PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH

COIMBATORE – 641 062

(Autonomous Institution Affiliated to Anna University)

2025 Regulations

Courses of Study, Scheme of Assessment and Syllabi

for

B.E. Electrical and Electronics Engineering

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING

Vision

To create a dynamic community of aspiring technologists in the field of Electrical and Electronics Engineering, by empowering our students with the skills and knowledge to confidently tackle global challenges in an ethical manner.

Mission

- Pursue excellence in education and research and produce globally competent electrical engineers, who will contribute to a sustainable and prosperous world.
- Promote multi-disciplinary and self-learning activities through project work
- Foster research, innovation and industry-institute collaboration

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Demonstrate expertise in their field, together with the ability to effectively communicate that expertise and use it for problem-solving, by way of analysis, design, and evaluation of electrical, electronic, and information systems.

PEO 2: Demonstrate commitment to teamwork while working with others of diverse cultural and multi-disciplinary backgrounds.

PEO 3: Demonstrate continuous learning through professional development and self-study.

PEO 4: Demonstrate leadership and initiative to advance professional and organisational goals Ethically.

PROGRAM OUTCOMES (POs)

PO1 Engineering knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3 Design/development of solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4 Conduct investigations of complex problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)

PO5 Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6 The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)

PO7 Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8 Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams

PO9 Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10 Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments

PO11 Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1 Model, design, simulate and analyze the performance of Electric Circuits, Machines, power systems, power electronics and smart control techniques for sustainable and industrial applications.

PSO 2 Design, automate, analyze, and validate electronic circuits, embedded systems, and FPGA based hardware circuits integrating artificial and machine learning algorithms for real-time engineering applications.

B.E. ELECTRICAL AND ELECTRONICS ENGINEERING
(Minimum No. of credits to be earned: 168)

S. No.	Course Code	Course Title	Hours /Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER I										
THEORY										
1	25MA101	Calculus and its Applications	3	1	0	4	40	60	100	BS
2	25PH103	Physics for Electrical Engineering	3	0	0	3	40	60	100	BS
3	25CY103	Chemistry for Electrical Engineering	3	0	0	3	40	60	100	BS
4	25ME101	Basics of Mechanical Engineering	2	2	0	4	40	60	100	ES
5	25HS101	English Language Proficiency	3	1	0	4	40	60	100	HS
6	25HS102	*தமிழர் மரபு* / Heritage of Tamils	1	0	0	1	40	60	100	HS
PRACTICALS										
7	25BS112	Basic Sciences Laboratory	0	0	4	2	60	40	100	BS
8	25GE111	Design Thinking for Innovation	0	0	2	1	100	0	100	ES
9	25GE112	Engineering Graphics	0	0	4	2	60	40	100	ES
10	25EE111	Problem Solving and Python Programming Laboratory	0	0	2	1	60	40	100	ES
MANDATORY COURSES										
11	25GEM01	Induction Programme**	-	-	-	-	-	-	-	MC
12	25HSO01/ 25HSO02	Physical Education/ Yoga and Health	0	0	2	Grade	-	-	-	MC
Total 33 periods			**15**	**4**	**14**	**25**	**520**	**480**	**1000**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER II										
THEORY										
1	25MA201	Complex Variables and Transforms	3	1	0	4	40	60	100	BS
2	25EE201	Electric Circuits and Networks	3	1	0	4	40	60	100	ES
3	25EE202	Electromagnetic Fields	3	1	0	4	40	60	100	ES
4	25PH203	Semiconductor Devices	3	0	0	3	40	60	100	BS
5	25EE203	Programming in C Language	3	0	0	3	40	60	100	ES
6	25HS201	*தமிழரும் தொழில்நுட்பமும்* / Tamils and Technology	1	0	0	1	40	60	100	HS
PRACTICALS										
7	25HS21_	Language Elective	0	0	4	2	60	40	100	HS
8	25EE211	Circuits and Devices Laboratory	0	0	2	1	60	40	100	ES
9	25EE212	Programming in C Laboratory	0	0	2	1	60	40	100	ES
10	25EEC01	Workplace Communication Skills	0	0	2	-	100	0	100	EEC
MANDATORY COURSES										
11	25GEM02	Activity Point Programme I*	-	-	-	-	-	-	-	MC
12	25HSO01/ 25HSO02	Physical Education/ Yoga and Health	0	0	2	Grade	-	-	-	MC
Total 31 periods			**16**	**3**	**12**	**23**	**520**	**480**	**1000**	

**** As per AICTE norms;**
*** As per AICTE norms; Total 60 hrs.; Grade: Non-Credit Course**

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC - Mandatory Course; CA - Continuous Assessment; ESE - End-Semester Examination
L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER III										
THEORY										
1	25MA304	Matrix Theory and Numerical Methods	3	1	0	4	40	60	100	BS
2	25EE301	Electronic Circuits	3	1	0	4	40	60	100	ES
3	25EE302	Measurements and Instrumentation	3	0	0	3	40	60	100	ES
4	25EE303	DC Machines and Transformers	3	0	0	3	40	60	100	PC
5	25HS301	Project and Finance Management	3	0	0	3	40	60	100	HS
PRACTICALS										
6	25EE311	DC Machines and Transformers Laboratory	0	0	4	2	60	40	100	PC
7	25EE312	Electronic Circuits Laboratory	0	0	2	1	60	40	100	ES
8	25EEC02	Foundations of Problem Solving	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
9	25MC0_ _	Mandatory Course I	2	0	0	Grade	100	0	100	MC
10	25GEM03	Activity Point Programme II*	-	-	-	-	-	-	-	MC
Total 27 periods			**17**	**2**	**8**	**21**	**520**	**380**	**900**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER IV										
THEORY										
1	25MA403	Stochastic Processes and Statistical Analysis	3	1	0	4	40	60	100	BS
2	25EE401	Generation, Transmission and Distribution	3	0	0	3	40	60	100	PC
3	25EE402	Digital Electronics	3	1	0	4	40	60	100	PC
4	25EE403	Linear Integrated Circuits	3	0	0	3	40	60	100	PC
5	25EE404	AC Machines	3	1	0	4	40	60	100	PC
PRACTICALS										
6	25EE411	AC Machines Laboratory	0	0	4	2	60	40	100	PC
7	25EE412	Digital Electronics and LIC Laboratory	0	0	4	2	60	40	100	PC
8	25EEE01	Mini-Project I	0	0	2	1	100	0	100	EEC
9	25EEC03	Problem Solving	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
10	25MC0_ _	Mandatory Course II	2	0	0	Grade	100	0	100	MC
11	25GEM04	Activity Point Programme III*	-	-	-	-	-	-	-	MC
Total 32 periods			**17**	**3**	**12**	**24**	**620**	**380**	**1000**	

*** As per AICTE norms; Total 60 hrs.; Grade: Non-Credit Course**

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L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER V										
THEORY										
1	25EE501	Control Systems	3	1	0	4	40	60	100	PC
2	25EE502	Power Electronics	3	1	0	4	40	60	100	PC
3	25EE503	Microprocessor and Microcontrollers	3	0	0	3	40	60	100	PC
4	25EE504	Digital Signal Processing	3	1	0	4	40	60	100	PC
5	25EEP_ _	Professional Elective I	3	0	0	3	40	60	100	PE
PRACTICALS										
6	25EE511	Power Electronics Laboratory	0	0	2	1	60	40	100	PC
7	25EE512	Microprocessor and Microcontrollers Laboratory	0	0	4	2	60	40	100	PC
8	25EE513	Instrumentation and Control Laboratory	0	0	2	1	60	40	100	PC
9	25EEE02/ 25EEE03	Internship – I / Community Project	0	0	0	1	100	0	100	EEC
10	25EEC04	Aptitude Skills	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
11	25GEM05	Activity Point Programme IV*	-	-	-	-	-	-	-	MC
Total 28 periods			**15**	**3**	**10**	**24**	**580**	**420**	**1000**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VI										
THEORY										
1	25EE601	Power System Analysis	3	1	0	4	40	60	100	PC
2	25EE602	Electric Drives and Control	3	0	0	3	40	60	100	PC
3	25EE603	Data Structures using C++	2	2	0	4	40	60	100	ES
4	25_ _O_ _	Open Elective I	3	0	0	3	40	60	100	OE
5	25EEP_ _	Professional Elective II	3	0	0	3	40	60	100	PE
PRACTICALS										
6	25EE611	Electric Drives and Control Laboratory	0	0	2	1	60	40	100	PC
7	25EEE04	Mini-Project II	0	0	2	1	100	0	100	EEC
8	25EEC05	Enhancing Problem Solving Ability with Code	0	0	2	1	100	0	100	EEC
MANDATORY COURSES										
9	25GEM06	Activity Point Programme V*	-	-	-	-	-	-	-	MC
Total 23 periods			**14**	**3**	**6**	**20**	**460**	**340**	**800**	

*** As per AICTE norms; Total 60 hrs.; Grade: Non-Credit Course**

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L-Lecture; T-Tutorial; P-Practical; C-Credits

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VII										
THEORY										
1	25EE701	Power System Protection and Switchgear	3	1	0	4	40	60	100	PC
2	25EE702	Electrical Machine Design	3	1	0	4	40	60	100	PC
3	25EEP_ _	Professional Elective III	3	0	0	3	40	60	100	PE
4	25EEP_ _	Professional Elective IV	3	0	0	3	40	60	100	PE
5	25_ _O_ _	Open Elective II	3	0	0	3	40	60	100	OE
PRACTICALS										
6	25EE711	Power System Laboratory	0	0	2	1	60	40	100	PC
7	25EEE05	Project Work I	0	0	4	2	100	0	100	EEC
8	25EEE06	Internship II	0	0	0	1	100	0	100	EEC
Total 23 periods			**15**	**2**	**6**	**21**	**460**	**340**	**800**	

S. No.	Course Code	Course Title	Hours / Week			C	Maximum Marks			CAT
			L	T	P		CA	ESE	Total	
SEMESTER VIII										
THEORY										
1	25EEP_ _	Professional Elective V	3	0	0	3	40	60	100	PE
2	25EEP_ _	Professional Elective VI	3	0	0	3	40	60	100	PE
PRACTICALS										
3	25EEE07	Project Work II	0	0	8	4	60	40	100	EEC
Total 14 periods			**6**	**0**	**8**	**10**	**140**	**160**	**300**	

Summary of Credit Distribution

BE ELECTRICAL AND ELECTRONICS ENGINEERING										
S. No.	Course Category	Credits Per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	HS	5	3	3	0	0	0	0	0	**11**
2	BS	12	7	4	4	0	0	0	0	**27**
3	ES	8	13	8	0	0	4	0	0	**33**
4	PC	0	0	5	18	19	8	9	0	**59**
5	PE	0	0	0	0	3	3	6	6	**18**
6	OE	0	0	0	0	0	3	3	0	**6**
7	EEC	0	0	1	2	2	2	3	4	**14**
8	MC	-	-	-	-	-	-	-	-	-
TOTAL		**25**	**23**	**21**	**24**	**24**	**20**	**21**	**10**	**168**

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L-Lecture; T-Tutorial; P-Practical; C-Credits

LIST OF PROFESSIONAL ELECTIVE COURSES: VERTICALS

S. No.	Vertical 1 Embedded Systems	Vertical 2 Power Electronics and Drives	Vertical 3 Electric Vehicle Technology	Vertical 4 Power System	Vertical 5 Diversified Courses
1	25EEP01 Embedded System Design	25EEP09 Modelling and simulation of power converters	25EEP17 Electric Vehicle Architecture	25EEP25 Power System Operation and Control	25EEP33 Artificial Intelligence and Machine Learning Fundamentals
2	25EEP02 Embedded Programming	25EEP10 Switched Mode Power Conversion	25EEP18 Design of motors and Converters for Electric Vehicle	25EEP26 Renewable Energy Systems	25EEP34 Data Analytics
3	25EEP03 Internet of Things (IoT) and its applications	25EEP11 Control of Power Electronic Circuits	25EEP19 Intelligent Control of Electric vehicle	25EEP27 Smart Grid	25EEP35 VLSI Design Techniques
4	25EEP04 Operating Systems	25EEP12 Special Electrical Machine	25EEP20 Battery Management System	25EEP28 Energy Management and Auditing	25EEP36 Cyber Security
5	25EEP05 Computer Architecture	25EEP13 Power electronics for Renewable Energy Systems	25EEP21 Design of Electric vehicle Charging System	25EEP29 Utilization and Conservation of Electrical Energy	25ICP12 Virtual Instrumentation
6	25EEP06 System Design using FPGA	25EEP14 Multilevel Power Converters	25EEP22 Testing of Electric vehicles	25EEP30 HVDC and FACTS	25EEP37 PLC and SCADA
7	25EEP07 Digital Image Processing	25EEP15 Dynamic Modelling, Analysis and Design of Drives	25EEP23 Grid Integration of Electric Vehicles	25EEP31 Power quality and Management	25EEP38 Electrical system estimation and costing
8	25EEP08 Automotive Electronics	25EEP16 Embedded Control of Electric Drives	25EEP24 Artificial Intelligence for Autonomous vehicles	25EEP32 High Voltage Engineering	25EEP39 Model Based Systems

LIST OF COURSES FOR MINOR DEGREE PROGRAMME IN ELECTRIC VEHICLE

S. No.	Course Code	Course Title
1	25EEM01	Basics of Electric Vehicle
2	25EEM02	Hybrid Electric Vehicles
3	25EEM03	Embedded System for Automotive Applications
4	25EEM04	Energy Storage Systems
5	25EEM05	Electric Machines for EVs
6	25EEM06	EV Data Analytics and Cyber Security
7	25EEM07	Design Modelling and Simulation of Electric Vehicle
8	25EEM08	Unmanned Aerial Vehicles

LIST OF OPEN ELECTIVE COURSES

S. No.	Course Code	Course Title
1	25EEO01	Industrial Automation
2	25EEO02	Embedded system and Internet of Things
3	25EEO03	Energy Technologies
4	25EEO04	Sensors and Actuators
5	25EEO05	Electrical Drives
6	25EEO06	Electric Vehicle Technology
7	25EEO07	Biomedical Instrumentation
8	25EEO08	Electrical safety practices and standards

LIST OF ONE CREDIT COURSES

S. No.	Course Code	Course Title
1	25EE901	PCB Designing
2	25EE902	Modelling and Computational Tools for Electrical Engineers
3	25EE903	VHDL and Verilog Programming
4	25EE904	Electric Vehicle Technology
5	25EE905	Data Science and Analytics for Electrical Engineers

LIST OF LANGUAGE ELECTIVE COURSES

S. No.	Course Code	Course Title
1	25HS211	Communication Skills for Engineers
2	25HS212	Basic German
3	25HS213	Basic Japanese

LIST OF MANDATORY COURSES

S. No.	Course Code	Course Title
1	25MC001	Environmental Science
2	25MC002	Indian Constitution
3	25MC003	Industrial Safety
4	25MC004	Disaster Risk Reduction and Management
5	25MC005	Indian Knowledge System for Sustainable Human Development
6	25MC006	Strategic Data Management and Governance
7	25MC007	Professional Ethics
8	25HSO01	Physical Education
9	25HSO02	Yoga and Health

SEMESTER I
25MA101 CALCULUS AND ITS APPLICATIONS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

DIFFERENTIAL CALCULUS: Functions of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. **(9+3)**

INTEGRAL CALCULUS: Double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, double integrals in polar form. **(9+3)**

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS: Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling, decay and growth problems. **(9+3)**

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS: Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations mass spring systems, electric circuits. **(9+3)**

VECTOR CALCULUS: Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field – line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes' theorem. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS

1. J. Hass, C. Heil, and D. W. Maurice, '*Thomas Calculus'*. Pearson Education, New Delhi, 2018.
2. Erwin Kreyszig, '*Advanced Engineering Mathematics'*. Wiley India, New Delhi, 2018.

