adversarial networks (GAN).

UNIT: V **DEEP LEARNING FOR VISUAL COMPUTING AND NATURAL LANGUAGE PROCESSING** **9**

Very Deep CNN for Classification (GoogleNet, ResNet, DenseNet,AlexNet,VGGNet) - Object Localization (RCNN) and Semantic Segmentation, Generative Models with Adversarial Learning. Word Representations (Word2Vec, Glove, fastText), Pretrained Bi-LSTMs: ELMO, Attention Mechanism - Pretrained Transformers: BERT, GPT, T5, BART.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Develop algorithms for various machine learning and deep learning techniques.
CO2	Apply regularization and optimization methods to improve the performance of deep neural networks.
CO3	Implement convolution neural networks and sequence models to solve practical problems.
CO4	Utilize auto encoders and deep generative models for real-world applications.
CO5	Employ deep learning methods in domains such as Visual Computing and Natural Language Processing.

TEXT BOOK:

1 Yoshua Bengio, Ian J.Goodfellow, and Aaron Courville, "Deep Learning", MIT Press, 2016.

REFERENCES:

1 Li Deng, Dong Yu, “Deep Learning: Methods and Applications", now publishers, 2014.

2 Simon Haykin, “Neural Networks and Learning Machines”, Pearson Education, 3rd edition, 2016.

3 Sivanandam S.N., Deepa S.N., “Principles of Soft Computing”, Wiley India Pvt. Ltd, 3rd Edition, 2019.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	-	1	-	-	-	-	-	-	2	3	2	-
CO2	2	3	2	2	3	-	-	-	-	-	-	2	3	2	-
CO3	1	3	3	3	3	-	-	-	-	-	-	2	3	3	2
CO4	1	2	3	2	2	-	-	-	-	-	-	2	3	3	2
CO5	1	2	3	2	3	-	-	-	-	-	-	2	3	3	3
Avg.	**2**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	**2**	**3**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OECS06	ETHICAL HACKING AND NETWORK DEFENSE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Understand and analyze different information security threats and their countermeasures.
2	Explore the phases, methodologies, and tools used in ethical hacking.
3	Study techniques for system and network hacking along with relevant defensive measures.
4	Examine hacking approaches in wireless networks and mobile platforms.
5	Identify vulnerabilities in web servers and web applications and explore mitigation strategies.

UNIT: I ETHICAL HACKING OVERVIEW AND VULNERABILITIES 9

Introduction to Ethical Hacking, Information security, CIA triad, Cyber attack types, Types of hackers, Phases of Ethical Hacking, Types of Ethical Hacking, Goal of Cyber attacks, The cyber kill chain, Information security controls, Information security laws and standards, Malware and other digital attacks: Malware and its types, life cycle of malware, Trojan, Virus and Worms – list of countermeasures.

UNIT: II RECONNAISSANCE, SCANNING, AND ENUMERATION 9

Reconnaissance – Overview, Types, Goals, Google hacking, Tools, Investigating the website, Wayback Machine, Countermeasures, Social Engineering - Understanding Social Engineering, Attack phases, Insider threat, Indentity threat, Counter measures, Scanning networks – Grasping scanning, Understanding the three-way handshake, Checking for live systems and ports, Scanning types, Banner grabbing and OS fingerprinting, Vulnerability scanning, Proxies and Anonymizers, Enumeration.

UNIT: III SYSTEM AND NETWORK HACKING 9

System Hacking – Phases, Gaining access and cracking Passwords, Escalating privileges, Maintaining access and executing applications, Hiding tools, Covering your tracks, Network Hacking – Sniffing, Types of Sniffing, Hardware versus software sniffing, DHCP assaults, MAC attacks, ARP poisoning, DNS poisoning, Detecting sniffing, Session-hijacking, Evading IDS, Firewalls, Honey pots.