REFERENCES

1. H. Anton, I. Bivens, and S. Davis, '*Calculus*'. John Wiley and Sons, USA, 2016.
2. C. R. Wylie and L. C. Barrett, '*Advanced Engineering Mathematics*'. Tata McGraw-Hill, New Delhi, 2019.
3. D. G. Michael, '*Foundations of Applied Mathematics*'. Dover Publications, New York, 2013.
4. Gilbert Strang, '*Calculus*'. Wellesley Cambridge Press, USA, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Calculus, Differential Equations and Vector Calculus.	**K2**
CO2	Apply the techniques of Calculus, Differential Equations and Vector Calculus to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Calculus, Differential Equations and Vector Calculus.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Calculus, Differential Equations and Vector Calculus.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		3											
CO4					2								
	3	**3**			**2**								

1 – low, 2 – medium, 3 – high

25PH103 PHYSICS FOR ELECTRICAL ENGINEERING
(Common to EEE, ECE and EE-VLSI)

3 0 0 3

ELECTROMAGNETISM: Review of definitions of fundamental terms. Permeability. Forces due to currents - Uniform and non-uniform magnetic fields - Static and time-varying magnetic fields. Electromagnetic induction - Expression for induced emf. Electric fields definition of fundamental terms. Dielectric constant, Permittivity. Dielectric displacement. Gauss theorem. Electromagnetic waves. Propagation of electromagnetic waves through isotropic media. Maxwell's equations and interpretation of Maxwell's equations. **(9)**

QUANTUM MECHANICS: Wave particle duality, de Broglie waves- Heisenberg's uncertainty principle. Wave function- normalization. The wave equation - Schrodinger's equation of motion: Time dependent form, steady-state form. Particle in a box - Quantum Tunneling and applications: Zener diode and Tunnel diode. **(9)**

ELECTRICAL PROPERTIES: Conducting materials-quantum free electron theory -Fermi Dirac Statistics-Band theory of solids-the density of states. Dielectrics-types of polarization-measurement of dielectric permittivity-Loss Factor-Dielectric loss mechanisms. **(9)**

PHYSICS OF SEMICONDUCTORS: P type and N type semiconductors-the effective mass. Electrical conductivity in P type and N type semiconductors - P-N junction, rectifier equation. Hall effect and its applications. Hetero junction-Quantum well, wire, dots- Optical properties of Semiconductors: LD, LED, Photo diode. Introduction to MEMS. **(9)**

MAGNETIC PROPERTIES: Types of magnetic materials-domain theory-hysteresis- hard and soft magnetic materials-Applications-eddy current brakes, regenerative braking. Magnetic lenses, Magnetostriction. Superconductivity –Meissner's effect- Josephson junction, SQUID magnetometer, applications. **(9)**

Total L: 45 periods

TEXTBOOKS:

1. William D Callister Jr, '*Materials Science and Engineering-An Introduction'*. John Wiley and Sons Inc., 10th Edition, New York, 2018.
2. Arthur Beiser, '*Concepts of Modern Physics*'. Tata McGraw Hill, India, 2017.
3. Richard Wolfson, '*Essential University Physics*'. Vols 1 and 2. Pearson Education, Singapore, 2021.

REFERENCES:

1. Rolf E. Hummel, '*Electronic Properties of Materials*'. Springer, 2013
2. Van Vlack, '*Elements of Material Science and Engineering*'. Pearson Education India, 2008.
3. S. M. Sze, '*Physics of Semiconductor Devices'*. John Wiley and Sons, USA, 4th Edition, 2021.
4. D. Halliday, R. Resnick and Walker, '*Fundamentals of Physics*'. John Wiley and sons, 12th edition, 2021.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of electromagnetism, quantum mechanics, electrical properties, semiconductors, and magnetic materials, focusing on their principles and applications in engineering.	**K2**
CO2	Apply mathematical models to calculate electromagnetic field parameters, quantum states, carrier concentration in semiconductors, and magnetic flux in engineering systems.	**K3**
CO3	Analyze the performance of materials and devices based on their electrical, magnetic, and quantum properties, using appropriate equations and measurement techniques.	**K4**
CO4	Prepare a report or presentation on the applications of quantum mechanics, semiconductor devices, and magnetic materials in modern electronic systems, emphasizing their operational principles and practical uses.	**–**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4						1			1		1		
	3	**1**				**1**			**1**		**1**		

1 – low, 2 – medium, 3 – high

25CY103 CHEMISTRY FOR ELECTRICAL ENGINEERING

3 0 0 3

ELECTROCHEMISTRY: Electrode potential – standard and reference electrodes, Nernst equation, emf series – applications. Galvanic and concentration cells. Applications of potential measurements - redox titration, sensors – ion-selective electrodes –glass electrode - pH measurement, potentiometric gas sensing – oxygen sensor, dissolved CO_2 sensor - Conductance measurements – applications – conductometric titrations. **(9)**

BATTERIES AND FUEL CELLS: Batteries- types - battery characteristics-fabrication and working of zinc-carbon and lithium primary cells, lead- acid, Ni-metal-hydride and lithium ion batteries. Advanced and specialty batteries, supercapacitors. **Fuel cells**: Classification, working principle and components of proton exchange membrane, direct methanol, solid oxide, and molten carbonate fuel cells. Hydrogen as a fuel-production and storage**.** **(9**)

CORROSION: Atmospheric corrosion- oxidation – Pilling –Bedworth rule. Electrochemical corrosion – galvanic and differential aeration corrosion, soil corrosion. Rate of corrosion - factors influencing corrosion. Corrosion control –protective coatings - metallic coatings – galvanising, tinning, chemical conversion coatings– anodising, phosphating, chromating. Paints– constituents and their functions. Vitreous enamel coatings. Cathodic protection - sacrificial anode and impressed current methods. Corrosion in electronic components - vapour phase inhibitors, dehumidifier gels. Corrosion issues in power transmission and distribution. **(9)**

POLYMERS: Mechanisms of polymerisation reactions – chain and condensation, copolymers, degree of polymerisation, polydispersity, topologies - amorphous and crystalline states. Thermal properties - thermoplastics and thermosetting plastics, mechanical properties, electrical properties– conducting polymers – charge transport, doping and applications, insulating polymers - dielectric breakdown – aging of polymers - protective and functional additives. Modification of properties of polymers – composites – types of fillers. Photoresists – chemistry, types, application in microchip fabrication – overview. Adhesives – chemical types, application methods, factors influencing adhesion, applications in electronic packaging. **(9)**

CHEMICAL PROCESSES AND MATERIALS FOR ELECTRONICSAND ELECTRICAL ENGINEERING: Ultrapure water for electronics industry – specification, water purification – ion exchange, reverse osmosis, continuous electrode ionization. PCB fabrication – electroless and electroplating of copper and nickel – formation of copper track on plastic board. Electroforming of nickel - fabrication of CD stampers. Soldering alloys – phase diagrams, lead free alloys. Oils for insulation and lubrication–- chemical constitution, characterisation of oils – kinematic viscosity, water content, neutralisation value, flash and fire point, cloud and pour point, oxidation stability, electric properties - breakdown voltage, dielectric constant, dissipation factor. Grease – preparation, types and properties. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Shashi Chawla, '*A Textbook of Engineering Chemistry*'. Dhanpat Rai and Co., 6th edition, 2022.
2. Derek Pletcher and Frank C. Walsh, '*Industrial Electrochemistry*'. Chapman and Hall, 1993.

REFERENCES:

1. J. M. G. Cowie and Valeria Arrighi, '*Polymers: Chemistry and Physics of Modern Materials*'. CRC Press, 3rd edition 2016.
2. Florinel-Gabriel Banica, '*Chemical Sensors and Biosensors – Fundamentals and Applications'*. John Wiley and Sons Ltd, 2012.
3. Peter Van Zant, '*Microchip Fabrication: A Practical Guide to Semiconductor Processing*'. McGraw Hill, 2014.
4. Ravindra Arora and Wolfgang Mosch, '*High Voltage Electrical Insulation Engineering*'. John Wiley and Sons Ltd., 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts of electrochemical methods and engineering materials.	**K2**
CO2	Apply the concepts of electrochemistry and polymer technology in electrical and electronic systems.	**K3**
CO3	Analyze the properties of materials and select the appropriate materials for engineering applications	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3										3		
CO3		3						1	1				
	3	**3**						**1**	**1**		**3**		

1 – low, 2 – medium, 3 – high

25ME101 BASICS OF MECHANICAL ENGINEERING

2 2 0 4

BASIC MANUFACTURING PROCESSES: Carpentry, Fitting, Lathe, Welding, Smithy, Foundry and Sheet Metal-Basic tools, applications and practices; Overview of manufacturing processes-Introduction to metal casting process, bulk deformation processes, powder metallurgy and plastic processing. **(6+6)**

POWER TRANSMISSION: Types of drives, construction and operation of belt drives, flat and V belts, rope drive, chain drive; Gear drives - spur, helical, bevel, worm and worm wheel, rack and pinion; Gear trains - simple and compound gear trains. **(6+6)**

BASIC CONCEPTS OF THERMODYNAMICS AND FLUID MECHANICS: Thermodynamics: System, property, state and equilibrium, process and cycle, work, heat and other forms of energy, zeroth law and application, first law of thermodynamics-application to closed and open systems, second law of thermodynamics - Clausius and Kelvin- Planck statements; Fluid mechanics: Properties of fluids, measurement of pressure using manometers, flow measurement using orifice, venturi-meter, nozzle meters and pitot tubes. **(6+6)**

INTERNAL COMBUSTION ENGINES AND AIR COMPRESSORS: Engines: Classification of IC engines, construction and working principle of petrol and diesel engines, four stroke and two stroke cycles, comparison of four stroke and two stroke engines, petrol, diesel and duel engines, Electrical vehicle; Air compressors: Classification, constructional details and working principle-axial flow, reciprocating and centrifugal compressors. **(6+6)**

PUMPS, TURBINES, REFRIGERATION AND AIR-CONDITIONING: Pumps: Basic concepts of centrifugal and reciprocating pumps - constructional details and working principle; Turbines: Principle and working of Pelton wheel, Francis and Kaplan turbine; Refrigeration and air conditioning: Principle and working of vapour compression and absorption systems, layout of typical domestic refrigerator; window and split type room air conditioners. **(6+6)**

Total L: 30 + T: 30 = 60 periods

TEXT BOOKS:

1. S. Kalpakjian. '*Manufacturing Engineering and Technology'*. Pearson Education India Edition, 2013
2. K. Venugopal, V. Prabhu Raja and G. Sree Kanjana, '*Basic Mechanical Engineering*'. Anuradha Publications, Chennai, 2014

REFERENCES:

1. L. S. Jayagopal and R. Rudramoorthy, '*Elements of Civil and Mechanical Engineering*'. Vikas Publishing House Pvt. Ltd., 2003
2. D. S. Kumar, '*Fluid Mechanics and Fluid Power Engineering*'. Kataria and Sons, New Delhi, 2010
3. V. Ganesan, '*Internal Combustion Engines*'. Tata McGraw Hill, 2007

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles of thermodynamic systems, fluid machinery, internal combustion engines, and refrigeration and air-conditioning units.	**K2**
CO2	Apply basic concepts of mechanical, fluid, and thermal systems to practical engineering scenarios.	**K3**
CO3	Analyze various power transmission mechanisms including belt, chain, rope, and gear drives for mechanical motion and force transfer.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 – high

25HS101 ENGLISH LANGUAGE PROFICIENCY
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

3 1 0 4

VOCABULARY: Etymology-Prefixes and suffixes–Synonyms–Antonyms–Guessing meanings from context–Word formation- Single-word substitutes- Different forms of a word–Phrasal verbs–Collocations. **(9+3)**

LISTENING AND SPEAKING: Understanding listening – Listening techniques - Introducing oneself and others – Seeking and sharing information– Description-Conversation skills– Extempore speaking– Speech practice in varied formal contexts. **(9+3)**

GRAMMAR: Wh-questions – Yes/no questions– Parts of speech – Articles– Prepositions–Gerunds–Conjunctions-Degrees of comparison– Tenses– Modal verbs – Adverbs - Direct and indirect questions. **(9+3)**

READING: Reading strategies: Skimming and scanning, predicting– Reading comprehension: techniques –Practice reading. **(9+3)**

WRITING: Discourse markers – Dialogue writing - Completing sentences – Jumbled sentences – Paragraph writing –Writing compare & contrast paragraphs – Letter writing. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXTBOOKS:

1. K. N. Shoba and Lourdes Joavani Rayen, '*Communicative English*'. Cambridge University press, Cambridge, 2021.
2. Raymond Murphy, '*Intermediate English Grammar*'. Cambridge University Press, New Delhi, 2020.
3. Dr M. Sambaiah, '*Technical English an integrated text book*'. Wiley India Pvt. Ltd., 2025.

REFERENCES:

1. Raymond Murphy, '*English Grammar in Use*'. Cambridge University Press, New Delhi 2020.
2. N. P. Sudharshana and C. Savitha, '*English for Engineers*'. Cambridge University Press, New York, 2018.
3. Helen Naylor with Raymond Murphy, '*Essential English Grammar*'. Cambridge University Press, New Delhi, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate the ability to recognize and use a wide range of vocabulary and key grammatical structures accurately, while developing inferential reading skills to comprehend, interpret, and analyze written texts across diverse contexts.	**K2**
CO2	Organize their ideas logically in essay writing, develop paragraphs with clear topic sentences and adapt their letter-writing skills to various real-world scenarios.	**K3**
CO3	Demonstrate clear and confident speaking skills in formal and informal contexts.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									3		3		
CO2									3		3		
CO3									1		1		
									3		**3**		

1 – low, 2 – medium, 3 – high

25HS102 *தமிழர் மரபு*
(Common to all B.E./B.Tech./B.Des. Degree Programmes)

1 0 0 1

மொழி மற்றும் இலக்கியம்: *இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச்சார் பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க்காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.* **(3)**

மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை: *நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரி முனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வியல் கோவில்களின் பங்கு.* **(3)**

நாட்டுப்புறக்கலைகள் மற்றும் வீரவிளையாட்டுகள்: *தெருக்கூத்து, கரகாட்டம், வில்லுப் பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.* **(3)**

தமிழர்களின் திணைக்கோட்பாடுகள்: *தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக்கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்க காலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்க கால நகரங்களும் துறைமுகங்களும் – சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.* **(3)**

இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: *இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப் பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப் படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.* **(3)**

Total L: 15 Periods

25HS102 HERITAGE OF TAMILS
(Common to all B.E./B.Tech./B.Des. Degree Programmes)

1 0 0 1

LANGUAGE AND LITERATURE: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan. **(3)**

HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE: 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. **(3)**

FOLK AND MARTIAL ARTS: Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamil. **(3)**

THINAI CONCEPT OF TAMILS: 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 Chola. **(3)**

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE: Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books. **(3)**

Total L: 15 Period

TEXT – CUM – REFERENCE BOOKS:

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

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the Dravidian language family, outline the features of Tamil classical literature, and explain the development of Tamil art, sculpture, and temple-related traditions in a historical context.	**K2**
CO2	Demonstrate the cultural relevance of Tamil folk and martial arts, apply the concepts of Sangam landscape classification to social contexts, and relate Tamil contributions to India's freedom struggle, cultural legacy, and Siddha medicine.	**K3**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1							3				3		
CO2							3				3		
							3				**3**		

1-Low, 2-Medium, 3-High

25BS112 BASIC SCIENCES LABORATORY
(Common to EEE, ECE, Mech and EE-VLSI)

0 0 4 2

Physics (Any eight experiments)

1. Measurement of Hall coefficient of a semiconductor using Hall effect setup.
2. Determination of Young's modulus of the material- Uniform Bending
3. Determination of electrical resistivity of a given material using four probe setups.
4. Determination of wavelength of laser using diffraction grating - LASER.
5. Determination of Thickness of a thin wire – Air wedge method.
6. Study of I-V characteristics of solar cell and determination of its efficiency
7. Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
8. Determination of Planck's constant and work function of a metal -Photoelectric Effect
9. Determination of bandgap of a semiconductor – Post office box.
10. Determination of force in Truss Bridge
11. Validation of faraday's law of induction
12. Interpreting the working mechanism of spirometer, CO_2 sensor, venturi tube and heart rate sensor

Demonstration:

1. Determination of Numerical Aperture and Acceptance angle - Optical Fiber
2. Study the energy loss of a ferrite magnetic material specimen by B-H curve.

REFERENCES:

1. Department of Physics, Physics Laboratory Observation, 2025.

Jerry D Wilson, A. Cecilia and Hernandez Hall, '*Physics Laboratory Experiments*'. Boston, Cengage Learning, 2016.

Chemistry (Any eight experiments):

1. Determination of total, temporary & permanent hardness of water by EDTA method.
2. Determination of strength of acids in a mixture of acids using conductivity meter.
3. Determination of strength of given hydrochloric acid using pH meter.
4. Estimation of iron content of the given solution using potentiometer.
5. Corrosion experiment-weight loss method.
6. Electroplating of copper and Nickel and determination of coulombic efficiency.
7. Designing a battery and determination of its characteristics.
8. Construction of phase diagram of a simple eutectic system.
9. Determination of kinematic viscosity and acid value of a lubricating oil.
10. Anodizing of aluminium and determination of thickness of anodised film.

Total P: 60 periods

REFERENCE:

1. J Mendham, Vogel's Textbook of '*Quantitative Chemical Analysis'*. 6th Edition, Pearson Education, 2009**.**

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Relate the scientific principles and compare the experimental results with theoretical calculations and apply graphical analysis to visualise the importance of precise measurements.	**K3**
CO2	Analyse the experimental result outcomes using analytical and experimental skills for various engineering materials and applications.	**K4**
CO3	Demonstrate the measurement of water quality parameters in the given water sample	**K3**
CO4	Analyze the properties of materials for Engineering applications	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2		2											
CO3	3								3		3		
CO4				3				3					
	3	**2**		**3**				**3**	**3**		**3**		

1 – low, 2 – medium, 3 – high

25GE111 DESIGN THINKING FOR INNOVATION
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 1

Foundations of Design Thinking: History & Origins: Roots in Creative Problem Solving: Traces back to mid-20th century practices in architecture, engineering, and psychology. Herbert Simon's "Sciences of the Artificial" (1969): Introduced design as a way of thinking distinct from scientific inquiry. IDEO and the Rise of Human-Centered Design: Popularized design thinking as a repeatable, user-focused innovation process. Stanford school's Influence: Helped institutionalize design thinking in education and entrepreneurship.

Variations of Design Thinking Phases: IDEO's 3-Phase Model: Inspiration, Ideation, Implementation A flexible, non-linear approach emphasizing creativity and action. Stanford school's 5-Phase Model: Empathize, Define, Ideate, Prototype, Test A structured yet iterative framework centered on user empathy. Double Diamond Model (Design Council UK): Divides the process into Discover, Define, Develop, and Deliver—highlighting divergent and convergent thinking.

Related Concepts & Frameworks: Human-Centered Design (HCD): Focuses on designing solutions that deeply resonate with users' needs and contexts. Systems Thinking: Encourages understanding the broader ecosystem and interdependencies within a problem space. Agile & Lean UX: Integrates design thinking with iterative development and minimal viable experimentation. Service Design: Applies design thinking to orchestrate holistic user experiences across touchpoints. Participatory Design: Involves stakeholders directly in the design process to ensure relevance and inclusivity.

EMPATHIZE: Apply Human-Centric Design Principles: Focus on designing solutions that prioritize user needs, experiences, and values throughout the process. Consult Experts: Engage with subject matter experts to gain foundational knowledge about the problem space. Competitive Analysis: Identify & studying similar products or services to identify gaps and opportunities. Stakeholder Interviews: Engaging with people who influence or are affected by the product or service. Conduct Observations: Observe users in their natural environment to understand behaviors, challenges, and interactions. Engage with Users: Use interviews, conversations, and other methods to connect with users and hear their stories. Immerse Yourself: Step into the users' context to experience their environment and challenges firsthand. Create Empathy Maps: Visualize what users say, think, feel, and do to synthesize insights. Identify User Needs and Pain Points: Extract meaningful patterns and needs from user interactions and observations. Set Aside Assumptions: Approach the research with an open mind, suspending personal biases and preconceptions. Document Insights: Capture quotes, observations, and emotional cues to inform the next stage (Define). **(6)**

DEFINE: Organize Research Findings: Review and structure the data collected during the Empathize stage. Analyze Observations: Identify patterns, themes, and insights from user interactions and behaviors. Craft a Human-Centered Problem Statement: Frame the problem from the user's perspective, focusing on their needs—not business goals. Avoid Business-Centric Framing: Refrain from defining problems based on company objectives alone (e.g., market share). Persona Development: Synthesizing research into user personas to guide design decisions. Use Empathy to Guide Definition: Ensure the problem statement reflects real user challenges and motivations. Develop Point-of-View Statements: Create concise summaries that capture who the user is, what they need, and why. Prepare for Ideation: Formulate "How Might We" questions to spark creative thinking in the next phase. **(6)**

IDEATE: Review the Problem Statement: Revisit the user-centric problem defined in the previous stage to guide ideation. Explore Multiple Perspectives: Encourage diverse viewpoints to broaden the range of potential solutions. Use Ideation Techniques: Apply methods like Brainstorming, Brain writing, SCAMPER, and Worst Possible Idea to spark creativity. Encourage Free Thinking: Create a judgment-free space to generate as many ideas as possible without filtering. Expand the Problem Space Push boundaries and explore unconventional or extreme ideas to uncover hidden opportunities. Refine and Select Ideas: Use evaluation techniques to identify promising concepts that address user needs effectively. Prepare for Prototyping: Choose ideas that are feasible and impactful to develop into tangible prototypes in the next stage. **(6)**

PROTOTYPE: Build Low-Cost Prototypes: Create simple, scaled-down versions of the product or its features to explore ideas. Experiment with Solutions: Implement different solutions from the Ideate stage into prototypes for testing. Test Internally and Externally: Share prototypes with team members, other departments, or a small group of users. Observe User Interactions: Watch how users engage with the prototypes to uncover usability issues and insights. Evaluate and Iterate: Accept, refine, or discard prototypes based on user feedback and performance. Identify Limitations: Discover constraints and challenges in the proposed solutions through hands-on testing. Gain Deeper User Understanding: Learn how users think, feel, and behave when interacting with the product. **(6)**

20

TEST: Conduct Rigorous Testing: Evaluate the complete product using the most promising prototypes. Observe Real User Interactions: Study how users behave, think, and feel while using the product. Gather Feedback and Insights: Collect qualitative and quantitative data to assess usability and effectiveness. Identify Remaining Issues: Detect limitations, pain points, and areas for improvement. Refine and Iterate: Use test results to improve the product and revisit earlier stages if needed. Redefine Problems if Necessary: Reframe or adjust problem statements based on new insights. Enhance Understanding of Users: Deepen empathy and knowledge of user needs through real-world testing. **(6)**

Design Thinking & Customer Centricity: A human-centered approach that blends empathy and innovation to create solutions that truly resonate with customer needs. Practical Examples of Customer Challenges: Real-world scenarios where customers face friction, unmet needs, or emotional disconnects in their product or service journey. Use of Design Thinking to Enhance Customer Experience: Applying iterative problem-solving and user insights to craft experiences that are intuitive, delightful, and deeply relevant. Parameters of Product Experience: Key dimensions like usability, accessibility, emotional impact, and consistency that shape how customers perceive and interact with a product. Alignment of Customer Expectations with Product Design: Ensuring that every design decision reflects what customers value, expect, and aspire to achieve through the product.

Total P: 30 periods

TEXT BOOKS

1. T. Brown, '*Change by Design*'. Harper Business, 2009.
2. J. Liedtka and T. Ogilvie, '*Designing for Growth*'. Columbia Business School Publishing, 2011.

REFERENCE BOOKS

1. T. Kelley and D. Kelley, '*Creative Confidence*'. Crown Business, 2013.
2. Stanford d. School resources: https://dschool.stanford.edu/
3. https://apphaus.sap.com/toolkit/methods#design-thinking

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply empathy-driven research to understand user needs.	**K3**
CO2	Frame actionable problem statements and generate creative ideas.	**K6**
CO3	Develop and test prototypes to refine innovative solutions to real-world problems.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					3	3	3	3		3		
CO2		2				2	2	2	2		2		
CO3			1			1	1	1	1		1		
	3	**2**	**1**			**3**	**3**	**3**	**3**		**3**		

1 – low, 2 – medium, 3 – high

25GE112 ENGINEERING GRAPHICS
(Common to EEE, ECE, ICE and EE-VLSI)

0 0 4 2

INTRODUCTION TO ENGINEERING GRAPHICS (4)

1. Introduction to Engineering Graphics.
2. Lettering practice as per BIS.
3. Principles of Dimensioning.

ORTHOGRAPHIC PROJECTIONS (40)

1. Introduction to Orthographic Projections.
2. Drawing multiple views from pictorial views of objects.
3. Projection of points.
4. Projection of straight lines (only First angle projections) inclined to both the principal planes.
5. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.
6. Projection of simple solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

SECTION OF SOLIDS (8)

1. Section of simple solids in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other and obtaining true shape of section.

ISOMETRIC PROJECTIONS (8)

1. Isometric projection of simple solids in simple vertical positions.

Total P: 60 periods

TEXT BOOKS:

1. N.D. Bhatt, '*Engineering Drawing*'. Charotar Publishing House Pvt. Ltd., 55th Edition, 2025.
2. K.C. John, '*Engineering Graphics for Degree*'. Prentice Hall India Publishers, 2009.
3. K.V. Natarajan, '*A Text book of Engineering Graphics*'. Dhanalakshmi Publications, 34th Refined Edition, 2021.

REFERENCES:

1. K. Venugopal and V. Prabhu Raja, '*Engineering Graphics*'. New Age International Publishers, 17th Edition, 2024.
2. '*Bureau of Indian Standards*'. Engineering Drawing Practices for Schools and Colleges SP 46-2003, BIS, New Delhi, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Use the standards and specifications for engineering drawing.	**K2**
CO2	Apply projection techniques to create basic shapes, solids, and sectioned objects.	**K3**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3												
CO2	1												
	3												

1 – low, 2 – medium, 3 - high

25EE111 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing algorithm and flow charts for the same.
2. Python programming using simple statements and expressions
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool and developing a game activity using Pygame.

Total P:30 periods

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 and Development Limited, 2017.

REFERENCES:

1. Paul Deitel and Harvey Deitel, 'Python for Programmers'. Pearson Education, 1st Edition, 2021.
2. John V Guttag, 'Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'. 3rd Edition, MIT Press, 2021

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the basic constructs of Python Programming	**K2**
CO2	Apply the different data structures like list, tuple, set or dictionary to solve complex problems.	**K3**
CO3	Implement real-time applications using the modules and packages	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							2	1
CO3			2		3							2	1
	3		**2**		**3**							**2**	**1**

1 – low, 2 – medium, 3 – high

25GEM01 INDUCTION PROGRAMME
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

All students shall undergo an induction programme at the beginning of the first semester for a duration of three weeks as per the guidelines of All India Council for Technical Education (AICTE). A student completing the induction programme will be awarded a completed grade in the grade sheet, and only the students who complete the induction programme shall be considered as eligible for award of degree subject to satisfying other conditions. A student who does not complete the induction programme in the first semester shall redo the same in the subsequent semester.

SEMESTER II

25MA201 COMPLEX VARIABLES AND TRANSFORMS

(Common to CIVIL, EEE, ECE, ICE, MECH and EE-VLSI)

3 1 0 4

COMPLEX DIFFERENTIATION: Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. **(9+3)**

COMPLEX INTEGRATION: Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). **(9+3)**

LAPLACE TRANSFORMS: Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, unit step function, second shifting theorem, Dirac's delta function, periodic functions, differentiation and integration of transforms, solving ODEs with constant coefficients and initial value problems. **(9+3)**

FOURIER ANALYSIS: Fourier series – arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. **(9+3)**

PARTIAL DIFFERENTIAL EQUATIONS: Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by Fourier series. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS

1. Erwin Kreyszig, '*Advanced Engineering Mathematics*'. Wiley India, New Delhi, 2018.
2. G. Z. Dennis, '*Advanced Engineering Mathematics*'. Jones and Bartlett Pvt Ltd, New Delhi, 2017.

REFERENCES

1. G.Z. Dennis and D. S. Patrick, '*A first course in Complex Analysis with Applications*'. Jones and Bartlett Pvt Ltd, New Delhi, 2015.
2. C. R. Wylie and L. C. Barret, '*Advanced Engineering Mathematics*'. Tata McGraw-Hill, New Delhi, 2019.
3. Peter V. O Neil, '*Advanced Engineering Mathematics*'. Cengage, New Delhi, 2018.
4. G. D. Dean, '*Advanced Engineering Mathematics with MATLAB*'. CRC Press, USA, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K2**
CO2	Apply the techniques of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems employing Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Complex Variables, Laplace Transforms, Fourier Analysis and Partial Differential Equations.	-

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25EE201 ELECTRIC CIRCUITS AND NETWORKS

3 1 0 4

DC CIRCUITS: Fundamentals of Circuit Elements –Independent and Dependent Sources - Ohm's law - Kirchhoff's Laws– Network Reduction Techniques- Series Circuits, Parallel Circuits and Star to Delta and Delta to Star Transformations. Mesh and Nodal analysis of DC circuits with independent and Dependent Sources. Network Theorems: Superposition Theorem – Thevenin's and Norton's Theorems–Maximum Power Transfer Theorem. **(10+4)**

AC CIRCUITS: Fundamental concepts of AC circuits, R, L and C elements -phasor diagram -complex impedance-real power, reactive power, apparent power, complex power and power factor -series and parallel circuits - Analysis using Mesh, Nodal, and Network theorems. **(10+4)**

THREE PHASE CIRCUITS: Phase sequence–Star and Delta connection–Phase and line quantities -Phasor diagram-Balanced and unbalanced loads–Analysis–3-phase power measurement–Two wattmeter method-Power factor calculation-Reactive power measurement. **(8+3)**

NETWORK TRANSIENTS: Transient concepts–Complex frequency-Transient response of simple RL, RC, and RLC series and parallel circuits for DC excitation. **(8+2)**

MAGNETICALLY COUPLED CIRCUITS AND TWO PORT NETWORKS: Self and Mutual inductance – Co-efficient of coupling-Dot convention-Analysis of coupled circuits. Two port network parameters–Interconnection of two port networks: series, parallel, and cascade–Network functions - Driving point and transfer impedance/admittance. **(9+2)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. Charles K. Alexander and Mathew N. O. Sadiku, '*Fundamentals of Electric Circuits*'. 5th edition, McGraw-Hill, 2013.
2. A. Sudhakar and S. P. Shyam Mohan, '*Circuits and Network Analysis and Synthesis*'. McGraw-Hill, 5th edition, 2017

REFERENCES:

1. A. Chakrabarti, '*Circuits Theory (Analysis and Synthesis)*'. Dhanpat Rai and Sons, New Delhi, 7th edition, 2018.
2. J. David Irwin and R. Mark Nelms, '*Basic Engineering Circuit Analysis*'. John Wiley and Sons, 12th edition, 2021.
3. William H. Hayt Jr, Jack E. Kemmerly, and Steven M. Durbin, '*Engineering Circuits Analysis*'. McGraw-Hill Publishers, New Delhi, 2020.
4. Allan H. Robbins and Wilhelm C. Miller, '*Circuit Analysis Theory and Practice*'. Cengage Learning India, 5th edition, 2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of DC/AC electric circuits and network theorems	**K2**
CO2	Solve DC/AC electric circuits using network reduction techniques, mesh and nodal methods, and evaluate resonance parameters	**K3**
CO3	Analyze and obtain the response of DC/AC electric circuits under transient as well as steady-state conditions	**K4**
CO4	Compute and simulate electrical parameters of DC/AC circuits under various operating conditions, and validate the results using Multisim/Pspice/MATLAB software	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4				1	1			1	1				1
	3	**2**		**1**	**1**			**1**	**1**				**3**

1 – low, 2 – medium, 3 - high

25EE202 ELECTROMAGNETIC FIELDS

3 1 0 4

VECTOR CALCULUS: Review of 3D Co-ordinate Systems - Gradient, Divergence and Curl Operations – Divergence theorem - Stokes' theorem - Line, Surface, and Volume integrals. **(8+2)**

ELECTROSTATIC FIELDS: Coulomb's law - Electric field intensity - Electric flux density -Gauss's law and its Applications-Absolute potential - Potential difference -Potential Gradient - Determination of electric field and potential due to point, line, surface, and volume charge distributions - Electric Dipole - Energy density in the electrostatic field. **(10+4)**

ELECTRIC FIELDS IN MATERIAL SPACE AND BOUNDARY-VALUE PROBLEMS: Properties of conductors and dielectrics - convection and conduction currents -polarization in dielectrics - dielectric constant and strength - continuity equation and relaxation time- Capacitance determination - Method of images - Boundary conditions involving conductors, dielectric, and free space - Poisson's and Laplace's equations- Uniqueness theorem - Solution of Laplace's equation of single variable only. **(8+2)**

MAGNETOSTATIC FIELDS: Biot-Savart's law - Ampere's circuital law and its applications -Magnetic flux density - Scalar and Vector magnetic potentials - Maxwell's equations for static EM fields - Forces due to magnetic fields - Force and Torque on a closed-circuit - Magnetic materials - Boundary conditions at the interface of two different magnetic materials. **(10+4)**

INDUCTANCE: Inductance of Solenoid, Toroid, Coaxial cable, and Transmission line - Energy density in the magnetic field - Lifting force of a magnet. **TIME VARYING FIELD:** Faraday's Law - Transformer and Motional EMFs - Displacement Current- Maxwell's Equations in final form - Poynting theorem. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Mathew N O Sadiku and S.V. Kulkarni, '*Principles of Electromagnetics*'. 6th Edition, Oxford, University Press, New Delhi, 2015.
2. William H Hayt Jr. and John A Buck, '*Engineering Electromagnetics*'. 9th Edition, Tata McGraw-Hill, 2019.