UNIT: IV HACKING WIRELESS NETWORKS AND MOBILE PLATFORMS 9

Wireless Security – Wireless network and its types, WEP encryption, Wi-Fi Protected Access, WPA2, WPA3, Security measures, Attack vectors, Methodology of wireless hacking, Hacking Bluetooth, Layers of wire security countermeasures, Vulnerabilities in mobile environment, OWASP's mobile risks, Hacking Android, Hacking iOS, Mobile device management.

UNIT: V WEB SERVERS AND WEB APPS HACKING 9

Web server security issues- Components of web server, Types of architecture, Web server attacks, Authorization attacks, Web application attacks, application coding errors, SQL injection into Backend Databases, vulnerabilities of web APIs, web shells, and web hooks, Detecting web server hacking attempts – Protective http headers, Web application security testing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Identify and evaluate different information security threats along with suitable countermeasures.
CO2	Apply reconnaissance, scanning, and enumeration techniques to gather information about target systems.
CO3	Perform and analyze hacking techniques on computer systems and networks with appropriate defensive measures.
CO4	Examine security challenges in wireless networks and mobile platforms and assess protection mechanisms.
CO5	Detect and analyze vulnerabilities in web servers and web applications to propose suitable mitigation strategies.

TEXT BOOKS:

1. Dale Meredith, "Certified Ethical Hacker (CEH) V12 Exam Guide", O’Reilly, 2022.
2. Michael T. Simpson and Nicholas D.Antill, "Hands-on Ethical Hacking and Network Defense", 4th Edition, Cengage Learning, Course Technology, 2022.

REFERENCES:

1. Rajat Khare, "Network Security and Ethical Hacking", Luniver Press, 2006.
2. Ramachandran V, “BackTrack 5 Wireless Penetration Testing Beginner’s Guide”, Third Edition, Packt Publishing, 2011.
3. Thomas Mathew, "Ethical Hacking", OSB publishers, 2004.
4. Riccardo Bernardini, “Cryptography – Recent Advances and Future Developments”, First Edition, IntechOpen, 2021.
5. Kevin Beaver, “Hacking for Dummies”, Wiley Publication, India, 6/e Edition, 2018.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1	-	1	-	1	1	-	-	-	2	3	2	1
CO2	2	3	2	2	3	-	-	-	-	-	-	2	3	3	2
CO3	1	3	3	3	3	1	-	-	-	-	1	2	3	3	3
CO4	1	2	3	2	2	-	-	1	-	-	-	2	3	3	2
CO5	1	2	3	2	3	-	1	-	-	1	-	2	3	3	3
Avg.	**2**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	**2**	**3**	**3**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEME05	ALTERNATIVE FULES AND ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To acquire knowledge on availability of possible alternate fuels and their properties to use as fuel in CI and SI engines.
2	To learn the properties, processing methods, and engine performance characteristics of vegetable oils as fuels.
3	To explain the production, properties, challenges, storage, and engine applications of hydrogen and LPG.
4	To study the production, purification, and combustion behaviour of biogas and natural gas in internal combustion engines.
5	To develop understanding of electric, hybrid, and fuel cell vehicle technologies, their components, configurations, and operational advantages.

UNIT: I	**ALCOHOL FUELS**	**9**

Introduction to alternative fuels. - Need for alternative fuels - Availability of different alternative fuels for SI and CI engines. Alcohols as fuels. Production methods of alcohols. Properties of alcohols as fuels. Methods of using alcohols in CI and SI engines. Blending, dual fuel operation, surface ignition and oxygenated additives. Performance combustion and emission characteristics in CI and SI engines. DME-DEE-as fuels.

UNIT: II	**VEGETABLE OILS**	**9**

Various vegetable oils and their important properties. Different methods of using vegetable oils engines – Blending, preheating Transesterification - emulsification - Performance –Combustion -Emission Characteristics in diesel engines.

9

UNIT: III HYDROGEN AND LPG

Production methods of hydrogen- properties of hydrogen- Problems associated with hydrogen as fuel - solutions. Different methods of using hydrogen in SI and CI engines- Performance - combustion – emission Characteristics in SI and CI engines. Hydrogen storage – safety aspects of hydrogen. LPG- properties of LPG-Performance-combustion -emission Characteristics in SI and CI engines.