REFERENCE:

1. Joseph A Edminister, '*Electromagnetics Schaum's Outline Series*'. Tata McGraw-Hill, New Delhi, 2014.
2. K. A. Gangadhar, '*Field Theory*'. Khanna Publishers, New Delhi, 2009.
3. Nannapaneni Narayana Rao, '*Elements of Engineering Electromagnetics*'. 6th Edition, Prentice Hall, New Delhi, 2011.
4. Nathan Ida, '*Engineering Electromagnetics*'. 3rd Edition, Springer, Switzerland, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts of electromagnetic fields including vector calculus, electrostatics, magnetostatics and electromagnetic wave theory.	**K2**
CO2	Apply the principles of vector calculus, electrostatics and magnetostatics to compute electric and magnetic field intensities, potentials, capacitance, inductance and energy storage in various media	**K3**
CO3	Analyze time-varying electromagnetic fields, Maxwell's equations and wave propagation characteristics in different media and solve electromagnetic field problems by combining concepts of electrostatics, magnetostatics and wave theory in different media	**K4**
CO4	Make a presentation on the applications of electrostatics and magnetostatics in the field of electrical and electronics engineering.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												1
CO3		2	1										1
CO4					1			1			1		
	3	**2**	**1**		**1**			**1**			**1**		**1**

1 – low, 2 – medium, 3 - high

25PH203 SEMICONDUCTOR DEVICES

3 0 0 3

P-N JUNCTION DIODE: Review of semiconductor properties, charge densities in semiconductor, Intrinsic and Extrinsic semiconductors - Energy band diagrams for P type and N type semiconductor. Theory of p-n junction, diode - V-I characteristics – Effect of temperature on characteristics, diffusion and transition capacitances, Elementary applications - Clippers and clampers, Diode switching times- p-n junction diode ratings. Zener diode - Avalanche breakdown and Zener breakdown mechanisms. **Photo devices:** Light Emitting Diodes (LED): Seven Segment Displays – Liquid Crystal Cells - Photoconductive cells -Photodiodes and Solar Cells-Photo transistors - Opto couplers. **(12)**

BIPOLAR JUNCTION TRANSISTOR: Construction of a BJT – working – transistor currents – transistor configurations - Modes of transistor operation and input-output characteristics – Early effect (base-width modulation) – Ebers Moll model. Transistor switching times - Transistor as a switch and an amplifier, small signal ac model, Miller effect capacitance – high frequency response- hybrid – π model - BJT ratings. **(8)**

FIELD EFFECT TRANSISTORS: JFET-JFET operation - V-I characteristics, transfer characteristics, regions of operation **MOSFET-** Construction of MOSFET-Types of MOSFET- Operation of enhancement and depletion type MOSFETs, V-I characteristics, transfer characteristics, analytic expression for drain current. Comparison of PMOS and NMOS devices - MOSFET biasing, MOSFET as a switch, resistor and amplifier, small signal ac model. Introduction to CMOS and BiCMOS devices. **(8)**

TRANSISTOR BIASING: AC and DC load lines - Need for stability of Q-Point - Bias stability- Biasing techniques - fixed bias, collector to base bias, self-bias. Bias compensation - Methods of MOSFET biasing. **(8)**

INTEGRATED CIRCUIT FABRICATION: Monolithic I C technology - Planar processes, Epitaxial growth, Oxidation, Photolithography, Diffusion, Ion implantation, metallization. BJT fabrication - need for buried layer, Junction and dielectric isolation, Fabrication of p-n-p, multiple emitter transistors., Monolithic diodes. NMOS enhancement and depletion MOSFETs, self-isolation, CMOS technology, Monolithic IC Resistors: sheet resistance - diffused, ion implanted, epitaxial, pinch, MOS and thin film resistors, Monolithic IC capacitors - junction, MOS and thin film capacitors. IC packaging. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. J. Millman and A. Grabel, '*Microelectronics*'. McGraw Hill Education, 2nd edition, 2017.
2. L. R. Boylestead and L. Nashelsky, '*Electronic Devices and Circuit Theory*'. Pearson Prentice Hall, 11th edition, New Delhi, 2015.

REFERENCES:

1. Abel S Sedra and Kenneth C Smith, '*Microelectronic Circuits*'. Oxford University Press, New York,2017.
2. Thomas L Floyd, '*Electronic Devices'*. Pearson Education, New Delhi, 2017.
3. David A Bell, '*Electronic Devices and Circuits*'. Oxford University Press, 2018.
4. Muhammad H Rashid, '*Introduction to PSpice using OrCAD for Circuits and Electronics*'. PHI Learning, New Delhi, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles, characteristics, and applications of semiconductor devices, including P-N junction diodes, bipolar junction transistors (BJTs), and field-effect transistors (FETs), focusing on their V-I characteristics, modes of operation, and applications.	**K2**
CO2	Apply theoretical concepts to calculate the operating characteristics of semiconductor devices, including the V-I characteristics of diodes, transistor switching times, and the performance of MOSFETs in various applications.	**K3**
CO3	Analyse the performance of semiconductor devices such as BJTs, MOSFETs, and integrated circuits by examining their characteristics, biasing techniques, and fabrication processes, and assess their impact on the design of electronic systems.	**K4**
CO4	Prepare a report or presentation on the working, applications, and performance of semiconductor devices such as diodes, BJTs, FETs, and MOSFETs, with an emphasis on their role in modern electronics.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1											
CO4						1			1				
	3	**1**				**1**			**1**				

1 – low, 2 – medium, 3 – high

25EE203 PROGRAMMING IN C LANGUAGE

3 0 0 3

INTRODUCTION: Analysing and Defining the Problem - Algorithm - Flowchart – Program development steps - Types of programming language. C: The C character set - Identifiers and keywords – Data types – Constants - Variables - Declarations -input and output functions-pre-processor directives. **(8)**

OPERATORS AND EXPRESSIONS: Arithmetic operators - Unary operators - Relational operators - logical operators - Assignment operators - Conditional operators - comma operator – size of operator -precedence and associativity- Library functions. Control Statements: simple if, if-else, nested if-else, else if ladder, switch case - while -do while - for - Nested loops - break – continue – go to statements. **(9)**

ARRAYS AND POINTERS: Defining an array - Processing an array - Multi dimensional arrays -strings.
Pointers: Definition - Pointer Arithmetic – types of pointer - constant pointer, pointer to a constant, void pointer, null pointer. **(10)**

FUNCTIONS: Function prototype - Defining a function – function call - Passing arguments to a function –nested function – recursive function- Storage classes - auto - static - extern and register variables. Pointers as Function Arguments, Pointers to Functions. **(9)**

STRUCTURES: Definitions - Processing a structure – Array and structures – Nested structures - Structures and functions. File Management: Defining, Opening and Closing a File, I/O operations on Files, Dynamic Memory Allocation: Malloc, Calloc, Free, Realloc, Linked List. **(9)**

Total L:45 periods

TEXT BOOKS:

1. B. W. Kernighan and D. M. Ritchie, '*Programming Language (ANSI C)*'. Prentice Hall of India, New Delhi, 2013.
2. H. M. Deitel and P. J. Deitel, '*C: How to Program*'. Prentice Hall of India, New Delhi, 2015.

REFERENCES:

1. B. Gottfried, '*Programming with C*'. McGraw Hill Education, New Delhi, 2018.
2. Herbert Schildt, '*C: The Complete Reference*'. McGraw Hill, New Delhi, 2017.
3. Ajay Mittal, '*Programming in C - A Practical approach*'. Pearson, New Delhi, 2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts and syntax of C Programming	**K2**
CO2	Write C programs involving structures, arrays of structures, nested structures, file I/O operations, and dynamic memory management techniques.	**K3**
CO3	Analyze the usage of operators, arrays, functions and structures to solve computational problems efficiently.	**K4**
CO4	Simulate the basic concepts of C programming using the open source software.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3								
CO3		2			2								
CO4			1		1			1		1	1	1	
	3	**2**	**1**		**3**			**1**		**1**	**1**	**1**	

1 – low, 2 – medium, 3 – high

25HS201 தமிழரும் தொழில்நுட்பமும்

1 0 0 1

நெசவு மற்றும் பானைத் தொழில்நுட்பம்: *சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.* **(3)**

வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: *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.* **(3)**

உற்பத்தித் தொழில் நுட்பம்: *கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணங்கள் – நாணயங்கள் அச்சடித்தல்- மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.* **(3)**

வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: *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.* **(3)**

அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்: *அறிவியல் தமிழின் வளர்ச்சி – கணினித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.* **(3)**

Total L: 15 periods

25HS201 TAMILS AND TECHNOLOGY

1 0 0 1

WEAVING AND CERAMIC TECHNOLOGY: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries. **(3)**

DESIGN AND CONSTRUCTION TECHNOLOGY: 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. **(3)**

MANUFACTURING TECHNOLOGY: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **(3)**

AGRICULTURE AND IRRIGATION TECHNOLOGY: 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 - Conch diving - Ancient Knowledge of Ocean - Knowledge Specific Societ.**(3)**

SCIENTIFIC TAMIL & TAMIL COMPUTING: 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. **(3)**

Total L: 15 Periods

TEXT – CUM – REFERENCE BOOKS

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

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify the significance of ancient Tamil technologies in weaving, pottery, metallurgy, and architecture, with emphasis on traditional design and construction methods across historical periods.	**K2**
CO2	Use insights from traditional Tamil knowledge systems in agriculture, irrigation, and marine sciences, and connect the development of Tamil language to its applications in digital platforms and computing.	**K3**

COs-POs & PSOs MAPPING

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1						1			1		1		
CO2						1			1		1		
						1			**1**		**1**		

1-Low, 2-Medium, 3-High

25EE211 CIRCUITS AND DEVICES LABORATORY

0 0 2 1

LIST OF EXPERIMENTS

1. Verification of Ohm's and Kirchhoff's laws
2. Verification of Superposition theorem and Norton's theorem
3. Verification of Thevenin's theorem and Maximum power transfer theorem
4. Series and Parallel resonance circuits
5. Three-Phase Power measurement by two wattmeter method (Balanced & unbalanced)
6. Characteristics of PN Junction Diode, Design and Implementation of Clipping and Clamping Circuits
7. Characteristics of Zener Diode, Design and Implementation of Zener Diode Voltage Regulator
8. Characteristics of BJT and Photo Transistor
9. Characteristics of MOSFET, JFET and Application of MOSFET as a Switch
10. Experiments on BJT Biasing Circuits.

Total P: 30 periods

REFERENCE:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering

COURSE OUTCOMES:

At the end of the course, students will be able to		**Bloom's Level**
CO1	Verify fundamental electrical laws and theorems through practical experimentation.	**K2**
CO2	Examine the characteristics of semiconductor devices such as PN junction diode, Zener diode, BJT, MOSFET, JFET and photo transistor; design and construct clipper, clamper, voltage regulator, and switching circuits.	**K3**
CO3	Measure and analyze electrical quantities in AC circuits, including resonance conditions and 3-phase power using the two-wattmeter method for both balanced and unbalanced loads.	**K4**
CO4	Construct BJT biasing circuits and evaluate their performance under various input conditions using lab equipment and/or simulation tools.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											2	
CO3		3										2	
CO4					3							2	
	3	**3**			**3**							**2**	

1 – low, 2 – medium, 3 – high

25EE212 PROGRAMMING IN C LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Simple programs to understand the concepts of data types.
2. Familiarizing conditional, control and repetition statements.
3. Usage of single and double dimensional arrays including storage operations.
4. Implementation of functions, recursive functions.
5. Defining and handling structures, array of structures and union.
6. Implementation of pointers, operation on pointers, dynamic storage allocation.
7. File handling.

Total P: 30 periods

REFERENCES:

1. Paul Deitel and Harvey Deitel, 'C How to Program: With an Introduction to C++'. 8th edition, Pearson Education, 2018.
2. Ajay Mittal, 'Programming in C - A Practical approach'. Pearson, New Delhi, 2010.
3. B. Gottfried, 'Programming with C, McGraw Hill Education'. New Delhi, 2018.
4. Herbert Schildt, 'C: The Complete Reference'. McGraw Hill, New Delhi, 2017.
5. B. W. Kernighan and D.M. Ritchie, 'C Programming Language (ANSI C)'. Prentice Hall of India, New Delhi, 2013

COURSE OUTCOMES

At the end of the course, students will be able to		Bloom's Level
CO1	Demonstrate the basic concepts of C programming through simple programs.	**K2**
CO2	Write a program that utilizes conditional statements, arrays, functions and structures is used to solve problems.	**K3**
CO3	Create modular programs with function calls, recursive functions, and pointer-based operations to enhance program structure and increase the coding efficiency.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							2	
CO3		2			2							2	
	3	**3**			**3**							**2**	

25EEC01 WORKPLACE COMMUNICATION SKILLS
(Common to CIVIL, CSE, EEE, ECE, ICE, MECH, AI&DS and EE-VLSI)

0 0 2 0

BUILDING COMMUNICATION SKILLS:

1. Introduction to Workplace Communication
2. Profile Building for Internships
3. English in the Workplace (Grammar & Vocabulary)
4. Professional Communication (Speaking & Writing)
5. Workplace Communication Tools
6. Career Exploration
7. Resume Update

Total P: 30 periods

SEMESTER III
25MA304 MATRIX THEORY AND NUMERICAL METHODS

3 1 0 4

EIGENVALUES AND EIGENVECTORS: Eigenvalues and eigenvectors of a real matrix – characteristic equation, properties - diagonalization - quadratic forms, reduction to canonical form by orthogonal reduction - Errors and approximations in numerical methods, power method for dominant eigenvalue. **(10+3)**

LINEAR ALGEBRAIC SYSTEM OF EQUATIONS AND NONLINEAR EQUATIONS: System of linear equations – Gauss elimination method, Crouts method, Gauss Seidal iterative method, Roots of equations - false-position method, Newton-Raphson method, Graeffe's root squaring method. **(8+3)**

INTERPOLATION, DIFFERENTIATION AND INTEGRATION: Newton's forward and backward interpolating polynomials, Lagrange and Newton's divided difference interpolating polynomials. Numerical differentiation, numerical integration - Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. **(12+4)**

ORDINARY DIFFERENTIAL EQUATIONS: Taylor-series method, Euler method, 4^{th} order Runge-Kutta method, multi-step method – Milne's method. **(6+2)**

PARTIAL DIFFERENTIAL EQUATIONS: Finite difference: elliptic equations – Laplace equation, Poisson equation – Liebmann method, parabolic equations-heat conduction equation-Crank Nicolson's method, hyperbolic equations – vibrating string. **(9+3)**

Total L: 45 +T: 15 = 60 periods

TEXT BOOKS:

1. David C Lay, Judi J McDonald, Steven R Lay '*Linear Algebra and its Application'*. Pearson Education, New Delhi, 2021.
2. Steven C Chapra and Raymond P Canale, '*Numerical Methods for Engineer'*. Tata McGraw Hill, New Delhi, 2021.

REFERENCES:

1. Curtis F Gerald and Patrick O Wheatly, '*Applied Numerical Analysis*'. Pearson Education, New Delhi, 2017.
2. Rizwan B, '*Introduction to Numerical Analysis Using MATLAB*'. Infinity Science Press, Hingham, 2010.
3. Richard L. B and Douglas J. F, '*Numerical Analysis*'. Thomas Learning, NewYork, 2017.
4. Howard Anton, Chris Rorres, Anton Haul '*Elementary Linear Algebra*'. Wiley India, New Delhi, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Matrix Theory and Numerical Methods.	**K2**
CO2	Apply the techniques of Matrix Theory and Numerical Methods to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems using Matrix Theory and Numerical Methods.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Matrix Theory and Numerical Methods.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25EE301 ELECTRONIC CIRCUITS

3 1 0 4

POWER SUPPLIES: Rectifiers – Half-wave and Full-wave rectifiers, Average and RMS value, Ripple factor, Regulation, Rectification efficiency, Transformer Utility Factor. Filters – Capacitor, Inductor, L-type and π -type, Ripple Factor, Regulation - Need for voltage regulators – Series and Shunt regulators, Comparison, Current limiting and protection circuits. **(9+3)**

SMALL SIGNAL AMPLIFIERS: Single stage BJT and FET amplifiers – RC coupled amplifier, Analysis at low, medium and high frequencies – BJT and MOS Differential amplifier, Differential and Common mode gain with resistive load and active load, CMRR - Cascade and Darlington Amplifiers. **(9+3)**

LARGE SIGNAL AMPLIFIERS: Power amplifiers– Classification, Single ended and Push-pull Configuration, Power dissipation, Output power and Conversion efficiency, Complementary symmetry power amplifiers, Class AB operation, Class C and Class D amplifiers, thermal considerations. **(9+3)**

FEEDBACK AMPLIFIERS: Basic concepts of feedback amplifiers – Effect of negative feedback on input and output resistances, gain, gain stability, distortion and bandwidth. Voltage and current feedback circuits. Application of negative feedback in voltage regulators**.** **(9+3)**

OSCILLATORS AND PULSE CIRCUITS: Oscillators – Barkhausen criteria, RC and LC oscillators using BJT – RC phase shift, Wien bridge oscillators, Hartley and Colpitt's oscillators, Frequency stability of oscillators, Crystal oscillators. Pulse circuits – RC integrator and Differentiator, Non-sinusoidal oscillators – Multivibrators – Bistable, Monostable, Astable multivibrators and Schmitt Trigger using BJT. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Millman J, Halkias C, Satya Brata Jit, '*Electronic Devices & Circuits*'. Tata McGraw-Hill, New Delhi, 4th edition, 2015.
2. Boylestead L R, Nashelsky L, '*Electronic Devices and Circuit Theory*'. Pearson Education, New Delhi, 11th edition, 2012.

REFERENCES:

1. David A Bell, '*Electronic Devices and Circuits'*. Oxford University Press, New Delhi, 2009.
2. Adel Sedra Kenneth. C Smith, '*Microelectronics Circuits*'. Oxford University Press, New Delhi, 2010.
3. Thomas L Floyd, '*Electronic Devices*'. Prentice Hall of India, New Delhi, 2011.
4. Millman J, Taub H, Mothiki S Prakash Rao, '*Pulse, Digital and Switching Waveforms*'. Tata McGraw-Hill, New Delhi, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working of diode and transistor-based application circuits.	**K2**
CO2	Implement electronic circuits using semiconductor devices.	**K3**
CO3	Analyze the performance parameters and behaviour of electronic circuits.	**K4**
CO4	Simulate and analyze the performance of electronic circuits using a simulation tool.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3										3		
CO3		3									3		
CO4			1		1						1		1
	3	**3**	**1**		**1**						**3**		**1**

1 – low, 2 – medium, 3 – high

25EE302 MEASUREMENTS AND INSTRUMENTATION

3 0 0 3

MEASUREMENT SYSTEMS: Methods – Classification of units –SI units- standards - modes of operation – functions –Applications – Input / Output Configuration of Measurement and Instrumentation – methods of correction. Static calibration – Static and Dynamic characteristics of Instruments: Accuracy, Precision, linearity, Resolution, Dead zone, loading effects- speed of response, Fidelity, measuring lag, Dynamic error. Errors in measurement: types of errors – statistical treatment of data – Histogram – Arithmetic mean – dispersion from mean – Average and standard deviation – variance – Normal or Gaussian Curve of errors. **(9)**

ANALOG INDICATING INSTRUMENTS: Types of ammeters and voltmeters- PMMC Instruments Moving Iron Instruments -Dynamometer type Instruments. Measurement of power and energy- Dynamometer type wattmeter - single phase Induction type energy meter, Calibration of meters, Instrument Transformers: ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications. **(9)**

MEASUREMENT OF R-L-C: Resistance measurement: Kelvin double bridge, Wheatstone bridge, substitution method, Loss of charge method, Guard Wire method. Measurement of inductance and capacitance: Maxwell, Anderson, Hay's and Schering Bridge. Measurement of Earth resistance – Megger. **(9)**

INSTRUMENTATION SYSTEMS: Elements of Instrumentation systems – Transducers - Classifications, Principle of operation of Resistance potentiometer, Strain Gauge, Inductive and capacitive transducers, LVDT, Piezo-electric transducers, Encoders, Hall effect sensors, and photo sensors and its applications. Measurement of Pressure: High Pressure and low-pressure measurement. Measurement of Temperature - Resistance thermometers, thermistors and thermocouples. **(9)**

ELECTRONIC INSTRUMENTS: Electronic voltmeter – Digital voltmeter of ramp and integrating types. Digital Multimeter- True RMS meters-Spectrum Analyser-Harmonic Distortion Analyser- Function Generator- Dual channel Oscilloscope-Digital storage Oscilloscope- PC based measurements. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Sawhney A K, '*A Course in Electrical and Electronic Measurement and Instrumentation*'. Dhanpat Rai & Sons, New Delhi, 2011.
2. David A. Bell, '*Electronic Instrumentation and Measurements*'. Oxford University Press, New Delhi, 2012.

REFERENCE BOOKS:

1. Doeblin E O, Dhanesh N Manik, '*Measurement Systems*'. McGraw-Hill, New Delhi, 2012.
2. Rangan C S, Sharma G R, Mani V S, '*Instrumentation Devices and Systems*'. Tata McGraw-Hill, New Delhi, 2004.
3. Kalsi H S, '*Electronic Instrumentation*'. Tata McGraw-Hill, New Delhi, 2013.
4. Albert D, Helfrick, William D Cooper, '*Modern Electronic Instrumentation and Measurement Techniques*'. Pearson Education, New Delhi, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles, characteristics, and operation of measurement systems, analog and electronic instruments, transducers, and measurement techniques for electrical parameters.	**K2**
CO2	Apply appropriate measurement methods, bridge circuits, and instrumentation techniques to determine electrical quantities such as resistance, inductance, capacitance, power, and energy.	**K3**
CO3	Analyze measurement errors, instrument characteristics, and performance of measurement systems using statistical methods and calibration techniques to evaluate accuracy and reliability.	**K4**
CO4	Develop instrumentation systems using software tools to acquire, analyze, and visualize electrical measurement data.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	3
CO3		3										1	3
CO4					3							1	3
	3	**3**			**3**							**1**	**3**

1 – low, 2 – medium, 3 – high

25EE303 DC MACHINES AND TRANSFORMERS

3 0 0 3

BASICS CONCEPTS OF ELECTRICAL MACHINES: Electromechanical Energy Conversion – Energy Balance during Electromechanical Energy Conversion – Field energy – Co-energy– Force and Torque in Electromechanical Systems – General Concepts of Rotating Machine. **(9)**

CONSTRUCTION AND OPERATION OF DC MACHINES: Basic Principles – Fundamentals of DC Generator, DC Motor – Constructional Features of DC Machine – Armature Winding in DC Machine – Armature Reaction – Methods for compensating the effects of Armature Reaction - Commutation Process – PMDC Motor. **(9)**

CHARACTERISTICS, CONTROL, AND TESTING OF DC MACHINES: Excitation of DC Machines –
Operating Characteristics of DC Generators, DC Motors – Starting of DC Motors – Speed Control of DC Motors – Braking of DC Motors – Losses and Efficiency – Testing of DC Machines. **(9)**

SINGLE PHASE TRANSFORMERS: Principle of operation – Constructional features – Equivalent Circuit - Voltage regulation– Losses –Testing of Transformers –Efficiency– All Day Efficiency–Polarity Test – Auto-Transformers – Parallel Operation – Special Purpose Transformers - Welding Transformers- Toroidal Transformers – Pulse Transformers. **(9)**

THREE PHASE TRANSFORMERS: Construction – Transformer Vector Groups – Grounding Transformers – Parallel Operation – Open Delta Connection – Three phase to Two Phase Conversion – Harmonics – Transients. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Prithwiraj Purkait, Indrayudh Bandyopadhyay, '*Electrical Machines*'. Oxford University Press, 2017
2. Ashfaq Husain, '*Electric Machines'*. Paper Back - 1, Dhanpat Rai & Co., Delhi, January 2016.
3. Nagrath, I. J. and Kothari.D. P., '*Electric Machines*'. McGraw-Hill Education, 6th edition, 2019.

REFERENCE BOOKS:

1. B. R. Gupta, '*Fundamentals of Electric Machines*'. New age International Publishers, 4th Edition, 2017.
2. S. K. Bhattacharya, '*Electrical Machines'.* McGraw - Hill Education, 4th Edition,2018
3. Murugesh Kumar K, '*Electrical Machines Vol. I*'. Vikas Publishing House, New Delhi,
4. P. S. Bimbhra, '*Electrical Machines'*. Khanna Publishing, 4th edition, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the electromechanical energy conversion, construction and principle of operation of transformers and DC machines	**K2**
CO2	Compute the magnetic circuit parameters and performance parameters of transformer and DC machines	**K3**
CO3	Analyze the performance parameter of dc machines and transformers for varying load conditions.	**K4**
CO4	Choose a suitable three-phase transformer connection for given application.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4	2												1
	3	**3**											**3**

1 – low, 2 – medium, 3 – high

25HS301 PROJECT AND FINANCE MANAGEMENT
(Common to all B.E. and B.Tech. Programme)

3 0 0 3

INTRODUCTION TO PROJECT MANAGEMENT: Project: Trends in project management, project management versus general management, agile project management, the three goals of a project, life cycle of projects, project selection methods, project portfolio process, case study – friendly assisted living facility. **(9)**

ROLE OF PROJECT MANAGER AND ORGANISATION: Project managers roles and responsibilities, selection of a project manager, project management as a profession, fitting projects into the parent organization, the project team and agile team roles, case study – the company with traditional functional organizational structure setting up teams for the new initiatives. **(9)**

PROJECT ACTIVITIES: The planning process, work-breakdown structure and other aids, risk management, methods of budgeting, cost estimation, scheduling the project with PERT and CPM networks, allocating resources, resource loading and leveling, Goldratt's Critical Chain, application – using Project Libre for project management, case study – success of Chandrayan-3. **(9)**

INTRODUCTION TO FINANCE MANAGEMENT: Overview - finance and related disciplines, scope and objectives of financial management, time value of money, valuation of securities, and risk and return and calculations with spreadsheet, analysis using cash flow statement and financial statements. **(9)**

PERSONAL FINANCE: Compounding, debt, equity and financial markets and investments- debt and bonds. Equity, mutual funds, hedge funds, real estate, and commodities, Personal financial plan to enhance wealth and job marketability, components of a financial plan, tools for planning – financial statements, applying time value concept of money and tax planning. **(9)**

Total L: 45 periods

TEXTBOOKS

1. Jack R. Meredith and Scott M. Shafer, '*Project Management in Practice*'. Wiley, 2021.
2. Khan M. Y. and Jain P. K., '*Basic Financial Management*'. Tata McGraw Hill, 2012.
3. Michael Fisher, *'Saving and Investing*'. Author House, 2005.
4. Jeff Madura, '*Personal Finance*'. Pearson, 2020.

REFERENCES

1. National Finance Olympiad, '*Personal Finance Handbook'*. Pockvue Solutions, 2024
2. Glen Arnold, '*Investing'*. Financial Times Guides, 2020
3. Rachel Siegel and Carol Yacht, '*Personal Finance'*. Open Textbook Library, Saylor Foundation, 2009
4. Google, '*Google Project Management: Professional Certificate'*. Google Project Management: Professional Certificate, Coursera.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts, principles, and practices of project and financial management.	**K2**
CO2	Apply project management tools, scheduling techniques, and financial planning methods to practical problems.	**K3**
CO3	Analyze project performance, risks, resource allocation, and financial decisions to identify appropriate solutions.	**K4**
CO4	Collaborate effectively as a team to plan, execute, and present project solutions using appropriate project management practices.	

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1												2	2
CO2	3									3		3	3
CO3		2								2		2	2
CO4			1		1		1	1	1	1	1	1	1
	3	**2**	**1**		**1**		**1**	**1**	**1**	**3**	**1**	**3**	**3**

1-low, 2-medium, 3-high

25EE311 DC MACHINES AND TRANSFORMERS LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Open Circuit Characteristics and Load Test on DC Shunt Generator.
2. Open Circuit Characteristics and Load Test on Compound Generator
3. Load Characteristics of DC Shunt and DC Compound Motor.
4. Load Test on DC Series Motor &Study of DC motor Starters.
5. Swinburne's test on DC Machine.
6. Hopkinson's test on DC Machine.
7. Electrical Braking of DC Shunt Motor
8. Load Test on Single Phase Transformer.
9. Open Circuit and Short Circuit Tests on Single Phase Transformer
10. Sumpner's Test on a Single-Phase Transformer.
11. Three Phase Transformer Connections.

Total P: 60 periods

REFERENCE:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG Institute of Technology and Applied Research, Coimbatore - 641062

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify suitable starter for DC motor and choose suitable three phase transformer connection for a given application.	**K2**
CO2	Conduct load test on DC machines and transformers and draw the performance curves	**K3**
CO3	Analyze the performance of DC machine and transformer for different loading conditions	**K4**
CO4	Work effectively in teams to perform experiments, analyze data, and present findings through well-documented reports	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										3		3
CO3		3									3		3
CO4								2	2				
	3	**3**						**2**	**2**		**3**		**3**

1 – low, 2 – medium, 3 – high

25EE312 ELECTRONIC CIRCUITS LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Design and Implementation of Half-Wave and Full-Wave Rectifier with and without Capacitor Filter
2. Design and implementation of Series Voltage Regulator
3. Frequency response analysis of Common Emitter Amplifier
4. Measurement of input and output impedance of Common Collector amplifier
5. Transfer characteristics of Differential amplifier
6. Design and verification of Power Amplifiers
7. Design and verification of RC Oscillators
8. Design and implementation of current mirror circuits.
9. Wave shaping using RC Filters
10. Design and implementation of Multivibrators

Total P: 30 periods

REFERENCES:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG Institute of Technology and Applied Research, Coimbatore - 641062

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain and demonstrate power supply, amplifier, filter and oscillator circuits.	**K2**
CO2	Apply the concepts analog circuit principles to implement the basic electronic circuits	**K3**
CO3	Analyse the frequency response and impedance of small signal amplifiers.	**K4**
CO4	Design an electronic circuit using semiconductor devices for given engineering applications.	**K6**
CO5	Work effectively in teams to perform experiments, analyse data, and present findings through well-documented reports	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3							3			3		3
CO3		2						2			2		2
CO4			2		2			2			2		2
CO5								2					
	3	**2**	**2**		**2**			**3**			**3**		**2**

1 – low, 2 – medium, 3 – high

25EEC02 FOUNDATIONS OF PROBLEM SOLVING

0 0 2 1

PROBLEM SOLVING:

1. Speed Mathematics (SAW, Oz, Mirror methods)
2. Speed Mathematics (High5, Minion, Butterfly methods)
3. Speed Mathematics (Inception, Golden eye methods)
4. Thinking with Numbers
5. Problem Solving with Visual information
6. Words Puzzles
7. Resume Writing Essentials

Total P: 30 periods

REFERENCES:

1. R. S. Agarwal, '*Quantitative Aptitude for Competitive Examination'*. S Chand Publishing, New Delhi, 2017.

SEMESTER IV

25MA403 STOCHASTIC PROCESSES AND STATISTICAL ANALYSIS

3 1 0 4

PROBABILITY AND DISCRETE RANDOM VARIABLES: Probability, axioms, conditional probability, law of total probability, Bayes theorem, discrete random variables, probability mass function, cumulative distribution function, binomial, Poisson and geometric random variables, expected values. **(9+3)**

CONTINUOUS RANDOM VARIABLES: Cumulative distribution function, probability density function, uniform, exponential and Gaussian random variables, expected values. **(9+3)**

PAIRS OF RANDOM VARIABLES: Joint cumulative distribution function, joint probability mass function, marginal probability mass function, joint probability density function, marginal probability density function, independent random variables, expected values, covariance, correlation and independence, central limit theorem. **(9+3)**

STOCHASTIC PROCESSES: Types of stochastic processes, Poisson process, discrete time Markov chains, classification of states, limiting state probabilities. **(9+3)**

STATISTICAL INFERENCE: Point estimation, interval estimation. Hypothesis testing: one and two tailed tests, tests concerning mean, proportion, and variance, single and two samples, tests for goodness of fit and independence of attributes. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Roy D Yates and David J Goodman, '*Probability and Stochastic Processes'*. Wiley India, New Delhi, 2021.
2. Ronald E. W, Raymond H. M, Sharon L. M and Keying Ye, '*Probability and Statistics for Engineers and Scientists'*. Pearson Education, New Delhi, 2016.

REFERENCE:

1. Saeed Ghahramani, '*Fundamentals of Probability with Stochastic Processes'*. CRC Press, USA, 2018.
2. Dougles C Montgomery and George C Runger, '*Applied Statistics and Probability for Engineers*'. Wiley India, New Delhi, 2018.
3. Athanasios P and Unnikrishna P. S, '*Probability, Random Variables and Stochastic Processes*'. Tata McGraw Hill, New Delhi, 2017.
4. Arnold O. A, '*Probability, Statistics and Queueing theory: with computer science applications'*. Academic press, USA, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts related to Probability, Random variables, Stochastic processes and Statistical inference.	**K2**
CO2	Apply the techniques of Probability, Random variables, Stochastic processes and Statistical inference to solve engineering problems.	**K3**
CO3	Analyze the solutions of engineering problems using Probability, Random variables, Stochastic processes and Statistical inference.	**K4**
CO4	Use modern tools to solve engineering problems with the help of Probability, Random variables, Stochastic processes and Statistical inference.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
CO4					1								
	3	**1**			**1**								

1 – low, 2 – medium, 3 – high

25EE401 GENERATION, TRANSMISSION AND DISTRIBUTION

3 0 0 3

GENERATION SYSTEMS: Structure of Electric Power System, Power system scenario, Types of generation- Thermal power plant, Hydro power plant, Oil & Gas power plant, Nuclear power plant, Renewable Energy Systems - Solar and Wind - Load capacity factor - Connected load factor - Load duration curve - Selection of units - Cost of generation – Tariffs. **(9)**

TRANSMISSION SYSTEMS & LINE PARAMETERS: Various systems of transmission – Advantages of high transmission voltages – Introduction to HVDC Transmission - Comparison of conductor materials required for various overhead systems. Electrical constants - Resistance, Inductance and capacitance of Single and 3 Phase lines – Bundled conductor lines - Effects of earth on line capacitance - Skin effect - Proximity effect - Transposition. **(9)**

MODELING AND PERFORMANCE OF TRANSMISSION LINE: Characteristics and performance of power transmission lines: short, medium, long lines, generalized constants, surge impedance and Surge impedance loading, Power flow, regulation, Series and shunt compensation, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect, Electrostatic and Electromagnetic interference with communication lines. **(9)**

OVERHEAD LINES AND UNDERGROUND CABLES: Components of overhead line, Insulators - Types - Potential distribution over a string of suspension insulators - Methods of increasing string efficiency. Testing of insulators - Stress and Sag in overhead lines – causes - Sag tension calculation -Vibration and dampers**.** underground cables: Types - Capacitance and insulation resistance - Sheath effects - Grading – Heating – Current rating. **(11)**

DISTRIBUTION SYSTEM: Substation types and Layout – components – feeders- distributers – service mains- Schemes of distribution – Radial and ring main systems - Calculation of voltage in distributors with concentrated and distributed loads - AC single phase and three phase systems - Requirements of distribution system - voltage regulation -voltage regulating devices- power factor improvements Introduction to Substation automation protocols. **(7)**

Total L: 45 periods

TEXT BOOKS:

1. Wadhwa C L, '*Electrical Power Systems'*. New Age International, New Delhi, 2012.
2. Singh S N, '*Electric Power Generation, transmission and distribution'*. PHI Learning Pvt Ltd, New Delhi, 2015.
3. B R Gupta, '*Power System Analysis and Design'*. S. K. Kataria & Sons, 2013.