UNIT: IV BIOGAS AND NATURAL GAS 9

Production methods of Biogas and Natural gas- Properties Scrubbing of CO2 and H2S from Biogas. Modification required to use in SI and CI Engines – Performance-combustion -emission characteristics of Biogas and Natural gas in SI and CI engines.

UNIT: V ELECTRIC, HYBRID AND FUEL CELL VEHICLES 9

Layout of Electric vehicle and Hybrid vehicles – Advantages and drawbacks of electric and hybrid vehicles. System components and drives- Electronic control system – Different configurations of Hybrid vehicles. Power split device. High energy and power density batteries – Basics of Fuel cell vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Acquire knowledge on possible alternate fuels and their properties to use as fuel in CI and SI Engines.
CO2	Develop knowledge in all the possible ways of using alcohols as a fuel in IC engines.
CO3	List the challenges and difficulties in using alternative fuel in internal combustion engines.
CO4	Identify the uses of hydrogen as fuel in IC Engines as an alternative for fossil fuels.
CO5	Understand the usefulness of natural acquiring gases towards IC Engines.

TEXT BOOK:

1	AyhanDemirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer-Verlag London Limited 2008, ISBN – 13:9781846289941.

REFERENCES:

1	Dr. G.Devaradjane, Dr. M.Kumaresan, "AutomobileEngineering" {, AMK Publishers, 2013.
2	Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.
3	Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN0-76-80-0052-1.
4	Science direct journals (Biomass& Bio energy, Fues, Energy, Energy conversion Management, Hydrogen Energy, etc.) on biofuels.
5	Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	3	2	1	2	2	2	3	3	3	2	3
CO2	3	3	3	2	3	2	1	2	2	3	2	3	3	3	3
CO3	3	3	3	2	3	2	1	2	3	2	3	3	3	3	3
CO4	3	3	3	2	3	2	1	2	3	3	3	3	3	3	3
CO5	3	3	3	2	3	2	1	2	3	3	3	3	3	3	3
Avg.	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OEME06	FOUNDATION OF ROBOTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	To study the kinematics, drive systems and programming of robots.
2	To study the basics of robot laws and transmission systems.
3	To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
4	To familiarize students with the various Programming and Machine Vision application in robots.
5	To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

UNIT: I	**FUNDAMENTALS OF ROBOT**	**9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load –Robot Parts and their functions – Need for Robots – Different Applications.

UNIT: II	**ROBOT KINEMATICS**	**9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional)– derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

UNIT: III	**ROBOT DRIVE SYSTEMS AND END EFFECTORS**	**9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servomotors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of all these drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper.

UNIT: IV SENSORS IN ROBOTICS 9

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data– signal conversion, image storage, lighting techniques, image processing and analysis.

UNIT: V PROGRAMMING AND APPLICATIONS OF ROBOT 9

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End- Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Interpret the features of robots and technology involved in the control.
CO2	Apply the basic engineering knowledge and laws for the design of robotics.
CO3	Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.
CO4	Explain the concept of kinematics, degeneracy, dexterity and trajectory planning
CO5	Demonstrate the image processing and image analysis techniques by machine vision system.

TEXT BOOKS:

1 Ganesh.S.Hedge,“A textbook of Industrial Robotics”, Lakshmi Publications, 2006.

2 Mikell.P.Groover, “Industrial Robotics – Technology, Programming and applications” McGraw Hill 2ND edition 2012.

REFERENCES:

1 Fu K.S. Gonalz R.C. and ice C.S.G.“Robotics Control, Sensing, Vision and Intelligence”,McGraw Hill book co. 2007.

2 YoramKoren, “Robotics for Engineers”, McGraw Hill Book, Co., 2002

3 Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill 2005.