REFERENCES:

1. Soni M L, Gupta P V, Bhatnagar U S and Chakrabarthi A, '*A Text Book on Power System Engineering*'. Dhanpat Rai & Co., New Delhi, 2013.
2. Uppal S L, '*Electrical Power Systems'*. Khanna Publishers, New Delhi, 2009.
3. Mehta V K, Rohit Mehta, '*Principles of Power Systems'*. S. Chand & Co., New Delhi, 2020
4. Kothari D P and Nagrath J, '*Power System Engineering'*. Tata McGraw-Hill, New Delhi, 2008.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of energy conversion from renewable and non-renewable energy sources and the structure of transmission and distribution systems	**K2**
CO2	Compute the performance of transmission line with different configurations, various line supports and insulators, distributors and underground cables	**K3**
CO3	Analyse the impact of sag and stress on the performance of transmission line under the dynamic weather conditions such as ice loading and windy atmospheric conditions	**K4**
CO4	Evaluate the voltage distribution characteristics of transmission and distribution system using simulation packages and validate the same using a scaled-down model of the real time system.	**K5**

COs-POs & PSOs MAPPING

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												1
CO3		3				1							2
CO4				1	1								2
	3	**3**		**1**	**1**	**1**							**2**

1 – low, 2 – medium, 3 – high

25EE402 DIGITAL ELECTRONICS

3 1 0 4

INTRODUCTION TO NUMBER SYSTEMS AND BOOLEAN ALGEBRA: Review of Number Systems – Number representation: Signed –Unsigned-Fixed point- Floating point- Computer codes-BCD- Gray code- Excess 3 code- Error detection and correction codes- Parity- Hamming codes- Boolean algebra-Basic Postulates and theorems-Switching functions - Canonical forms- Logic gates- Incompletely specified functions- Simplification of logic functions through K-maps and Quine – McClusky method. **(9+3)**

DIGITAL LOGIC FAMILIES: Characteristics of digital ICs – Voltage and current ratings-Noise Margin-Propagation Delay-Power dissipation. TTL logic family-Inverter-NAND-NOR-Totem pole- Open collector and tri-state outputs- wired output operations- CMOS logic Inverter- NAND, NOR High speed CMOS and ECL logic families- Comparison of performance of various logic families- Interfacing TTL and CMOS devices. **(6+3)**

COMBINATIONAL LOGIC DESIGN: Decoders, NAND, NOR, Encoders- Code Converter - Multiplexers and Demultiplexers- Implementation of Combinational circuits using Multiplexers and Demultiplexers-Hazards-Arithmetic circuits: Binary /BCD adders and subtractors- Magnitude comparator. **(8+3)**

SEQUENTIAL CIRCUITS: General model of sequential circuits- Latch- Flip-Flops – setup and hold times - Level triggering- Edge triggering- Master-slave configuration-Binary Counters-Shift register- Ring Counter- Johnson counter- Timing diagram. Mealy /Moore Models – Concept of state -State Diagram-State table - Minimal flip-flop/one hot realization -Design of synchronous sequential circuits - Up-down/Modulus counters- Sequence detector-Introduction to Asynchronous Sequential circuits. **(12+3)**

MEMORY AND PROGRAMMABLE LOGIC DEVICES: Memories – Read Write Operators – Timing Diagrams-ROM-PROM-EPROM- EEPROM-Static, Dynamic RAM- Semicustom design – Introduction to PLDs – ROM, PAL, PLA. Architecture of PLDs – PAL16L8, PAL16R4,22V10 - Implementation of digital functions. **Introduction to Verilog HDL**-Digital design process flow using HDL - Modules and ports - compiler directives - data types and operators - gate level modeling - data flow modeling – behavioural modeling - structural modeling-simple Verilog codes. **(10+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. Tocci R J, Widmer N and Moss G. '*Digital Systems: Principles and Applications*'. Pearson, New Delhi, 12th edition, 2017.
2. Leach D, Malvino A and Goutam Saha, '*Digital Principles and Applications*'. Tata McGraw-Hill, New Delhi, 8th edition, 2019.

REFERENCES:

1. Donald Givone, '*Digital Principles and Design'*. Tata McGraw-Hill, New Delhi 2017.
2. Anand Kumar A, '*Fundamentals of Digital Circuits'*. Prentice Hall of India, New Delhi 2016.
3. Nelson V P, Nagle H T, Carroll B D and Irwin J D, '*Digital Logic Circuit Analysis and Design'*. Prentice Hall International, New Jersey, 1996
4. Bhasker J '*A Verilog HDL Primer'*. BS Publications, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the principles of number systems, Boolean algebra, logic families, and digital design fundamentals including memory structures and HDL constructs.	**K2**
CO2	Apply Boolean algebra techniques, logic simplification methods, to implement combinational and sequential circuits for specified functionalities.	**K3**
CO3	Analyze the characteristics and performance of various digital logic families to determine their suitability in electronic circuit application.	**K4**
CO4	Design digital systems using combinational and sequential logic, applying optimization techniques and hardware description languages to solve real-world digital design problems.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		3										3	
CO4			2		2						2	2	2
	3	**3**	**2**		**2**						**2**	**3**	**2**

1 – low, 2 – medium, 3 – high

25EE403 LINEAR INTEGRATED CIRCUITS

3 0 0 3

OPERATIONAL AMPLIFIER CHARACTERISTICS: Functional Block Diagram – Symbol, Characteristics of an ideal operational amplifier, transfer characteristics, Circuit schematic of µA 741, Open loop gain, CMRR-input bias and offset currents, input and output offset voltages, offset compensation techniques. Frequency response, characteristics – stability, limitations, frequency compensation, slew rate. Transfer characteristics. **(9)**

APPLICATIONS OF OPERATIONAL AMPLIFIERS: Inverting and Non-inverting amplifiers – Voltage follower, Summing amplifier, Differential amplifier, Instrumentation amplifier. Integrator and Differentiator – Practical considerations. Voltage to Current and Current to Voltage converters, Phase changers. Sinusoidal oscillators. Active filters – Design of low pass, high pass, wide bandpass and Band stop Butterworth filters, Narrow band pass and notch filters. **(9)**

NON-LINEAR APPLICATIONS & SINGLE POWER SUPPLY OPERATIONAL AMPLIFIERS: Comparator – Regenerative comparator, Zero crossing detector, Window detector, Sample and hold circuit, Precision diode, Half and Full wave rectifiers, Active peak detector, Clipper and Clamper, Logarithmic, Exponential amplifiers and Multiplier, Square, and Triangular waveform generators. : Need for single power supply operational amplifiers – LM324, AC Inverting and Non-Inverting amplifiers, Applications. **(9)**

IC VOLTAGE REGULATORS: Block diagram of 723 general purpose voltage regulator – Circuit configurations, Current limiting schemes, output current boosting, Fixed and adjustable three terminal regulators- LM78XX, LM79XX, LM317, Switching regulators. **A-D and D-A Converters:** DAC/ADC performance characteristics – Digital to Analog Converters: Binary weighted and R-2R Ladder types – Analog to digital converters: Flash Type, Counter ramp, Successive approximation, Single slope, Dual slope and Sigma - Delta Converter. **(9)**

SPECIAL FUNCTION ICS: 555 Timer Functional block diagram and description – Monostable and Astable operation, Applications, 566 Voltage Controlled Oscillator, Analog Multiplier, Comparator ICs. PLL Functional Block diagram – Principle of operation, Building blocks of PLL, Characteristics, Derivations of expressions for Lock and Capture ranges, Applications: Frequency synthesis, AM and FM detection, FSK demodulator, Motor speed control. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Adel Sedra, Kenneth.C Smith, '*Microelectronic Circuits'*. 7th Edition, Oxford University Press, New Delhi, 2017.
2. Roy Choudhury Shail Jain, '*Linear Integrated Circuits*'. 5th Edition, New Academic Science, London, UK, 2018.

REFERENCES:

1. Gayakwad A R, '*OP-Amps and Linear Integrated circuits*'. 4th Edition, Prentice Hall India, New Delhi, 2015.
2. Coughlin F R, and Driscoll F F, '*Operational Amplifiers and Linear Integrated Circuits*'. 6th Edition, Prentice Hall of India, New Delhi, 2010.
3. Michael Jacob J, '*Applications and Design with Analog Integrated Circuits'*. 2nd Edition, Prentice Hall of India, New Delhi,2010.
4. K. Lal kishore, '*Operational Amplifiers and Linear Integrated Circuit'*. 1st Edition, Pearson, New Delhi, 2013.
5. Serigo Franco, '*Design with Operational Amplifiers and Analog Integrated Circuits'*. 4th Edition, Tata McGraw Hill, New Delhi, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the DC and AC performance characteristics of Op-amp, and its applications, working of 555 timer, LM565 phase-locked loop, analog multipliers, voltage regulators and A-D/D-A Converters.	**K2**
CO2	Apply the basic circuit laws to obtain circuit parameters and waveform in analog electronic circuits.	**K3**
CO3	Analyse analog electronic circuits that meet desired specifications.	**K4**
CO4	Design analog electronic circuits for the desired specifications, and demonstrate through mini-project.	**K6**
CO5	Conduct investigation on analog electronic circuits using MATLAB/ Multisim/Pspice/Proteus simulation tools.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											3	1
CO3		3										3	1
CO4			1		1	1		1		1	1	1	1
CO5					3							3	1
	3	**3**	**1**		**3**	**1**		**1**		**1**	**1**	**3**	**1**

1 – low, 2 – medium, 3 – high

25EE404 AC MACHINES

3 1 0 4

SYNCHRONOUS GENERATOR: Construction - types - Winding Factors - EMF Equation - Armature Reaction - Voltage Regulation; EMF, MMF, and ZPF Methods - Parallel Operation - Synchronization - Synchronizing power - Two reaction theory - Slip test - Phasor Diagrams - Voltage Regulation. **(9+3)**

SYNCHRONOUS MOTOR: Principle of Operation - Methods of Starting - Phasor Diagrams - Power Flow Equations - Effect of Varying load angle and excitation - V and Inverted V Curves - Synchronous Condenser - Hunting and Suppression Techniques. Introduction to PMSM -Rotor configurations **(9+3)**

THREE PHASE INDUCTION MOTOR: Types - Construction - electrical steel properties- MMF in Distributed AC Windings - Rotating Magnetic Field - Principle of Operation - Torque equation - Slip-Torque Characteristics - Equivalent Circuit - Phasor Diagram Losses and efficiency. **(9+3)**

TESTING AND CONTROL OF 3-PHASE INDUCTION MOTOR : No-Load and Blocked Rotor Tests -Circle diagram - Performance prediction - Starters - Cogging and Crawling - Speed Control methods - Braking - Principle of Induction Generators. **(9+3)**

SINGLE PHASE INDUCTION MOTOR: Construction - Principle of Operation - Double Revolving Field Theory - Equivalent Circuit - Methods of Starting - Types: Split phase, Capacitor type, Shaded pole and Universal Motor. **(9+3)**

Total L: 45 + T: 15 = 60 periods

TEXT BOOKS:

1. D P Kothari, I J Nagrath, '*Electric Machines'*. McGraw Hill Education (India) Private Limited, New Delhi, 2017.
2. K Murugesh Kumar, '*Electrical Machines – II'*. Vikas Publishing House, New Delhi, 2010.

REFERENCES:

1. Bimbhra P S, '*Electrical Machinery'*. Khanna Publishers, New Delhi, 2011.
2. A.E. Fitzgerald, Charles Kingsley Jr, Stephen D. Umans, '*Electric Machinery'*. Tata McGraw-Hill, New Delhi, 2011.
3. Ashfaq Husain, '*Electric Machines'*. Dhanpat Rai & Co., New Delhi, 2011.
4. Bhattacharya S K, '*Electrical Machines'*. Tata McGraw-Hill, New Delhi, 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the construction, working principle, starting, speed control and braking methods of AC machines.	**K2**
CO2	Compute the performance parameters of induction and synchronous machines by performing various tests under different loading conditions.	**K3**
CO3	Analyze the performance of induction and synchronous machines by conducting various tests and provide the inferences based on the magnitude and nature of load.	**K4**
CO4	Choose suitable starting and speed control techniques for AC machines for given application and specification.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4	2												2
	3	**3**											**3**

1 – low, 2 – medium, 3 – high

25EE411 AC MACHINES LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Predetermination of voltage regulation of Alternator by EMF and MMF methods
2. Predetermination of voltage regulation of Alternator by ZPF Method
3. Determination of V and Inverted V Curves of Synchronous Motor
4. Predetermination of voltage regulation of Salient Pole Alternator by Blondel's Method
5. Study of parallel operation of alternator.
6. Load Test on single Phase Induction Motors
7. Load Test on Three Phase Induction Motors
8. No load Test and Blocked Rotor Test on 3-Phase Induction Motor (circle diagram)
9. Electrical Braking of 3-Phase Induction Motor & Development of three phase induction Starter
10. Separation of Losses in 3-phase Induction Motor.
11. Speed control of three phase induction motor.
12. Energy efficiency comparison of induction motors

Total P: 60 periods

REFERENCES:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG Institute of Technology and Applied Research, Neelambur, Coimbatore – 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Compute the equivalent circuit and performance parameters of single-phase and three-phase induction motor by conducting suitable experiments.	**K3**
CO2	Analyze the regulation and performance of synchronous machines for different power factors, and loading conditions.	**K4**
CO3	Choose a suitable method for connecting alternators in parallel and select a suitable starter for three phase induction motor based on the load requirement.	**K5**
CO4	Work effectively in teams to perform experiments, analyze data, and present findings through well-documented reports and presentations	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3										3		3
CO2		3									3		3
CO3				2							2		2
CO4								1	1				
	3	**3**		**2**				**1**	**1**		**3**		**3**

1 – low, 2 – medium, 3 – high

25EE412 DIGITAL ELECTRONICS AND LIC LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Study of basic digital IC's and implementation of adder and subtractor circuits.
2. Design and implementation of code converters.
3. Study of multiplexer and demultiplexer, and design of combinational circuits using multiplexer and de- multiplexer.
4. Design and implementation of counters, shift registers and synchronous sequential circuits.
5. Implementation of combinational and sequential circuit using Verilog
6. Characteristics and applications of Op-Amp: Adder, Subtractor, zero crossing detector, integrator, and Differentiator
7. Waveform Generation using operational amplifiers.
8. Performance characteristics of Voltage regulator ICs
9. Design and implementation of 555 timer applications and VCO.
10. Design and implementation of Active filters.

Total P: 60 periods

REFERENCES:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG Institute of Technology and Applied Research, Neelambur, Coimbatore – 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the various types of combinational and sequential circuits and develop the logical circuit for the given scenario.	**K2**
CO2	Develop the op-amp applications such as inverting, non-inverting amplifier, Adder, comparator, Integrator, Differentiator, voltage regulator circuits and active filters.	**K3**
CO3	Analyze the waveform generator circuits such as timer IC 555 and IC 741.	**K4**
CO4	Work effectively in teams to perform experiments, analyze the analog and digital circuit, and present findings through well-documented reports and presentations.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2		2										3
CO3		3											2
CO4			2					1	1		1		1
	2	**3**	**2**					**1**	**1**		**1**		**2**

1 – low, 2 – medium, 3 – high

25EEE01 MINI-PROJECT I

0 0 2 1

Students should learn project selection methodologies and teamwork skills to design hardware/software products. Create a good technical report and gain motivation to explain project ideas clearly.

COURSE GUIDELINES:

- Students can choose projects based on industry defined problems or user defined problems which must emulate real-life problems.
- It is desirable that students should work on the project in group of 2 or 3 but not more than three.
- After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
- At the end, students must submit the final report of the project and the format for the same will be given by the department.
- The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
- The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
- The final evaluation of the project will be done based on the demonstration and presentation.

Total P: 30 periods

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify and define a problem statement relevant to simple engineering problems in electrical and electronics engineering.	**K2**
CO2	Apply basic electronic components and electric circuit concepts to develop a working project.	**K3**
CO3	Analyze and solve the complex problems to proposed project work	**K4**
CO4	Design and develop a basic electrical or electronic system to solve a real-world problem using appropriate tools and techniques.	**K6**
CO5	Demonstrate teamwork, project and finance planning, time management and communicate technical information effectively through reports and presentations.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	**3**				3							3	3
CO3		3			3							3	3
CO4			3	3	3	3						3	3
CO5						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 – high

25EEC03 PROBLEM SOLVING

0 0 2 1

PROBLEM SOLVING:

1. Algorithmic Thinking, Branching & Repetition Problems
2. Logical Reasoning - Data Arrangements & Relations
3. Solving problems based on Coding & decoding, Series, Analogy, Odd man out and Visual reasoning
4. Problems based on Ages, Logical Connectives, Syllogisms, Data Interpretation & Data Sufficiency
5. Solving problems on Clocks Calendars, Direction Sense & Cubes
6. Problems based on Number system, Percentages, Simple & Compound Interest
7. Resume Update

Total P: 30 period

REFERENCES:

1. R. S. Aggarwal, '*Quantitative Aptitude for Competitive Examination*'. S Chand Publishing, New Delhi, 2017.

SEMESTER V
25EE501 CONTROL SYSTEMS

3 1 0 4

INTRODUCTION AND TRANSFER FUNCTION MODELLING: Open loop and closed loop systems - Examples, Control system components. Transfer function of physical systems: Mechanical systems - Translational and Rotational systems, Electrical network, Thermal and hydraulic systems. Transfer function of DC servomotor, AC servomotor, Transfer function of overall systems. Block diagram-reduction techniques, Signal flow graphs. **(9+3)**

TIME RESPONSE ANALYSIS: Standard Test signals -Time response of first and second order systems, Performance criteria, Type of systems. Steady state error Analysis - position, velocity and acceleration error constants - Generalized error series - Feedback characteristics of control systems. **(9+3)**

FREQUENCY RESPONSE ANALYSIS: Frequency domain specifications - peak resonance, resonant frequency, bandwidth and cut-off rate, correlation between time and frequency responses for second order systems. Polar plot, Bode plot, Gain Margin and Phase Margin. **(9+3)**

STABILITY OF SYSTEMS: Characteristic equation - Location of roots of characteristic equation - Absolute stability and Relative stability. Routh Hurwitz criterion of stability - Necessary and sufficient conditions - Nyquist Stability - Principle of argument - Nyquist path - Nyquist stability criterion and determination of stability - Assessment of relative stability - Stability analysis using Bode Plot. Root locus concept, Rules for construction of Root Locus, stability analysis. Compensators and Controllers**:** Introduction to Compensators - Lag, Lead and Lag-Lead Compensators - Transfer function and Characteristics Controllers - P, PI and PID control modes **(9+3)**

STATE SPACE MODELS OF SYSTEMS: Advantages of state space representation, State space models of physical systems, State Space Representation: Companion Form (Controllable Canonical Form), Observable Canonical Form, Diagonal Canonical Form, Jordan Canonical Form, Determination of Transfer Function from State Space Model. **(9+3)**

Total L: 45 + T :15 = 60 Periods

TEXT BOOKS:

1. Gopal M, '*Control Systems Principles and Design*'. 4th Edition, Tata McGraw-Hill, New Delhi, India, 2012.
2. Norman S Nise, *'Nise's Control System Engineering*'. Wiley India Edition, John Wiley & Sons, New Delhi, 2018.

REFERENCES:

1. Farid Golnaraghi, Benjamin C. Kou, '*Automatic Control Systems*'. Tata McGraw-Hill, New Delhi, India 2018
2. Constantine H. Houpis, Stuart N. Sheldon, '*Linear Control System Analysis and Design with MATLAB*'. 6th Edition, CRC Press, Boca Raton, Florida, USA, 2013.
3. Ogatta K, '*Modern Control Engineering*'. Prentice Hall of India, New Delhi, 2013.
4. Richard C. Dorf, Robert H. Bishop, '*Modern Control Systems*'. 13th Edition, Pearson Education Ltd, New Jersey, USA, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain open-loop and closed-loop control systems, and develop transfer function and state-space models of mechanical, electrical and electromechanical systems.	**K2**
CO2	Determine the transfer function model of a given system and compute the time response, frequency response and stability of a given system.	**K3**
CO3	Analyse the given system for stability for varying values in time and frequency domains.	**K4**
CO4	Design, simulate, and analyze compensators, controllers, and control system parameters for specified applications.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							3	
CO3		3										3	
CO4			2		2							2	1
	3	**3**	**2**		**3**							**3**	**1**

1 – low, 2 – medium, 3 - high

25EE502 POWER ELECTRONICS

3 1 0 4

POWER SEMICONDUCTOR DEVICES: Introduction - Power Diodes - Power Transistors - Power MOSFETs – IGBTs - Thyristor family: SCR, TRIAC- Static and Dynamic characteristics – Introduction to wideband devices, GTO, IGCT -Introduction to intelligent power module-Protection circuits - Series and parallel connections – loss calculation- Interpretation of power device data sheet **(9+3)**

AC TO DC CONVERTERS: Uncontrolled Bridge Rectifiers: Single Phase and Three Phase Uncontrolled Rectifier with R, RL and RLE load - Continuous and discontinuous mode of operation - Average, RMS load voltage and load current, input power factor. Controlled Bridge Rectifiers – Single Phase and Three Phase (qualitative approach) Half and Fully Controlled Bridge Rectifier with R, RL load - Effect of free-wheeling diode - Average, RMS load voltage and load current, input power factor – Dual converters – HVDC Transmission- Principle of operation of PWM rectifier. **(9+3)**

DC TO DC CONVERTERS: Introduction - Time ratio control - Principle of step-up and step-down operation - Estimation of average load voltage and load current for continuous current operation –Switched mode power Converter – Ideal buck and Boost converter (steady state analysis) - Fly-Back Converter -Half and full bridge **(9+3)**

DC TO AC CONVERTERS: Types - Voltage source and current source inverters - Single phase bridge inverters - Three phase bridge inverters -PWM Techniques - Control of AC output voltage - Harmonic reduction- UPS. **(9+3)**

AC TO AC CONVERTERS: Single phase full wave controller with R and RL load - Estimation of RMS load voltage, RMS load current and input power factor - Three phase AC voltage controllers (qualitative approach)- Introduction to AC voltage controller with PWM control. **(9+3)**

Total L: 45 + T:15 = 60 Periods

TEXT BOOKS:

1. Rashid M H, '*Power Electronics – Circuits, Devices and Applications*'. 4th Edition, Prentice Hall of India, New Delhi, 2014.
2. P.S.Bimbhra, '*Power Electronics*'. 4th Edition, Khanna Publishers, New Delhi, 2006.

REFERENCES:

1. Ned Mohan, Tore M. Undeland, William P. Robbins, '*Power Electronics: Converters, Applications, and Design*'. 3rd Edition, John Wiley and Sons, Inc., New York, 2003.
2. Vedam Subramanyam, *'Power Electronics*'. New Age International, New Delhi, 1996
3. Joseph Vithayathil, '*Power Electronics*'. Tata McGraw-Hill, New Delhi, 2010.
4. M. D.Singh and K. B.Khanchandani, '*Power Electronics*'. 2nd Edition, Tata McGraw Hills Publishing Company Limited, New Delhi, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the static and switching characteristics of power semiconductor devices and PWM switching characteristics of power converters	**K2**
CO2	Develop a mathematical model of power converters to estimate the performance parameters of the power converters.	**K3**
CO3	Analyze power electronic circuits that meet desired specifications.	**K4**
CO4	Design power electronic circuits for the desired specifications, and demonstrate through mini-project.	**K6**
CO5	Conduct investigation on (Simulate and verify) power electronic circuits using MATLAB/ Multisim/Pspice/Proteus simulation tools.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											2	1
CO3		3										2	1
CO4			2						2	2		2	1
CO5				2	2			2	2	2	2	2	1
	3	**3**	**2**	**2**	**2**			**2**	**2**	**2**	**2**	**2**	**1**

1 – low, 2 – medium, 3 - high

25EE503 MICROPROCESSOR AND MICROCONTROLLERS

3 0 0 3

BASICS OF EMBEDDED C: Introduction to Embedded Systems - Embedded Software Programming Languages – Embedded C: Data Types – Storage Classes – Scope of Variables – Bitwise Operations – Cross-Platform Development - Integrated Development Environments - Super-loop-based Design Approach. Real time embedded system – Introduction to Real-Time Operating System – Definition – Characteristics Structure. **(7)**

ARCHITECTURE OF 8051 MICROCONTROLLER: Functional Block Diagram and Programmer's Model of 8051– Power Supply, Clock and Reset Circuit –Program and Data memory, Memory Organization – Pipelining. I/O Ports and Special Function Registers -Addressing modes – Instruction set - Assembly Language Programming. **(9)**

ON-CHIP PERIPHERALS OF 8051 MICROCONTROLLER: General Purpose Input / Output Ports – Timers / Counters – Serial Communication– External and Internal Interrupts – Power Saving Modes - Interfacing 8255 PPI with 8051 **(9)**

ARCHITECTURE OF ARM: RISC vs CISC - ARM7 Processor Fundamentals- Registers – Pipelining - ARM Instruction set and Thumb Instruction set-– Exception and Interrupt handling –Memory System – On-chip Peripherals of LPC2148: GPIO, Timers, RTC, ADC, PWM, Serial Ports – Introduction to ARM Cortex Mx – Processors core overview- Programmers Model **(10)**

OFF-CHIP PERIPHERAL INTERFACING: LED, Switch, Seven Segment Display, Matrix Keypad, LCD Interfacing, ADC, DAC and Sensor Interfacing– Interfacing of Relays, DC Motor, Stepper Motor and Servo Motor – SPI Protocol – I2C Protocol **(10)**

Total L: 45 Periods

TEXT BOOKS:

1. Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D Mckinlay, *'The 8051 Microcontroller and Embedded Systems*'. Pearson Education India, New Delhi, 2022.
2. Andrew Sloss, '*ARM System Developer's Guide*'. Elsevier, New Delhi, 2017.

REFERENCES:

1. Subrata Ghoshal, '*8051 Microcontroller: Internals, Instructions, Programming and Interfacing*'. Pearson Education India, New Delhi, 2010.
2. Kenneth Ayala, '*The 8051 Microcontroller*'. Cengage Learning India Pvt. Ltd., New Delhi,2016.
3. Steve Furber, *'ARM System-on-Chip Architecture*'. Pearson Education, Chennai,2017.
4. Joseph Yiu, '*The Definitive Guide to ARM Cortex M3 and Cortex M4 Processors*'. Third Edition, Elsevier India P Ltd, New Delhi, 2019.
5. K. V. Shibu, *'Introduction to Embedded Systems*'. 2nd Edition, McGraw Hill Education (I) P. Ltd., Chennai, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the architecture, programmer's model and off-chip peripheral interfacing of the 8051 and ARM7.	**K2**
CO2	Interface on-chip peripherals of 8051 and ARM7 for solving real time applications.	**K3**
CO3	Analyze the code efficiency, memory usage and execution time of programs developed for 8051 and ARM 7 using different addressing modes.	**K4**
CO4	Design and implement projects to solve real world problems using 8051 and ARM7 controller	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3			1								3
CO4			1		1								1
	3	**3**	**1**		**1**								**3**

1 – low, 2 – medium, 3 - high

25EE504 DIGITAL SIGNAL PROCESSING

3 1 0 4

DISCRETE-TIME SIGNALS AND SYSTEMS: Need and benefits of Digital Signal Processing –Sampling and Quantization of analog signals-Signal classification and basic operations on them – LTI system –Impulse response - Convolution sum and Correlation - I/O relationship - determination of Impulse response and Step response using Z transformation - A Typical DSP system. **(10+5)**

DISCRETE TRANSFORMS: Fourier Series and Fourier Transform - Discrete Fourier Transform (DFT) – Properties-DFT frequency axis – DIT - FFT and DIF - FFT radix2 algorithms - linear filtering via circular convolution - inverse FFT. **(8+4)**

DESIGN OF IIR DIGITAL FILTERS: Characteristics and applications of IIR filters - Design techniques for analog filters-frequency transformation-Digital IIR filter design: impulse invariant and bilinear transform methods – Canonical forms of Realization: direct, cascade, and parallel forms. **(10+4)**

DESIGN OF FIR FILTERS: Characteristics and applications of FIR filters - FIR filter design using Window functions - Canonical forms of Realization. **(8+2)**

GENERAL-PURPOSE DIGITAL SIGNAL PROCESSORS: Computer architectures for signal processing – pipelining - hardware multiplier – accumulator - special instructions - extended parallelism: SIMD, VLIW, and super scalar processing - Finite word length effects in IIR filters and FFT algorithms. **(9)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. Lonnie C Ludeman, '*Fundamental of Digital Signal Processing*'. Wiley, 2014.
2. Emmanuel C Ifeachor, Barrie W Jervis, '*Digital Signal Processing, A practical approach*'. Pearson Education, New Delhi, 2015.

REFERENCES:

1. John G Proakis, '*Digital Signal Processing: Principles, Algorithms, and Applications*'. Pearson Education, New Delhi, 2018.
2. Sanjit K Mitra, '*Digital Signal Processing, A Computer based Approach*'. McGraw-Hill, New Delhi, 2013.
3. Monson H Hayes, '*Schaum's Outline of Digital Signal Processing*'. 2nd Edition, McGraw-Hill Education, USA, 2011.
4. Dimitris G Manolakis, Vinay K Ingle, '*Applied Digital Signal Processing: Theory and Practice'*. 1st edition, Cambridge University Press, UK,2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamentals of discrete-time signals, systems, transforms, digital filters, and DSP architectures.	**K2**
CO2	Implement transform methods and digital filter design techniques for signal processing applications.	**K3**
CO3	Examine the behavior of discrete-time systems, filter responses, and DSP processor operations.	**K4**
CO4	Assess the performance of DSP techniques, filter design approaches, and processor architectures for real-time signal processing applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4				2	1								2
	3	**3**		**2**	**1**								**3**

1 – low, 2 – medium, 3 – high

25EE511 POWER ELECTRONICS LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Characteristics of MOSFET and IGBT
2. Characteristics of SCR and TRIAC
3. Single Phase and Three Phase Diode Bridge Rectifier with R and RL load
4. Single Phase half Controlled Thyristor Converter with R and RL load
5. Single Phase Fully Controlled Thyristor Converter with R and RL load
6. Design and implementation of DC Chopper
7. Single Phase AC Voltage Controller with R and RL Load.
8. Single phase PWM Inverter
9. Three phase PWM Inverter
10. Characteristics of Fly back Converter
11. Simulation of power converter circuits
12. Gate Pulse generation circuits using R, RC and UJT

Total P: 30 Periods

REFERENCES:

1. EEE Department, '*Power Electronics and Applications Lab Manual'*. PSG iTech, Coimbatore - 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Draw and Explain the VI characteristics of power semiconductor devices such as MOSFET, IGBT, SCR, TRIAC and its application in power converters.	**K2**
CO2	Estimate the performance parameters for step up and step down MOSFET based chopper and a single phase IGBT based PWM inverter.	**K3**
CO3	Analyze the single-phase and three-phase PWM inverter by comparing various PWM control techniques.	**K4**
CO4	Work effectively in teams to perform experiments, analyze the power electronic circuit, and present findings through simulation tools, reports.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2							3	1
CO3		3			2							3	1
CO4				2	2			2	2		2	2	1
	3	**3**		**2**	**2**			**2**	**2**		**2**	**3**	**1**

1 – low, 2 – medium, 3 - high

25EE512 MICROPROCESSOR AND MICROCONTROLLERS LABORATORY

0 0 4 2

LIST OF EXPERIMENTS:

1. Assembly Language Programming in 8051 Microcontroller
   (i) Arithmetic Operations
   (ii) Data Processing Operations
   (iii) Logical & Bit Manipulation Operations
2. Traffic light system interface using 8051
3. Keypad Interface using 8051.
4. Programming on-chip timer of 8051 Microcontroller in Polling and Interrupt methods.
5. Programming UART of 8051 Microcontroller in Polling and Interrupt methods.
6. Interfacing the Temperature sensor with 8051 microcontroller and displaying the result in LCD.
7. Stepper Motor and DC Motor Control using 8051 Microcontroller.
8. Interfacing DAC with ARM7 based Microcontroller.
9. PWM Signal Generation using ARM 7 based Microcontroller.
10. Mini Project