4 John. J.Craig, “Introduction to Robotics: Mechanics and Control” 2nd Edition, 2002.

5 Jazar, “Theory of Applied Robotics: Kinematics, Dynamics and Control”, Springer Indiareprint, 2010.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	2	2	1	1	1	1	1	2	2	3	2	3
CO2	3	3	3	2	2	-	1	1	2	2	2	2	3	2	3
CO3	3	3	3	2	2	1	1	1	2	2	3	2	3	2	3
CO4	3	3	3	2	2	1	1	1	2	2	3	2	3	2	3
CO5	3	3	3	2	2	-	1	1	2	2	3	2	3	2	3
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**3**	**2**	**3**

3 – High, 2 – Medium, 1- Low

CODE: 24OEAD05	BLOCKCHAIN ARCHITECTURE AND DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Analyze cryptographic primitives and their roles in ensuring blockchain security.
2	Evaluate Bitcoin's transaction lifecycle and the Proof of Work consensus mechanismfor securing the network.
3	Develop Ethereum smart contracts and token standards, including their role in the mining process.
4	Analyze various consensus mechanisms in permissioned blockchains for their effectiveness and applicability.
5	Develop blockchain solutions using Hyperledger frameworks, focusing on enterprise applications.

UNIT: I BLOCKCHAIN FUNDAMENTALS AND DIGITAL SIGNATURES 9

Cryptographic Hash Function - Properties of Hash Function – Digital Signature – Blockchain: Introduction – Types of Blockchain - Block in a Blockchain: Structure of a Block – Block Header – Transactions in a Block - Hash Pointer – Merkle Tree - Blockchain as a Hash chain – Accepting the longest chain – Orphaned Blocks – Blockchain Forks – UTXO and Account/Balance Models

UNIT: II ADVANCED JAVASCRIPT AND FRONTEND FRAMEWORKS 9

Advanced JavaScript (ES6 Features) – Document Object Model (DOM) – Introduction to Frontend Framework (React / Angular) – Components and Props – State Management – Routing – Form Handling – API Integration on the Frontend.

UNIT: III **ETHEREUM BLOCKCHAIN AND SMART CONTRACTS** **9**

Ethereum Blockchain - Ethereum Virtual Machine - Ethereum Accounts - Transactions in Ethereum - Ethereum Wallets - Ethereum Gas - Gas Price - Gas Limit - Mining in Ethereum - Ether Tokens – ERC 20 - Ethereum Improvement Proposals (EIP)

UNIT: IV **CONSENSUS MECHANISMS AND DISTRIBUTED SYSTEMS** **9**

Basics - Consensus - State Machine Replication - Distributed Consensus - Consensus Algorithms - PAXOS - RAFT - Byzantine General Problem - Practical Byzantine Fault Tolerance.

UNIT: V **HYPERLEDGER FRAMEWORKS AND FABRIC ARCHITECTURE** **9**

Introduction to Hyperledger - Hyperledger frameworks - Hyperledger Fabric Architecture - Hyperledger fabric transaction flow - Chaincode in Hyperledger Fabric - Hyperledger Composer - Hyperledger Indy

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1	Analyze cryptographic primitives and their role in blockchain security.
CO2	Evaluate Bitcoin transaction flow and the PoW mechanism.
CO3	Develop Ethereum smart contracts and implement token standards.
CO4	Analyze consensus mechanisms for permissioned blockchains.
CO5	Develop enterprise blockchain solutions using Hyperledger frameworks.

TEXT BOOKS:

1	Kumar Saurabh, Ashutosh Saxena, ―Blockchain Technology concepts and applications‖, Wiley. 2020.
2	Caitlin Long, Antony Lewis, ―The Basics of Bitcoins and Blockchains: An Introduction to Cryptocurrencies and the Technology that Powers Them‖, Mango Media, 2020.

REFERENCES:

1	Andreas M. Antonopoulos, ―Mastering Bitcoin: Programming the open blockchain‖, 2nd Release, 2017.
2	Andreas M. Antonopoulos and Wood M., ―Mastering Ethereum: Building Smart Contracts and DApps‖, O'Reilly Media, 2018.
3	Xun (Brian) Wu, Chuanfeng Zhang, and Andrew Zhang, ―Hyperledger Cookbook: Over 40 recipes implementing the latest Hyperledger blockchain frameworks and tools‖, Packt Publishing, 2019.
4	Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, ―Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction‖ , Princeton University Press , Kindle Edition, 2016.
5	Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2	3	2	1	1	1	1	2	1	3	3	2	1
CO2	2	3	2	3	2	1	1	1	1	2	1	3	3	2	1
CO3	2	2	3	3	3	1	1	1	2	2	2	3	2	3	3
CO4	3	3	2	3	2	1	1	1	1	2	1	3	3	2	2
CO5	3	2	3	3	3	1	1	1	2	3	2	3	2	3	3
Avg.	**3**	**3**	**2**	**3**	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**3**	**2**	**2**

3 – High, 2 – Medium, 1- Low

CODE: 24OEAD06	FULL STACK DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1	Understanding the fundamentals of web development and the client–server architecture.
2	Learning the essential technologies used in frontend development.
3	Exploring server-side programming and backend frameworks.
4	Understanding database concepts and integrating databases with applications.
5	Developing complete full stack applications and deploying them on cloud platforms

UNIT: I BASICS OF WEB DEVELOPMENT 9

Introduction to Web Technologies – Client–Server Model – HTML Basics – CSS Fundamentals – JavaScript Basics – Responsive Web Design – Introduction to Full Stack Architecture.

UNIT: II FRONTEND DEVELOPMENT 9

Advanced JavaScript (ES6 Features) – Document Object Model (DOM) – Introduction to Frontend Framework (React / Angular) – Components and Props – State Management – Routing – Form Handling – API Integration on the Frontend.

UNIT: III BACKEND DEVELOPMENT 9

Introduction to Server-Side Programming – Node.js Basics – Express.js Framework – Creating REST APIs – Middleware – Authentication (Sessions / JWT) – Error Handling – File Handling.

UNIT: IV DATABASE TECHNOLOGIES 9

Introduction to Databases – SQL (MySQL / PostgreSQL) – CRUD Operations – NoSQL Databases (MongoDB) – Collections and Documents – Schema Design – ORM / ODM (Sequelize / Mongoose) – Connecting Backend with Databases.

UNIT: V **FULL STACK INTEGRATION AND DEPLOYMENT** **9**

Connecting Frontend and Backend – API Requests and Responses – User Authentication Workflow – Security Best Practices (Validation, CORS, Hashing) – Version Control with Git & GitHub – Deployment of Full Stack Applications (Vercel, Netlify, Render, AWS).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 Explain the fundamentals of web technologies and full stack architecture.

CO2 Develop dynamic user interfaces using frontend technologies.

CO3 Build backend services and REST APIs using server-side frameworks.

CO4 Integrate applications with relational and NoSQL databases.

CO5 Design, test, deploy, and maintain full stack web applications.

TEXT BOOK:

1 Shama Hoque, *Full-Stack React Projects*, Packt Publishing, Latest Edition.

REFERENCES:

1 Mark Myers, *A Smarter Way to Learn JavaScript*, Kindle Edition.

2 Ethan Brown, *Web Development with Node and Express*, O’Reilly Media.

3 Robin Wieruch, *The Road to React*, Leanpub.

Mapping of Course outcomes to Programme Outcomes

Course Outcomes	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	-	-	-	-	-	-	-	2	-	2	2	2	3
CO2	2	2	3	-	3	-	-	-	-	2	-	2	3	3	2
CO3	2	3	3	2	3	-	-	-	-	2	-	2	3	3	2
CO4	3	2	2	2	3	-	-	-	-	-	-	2	3	3	2
CO5	2	2	3	2	3	-	-	2	2	2	2	2	2	-	3
Avg.	**2**	**2**	**3**	**2**	**3**	**-**	**-**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**

3 – High, 2 – Medium, 1- Low