Total P: 60 Periods

REFERENCES:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG iTech, Coimbatore - 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe assembly language programs for the 8051 micro controllers to perform arithmetic, data processing, and bit manipulation operations.	**K2**
CO2	Implement real-time interfacing using on chip peripherals of 8051 and ARM 7.	**K3**
CO3	Analyze the signals by implementing convolution, DFT and FFT operations using ARM 7.	**K4**
CO4	Design and execute DSP algorithms and filter implementations using DSP processors for signal processing tasks.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2						3		3
CO3		3			2						3		3
CO4			2		2			2	2	1	2		2
	3	**3**	**3**		**2**			**2**	**2**	**1**	**3**		**3**

1 – low, 2 – medium, 3 - high

25EE513 INSTRUMENTATION AND CONTROL LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Calibration of Temperature sensors (RTD / Thermocouple / Thermistor)
2. Measurement of Linear displacement using LVDT and Measurement of strain using Strain gauge
3. Burden Current Characteristics of Current Transformer
4. Measurement of a Physical variable using PC
5. i) Measurement of Pressure using Load cell, ii) Characteristics of Light Sensors: Photodiode, Phototransistor, LDR
6. Transfer function of DC Motor a) Armature Control Mode b) Field Control Mode
7. i) Transfer function of AC Servomotor, ii)Closed loop characteristics of DC motor with Proportional Integral and Derivative Control (Continuous)using MATLAB
8. Time & Frequency Response of the Systems, Stability Analysis of Systems using MATLAB
9. Study of response of First and Second order system using Linear System Simulator
10. Design of PID Controller using tuning methods in MATLAB

Total P: 30 Periods

REFERENCES:

1. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG iTech, Coimbatore - 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Test the sensors used for temperature measurement, LVDT, load cell, light sensors for their characteristics.	**K2**
CO2	Compute the parameters for the transfer function model for DC motor and AC servo motor.	**K3**
CO3	Analyse the stability of a given system using time response and frequency response analysis.	**K4**
CO4	Model and simulate the given control system.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				3							3	
CO3		3			3							3	
CO4				2	2						1	2	
	3	**3**		**2**	**3**						**1**	**3**	

1 – low, 2 – medium, 3 - high

25EEE02 INTERNSHIP – I

0 0 0 1

OBJECTIVES

- To expose students to industrial practices and work culture
- To apply classroom concepts in real-time scenarios
- To enhance technical, communication, and teamwork skills
- To understand professional ethics and responsibilities
- To work under the guidance of an industry mentor
- To understand the organizational structure and workflow
- To contribute Involvement in assigned tasks/projects
- To consolidated report preparation of the above

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge in real-time industrial environments to perform assigned tasks under guidance, analyze and solve practical problems using appropriate tools, adapt to organizational work culture, demonstrate technical, teamwork, and communication skills, follow professional ethics, and document and present the work effectively while engaging in continuous learning.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3	3	3	3

1- Low, 2-Medium, 3-High

25EEE03 COMMUNITY PROJECT

0 0 0 1

OBJECTIVES

- To identify real-time problems and needs within the community
- To develop awareness about social, environmental, and economic issues
- To apply technical and engineering knowledge for community welfare
- To encourage teamwork, leadership, and communication skills
- To conduct field visits, surveys, and interaction with local stakeholders
- To design and implement feasible and sustainable solutions
- To promote ethical values and social responsibility

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge to identify and solve real-time community problems, develop sustainable solutions, work effectively in teams, communicate with stakeholders, and demonstrate social, environmental, and ethical responsibility while documenting and presenting the work.	**K6**

COs-POs & PSOs MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low, 2-Medium, 3-High

25EEC04 APTITUDE SKILLS

0 0 2 1

APTITUDE SKILLS:

1. Reading comprehension
2. Sentence correction, Sentence completion and Para-jumbles
3. Vocabulary, Articles, Prepositions and Interrogatives
4. Critical reasoning
5. Ratio and Proportion, Profit and loss, Partnerships and averages
6. Permutation, Combination and Probability
7. Time, Speed and Distance
8. Resume progress check

Total P: 30 Periods

REFERENCES:

1. R.S. Aggarwal, '*Quantitative Aptitude for Competitive Examination*'. S Chand Publishing, New Delhi, 2017.
2. P.C. Wren and H. Martin, *'High school English grammar & composition*'. S Chand Publishing, New Delhi, 2017.
3. Norman Lewis, '*Word Power Made Easy*'. Goyal Publisher, New Delhi, 2011.

SEMESTER VI
25EE601 POWER SYSTEM ANALYSIS

3 1 0 4

MODELING & NETWORK FORMULATION: Formation of Y Bus – pi-equivalent circuit of transformer with off-nominal tap ratio - Z bus formation by using building algorithm Modelling of power system components - single line diagram- Per unit representation – advantages –Per unit reactance diagram- Primitive network. **(9+3)**

LOAD FLOW STUDIES: Formulation of load flow problem - bus classification – Load flow solution by Gauss - Seidal, Newton - Raphson and Fast decoupled methods - Comparison -. Computation of slack bus power, transmission loss and line flow. **(9+3)**

SHORT CIRCUIT STUDIES: Types of faults – Symmetrical components - Algorithms for fault calculations — positive, negative and zero sequence networks and impedance matrices – Analysis of Symmetrical and unsymmetrical fault using Z_{bus}. **(9+3)**

STABILITY STUDIES: Steady state and transient stability - Swing equation and its solution by Runge-Kutta method – Equal area criterion and its Application -methods of improving transient stability-Power quality problems-issues and causes. **(9+3)**

UNIT COMMITMENT AND ECONOMIC DISPATCH: Formulation of economic dispatch problem – I/O cost characterization – incremental cost curve – coordination equations without and with loss (No derivation of loss coefficients) – solution by direct method and λ-iteration method – statement of unit commitment problem – Dynamic programming method. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. D.P. Kothari, I Nagrath, '*Modern Power System Analysis*'. Tata McGraw-Hill, Fourth Edition, New Delhi, June 2017.
2. Hadi Saadat, '*Power System Analysis*'. First Edition, Tata McGraw-Hill, New Delhi, 2011.

REFERENCES:

1. B. R. Gupta, '*Power System Analysis and Design*'. S.Chand & Company Ltd., New Delhi, 2016.
2. T. K. Nagsarkar, M. S. Sukhija,'*Power System Analysis*'. Oxford University, Second Edition, New Delhi, 2014.
3. Roger C. Dugan, '*Electrical power systems quality*'. Tata McGraw-Hill, New Delhi, 2012
4. S. Ramar, S. Kuruseelan, '*Power System Analysis*'. PHI, New Delhi 2013.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of power system studies under static and dynamic conditions by economically scheduling the power generating units according to the load demand.	**K2**
CO2	Apply the knowledge of network theorems for modeling of the power system network and iterative algorithms for obtaining the power flow and short-circuit solutions.	**K3**
CO3	Analyze the rotor-angle and voltage stability condition of power system network with the presence of symmetrical and unsymmetrical faults at different locations of the network.	**K4**
CO4	Evaluate an impact of reactive power compensation on bus-voltages using the real-time power system model developed using simulation tool and report the inferences with proper justification for the suitable solution by working as an individual or as a member of a team.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		3										3	
CO4			2		2			2	2		2	2	
	3	**3**	**2**		**2**			**2**	**2**		**2**	**3**	

1 – low, 2 – medium, 3 – high

25EE602 ELECTRIC DRIVES AND CONTROL

3 0 0 3

INTRODUCTION TO ELECTRIC DRIVES: History and development of electric drives, Characteristics of Electrical &mechanical loads-ratings & Duties – RMS Power for variable mechanical load - Thermal characteristics – Torque Calculation for different motion profile and mechanical transmission - Basic elements of Electrical Drive - Classification of electric drives, & advantages of variable speed drives. **(9)**

DC DRIVES: Speed control of DC motors: Speed –torque equation and characteristics for armature &field control – four quadrant operation of Chopper fed Drive–PMDC drive – Control blocks of DC drive – Applications. **(9)**

INDUCTION MOTOR DRIVES: Speed control of 3 phase Induction Motors -V/f control, rotor control: Rotor resistance control -Static control of rotor resistance using DC chopper - Static Krammer and Scherbius drives –Vector Controlled Induction Motor Drives: dq frame machine theory -Principle – direct and indirect vector control – rotor flux and stator flux orientation control -sensor less control – Applications **(9)**

MAGNETIC AND RELUCTANCE MOTOR DRIVES: PMSM: Types - Principle-Field Oriented Control of PMSM – Field weakening - BLDC motor – Trapezoidal Drive scheme – Sensor less Control scheme. Stepper motor: principle of operation – Bipolar & Unipolar Drive schemes - SRM drive: principle of operation –Introduction to drive schemes- Classical bridge converter topology- Introduction to SynRM drive. **(9)**

DIGITAL CONTROLLERS FOR DRIVES: Digital techniques in speed control - Microprocessor/Microcontroller & PLC based control of drives- networking of drives - Selection of drives and control schemes for Steel rolling mills, Paper mills, Cement mills, Machine tools, Lifts and Cranes. Robot – AGVs **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Dubey G K, *'Fundamentals of Electrical Drives*'. Narosa Publishing House, New Delhi, 2012.
2. Vedam Subramanyam, '*Electric Drives: Concepts and Applications'*. Tata McGraw-Hill, New Delhi, 2011.

REFERENCES:

1. Ramu Krishnan R, '*Permanent-Magnet Synchronous and Brushless DC Motor Drives*'. CRC Press, 2017
2. Ned Mohan, Siddharth Raju '*Analysis and Control of Electric Drives: Simulations and Laboratory Implementation*'. Wiley, 2021.
3. Juha Pyrhonen, Valeria Hrabovcova, R. Scott Semken, '*Electrical Machine Drives Control: An Introduction*'. Wiley, 2016.
4. Peter, Vas, *'Vector control of AC machines'*. Oxford University Press,1990.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the motor load characteristics, power converters and controllers for electric drives.	**K2**
CO2	Compute the performance parameters for converter fed DC/AC drives	**K3**
CO3	Analyse intelligent control algorithms for electrical drives.	**K4**
CO4	Select and simulate electric drives for real time applications.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								
CO3		3			2							2	
CO4			2		2							2	
	3	**3**	**2**		**2**							**2**	

1 – low, 2 – medium, 3 - high

25EE603 DATA STRUCTURES USING C++

2 2 0 4

INTRODUCTION TO DATASTRUCTURES & ALGORITHMS: Data types - Primitive data structures - Linear and non-linear data structures - Data structure operations. Algorithms: Analysis of Algorithms – best case, average case, and worst-case complexities – Big O notation – Pseudo code for algorithms – Simple algorithms and their analysis. **(3+2)**

INTRODUCTION TO OBJECT-ORIENTATION & C++: Characteristics of Object–oriented Programming – Encapsulation – Inheritance – Polymorphism – Aggregation – Implementation using C++ **(4+8)**

ARRAY, STACK, & QUEUES: Arrays – storage structure for 1-D and 2-D arrays. Sparse matrix -Stacks - Array implementation of stacks - stack operations - Applications - Conversion of infix expressions to polish notation - Parenthesis checking - Array implementation of strings - Operation on strings. Array implementation - Queue operations -Types - Dequeues - Priority queues**.** **(5+4)**

LINKED LIST &TREES: Operation of linear list - Linked list – Linked Implementation of stacks and queues - Circular list – Doubly-linked list - List with header node. Definitions - Binary trees - Operations on binary trees - Storage representation – Threaded binary tree - Application of trees - Manipulation of arithmetic expression - Huffman's algorithm **(8+6)**

SORTING & SEARCHING: Exchange Sorting: Bubble sort, quick sort –Selection sorting: Straight selection sort, Binary tree sort, Heap sort - Insertion sorting: Simple insertion sort, Shell sort, Address calculation sort – Merge sort – Radix sort. Linear search - Binary search – Tree searching: Binary search tree, Insertion & Deletion of an element, Efficiency – Hashing - Introduction to Multiway search trees **(10+10)**

Total L: 30 + T: 30 = 60 Periods

TEXT BOOKS:

1. Yedidayah Langsam, Moshe J. Augenstein, Aaron M. Tanenbaum, '*Data Structures using C and C++*'. Pearson Education, Chennai, 2019.
2. Vijayalakshmi Pai G A, '*Data Structures and Algorithms: Concepts, Techniques and Applications*'. McGraw Hill Education (I) P. Ltd, New Delhi, 2017.

REFERENCES:

1. D. S. Malik, '*Data Structures using C++*'. 2nd Edition, Course Technology, Cengage Learning,2009.
2. Bjarne Stroustrup, '*The C++ Programming Language*'. 3rd Edition, Pearson Education, 2017
3. Herbert Schildt, '*C++: The complete Reference*'. 4th Edition, McGraw Hill Education,2017
4. Narasimha Karumanchi, *'Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles(C/C++)*'. 5th Edition, Career Monk Publications, Hyderabad, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the principles of algorithm analysis, object-oriented concepts, and their implementation using C++	**K2**
CO2	Apply linear data structures such as arrays, stacks, and queues to develop solutions for computational problems.	**K3**
CO3	Analyze the performance and implementation of linked lists and tree-based data structures in solving real-world problems.	**K4**
CO4	Evaluate and select appropriate sorting and searching techniques, including hashing and tree-based methods, based on efficiency.	**K5**

COs-POs & PSOs MAPPING

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

1 – low, 2 – medium, 3 - high

25EE611 ELECTRIC DRIVES AND CONTROL LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. PWM generation using WAVECT controller.
2. Performance analysis of inverter circuit using WAVECT controller.
3. Performance analysis of DC-DC converter using WAVECT controller.
4. Performance analysis of induction motor drive in V/F control modes.
5. Performance analysis of stepper motor drive.
6. Performance analysis of DC motor drive.
7. Performance analysis of BLDC drive.
8. Performance analysis of SRM drive.
9. Simulation of V/F control of induction motor drive.
10. Simulation of FOC of induction motor drive.

Total P: 30 Periods

REFERENCES:

1. Department of EEE, '*Electric Drives and Data Structures Laboratory Manual*'. PSG iTech, Coimbatore - 641062

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the operation and control of motor drives and power converters using controllers and simulation tools.	**K2**
CO2	Apply controller-based techniques to control and operate various electric motor drives and converter	**K3**
CO3	Analyze the behavior and performance of inverter, converter, and motor drive systems under different control strategies.	**K4**
CO4	Evaluate the performance of electric motor drives by employing suitable control techniques.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3			2	1		1	3	3
CO3		3			3			2	1		1	3	3
CO4			2		2			2	1		1	2	2
	3	**3**	**2**		**3**			**2**	**1**		**1**	**3**	**3**

1 – low, 2 – medium, 3 - high

25EEE04 MINI PROJECT II

0 0 2 1

- Students should learn project selection methodologies and teamwork skills to design hardware/software products.
- Create a good technical report and gain motivation to explain project ideas clearly.

COURSE GUIDELINES:

- Students can choose project based on industry defined problem or user defined problem which must emulate the real-life problems.
- It is desirable that students should work on the project in group of 3 or 4 but not more than four.
- After making the group, students must decide the title of the project and they will present to the department. Also, students will prepare the proposal report of 4-5 pages and submit at the time of presentation.
- At the end, students must submit the final report of the project and the format for the same will be given by the department.
- The plagiarism check for the final report is to be done through the required software suggested by the department and the report must be having similarity less than 25%.
- The students will report to the respective guide/supervisor at every fortnight to discuss their progress.
- The final evaluation of the project will be done based on the demonstration and presentation.

Total P: 30 Periods

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Identify and define a problem statement relevant to engineering problems in electrical and electronics engineering.	**K2**
CO2	Apply the concept of electrical and electronics engineering to develop a working model.	**K3**
CO3	Evaluate the societal, environmental and ethical impacts of the proposed solution.	**K5**
CO4	Design and develop an electrical or electronic system to solve a real-world problem using appropriate tools and techniques.	**K6**
CO5	Demonstrate teamwork, project planning, time management and communicate technical information effectively through reports and presentations.	-

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3								
CO3		2			3								
CO4			2	2	3							3	3
CO5						2	2	2	2	2	2		
	3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**

1 – low, 2 – medium, 3 - high

25EEC05 ENHANCING PROBLEM SOLVING ABILITY WITH CODE

0 0 2 1

SOFTWARE EXPERIMENTS:

1. Compilation, Namespace, Header file, Data types, Variables, Declaration, Scope of variables
2. Input / Output, Type Conversion, Operators
3. For, While, Do-while, break, continue.
4. Decision Making
5. Problem solving Pattern Programming
6. Arrays
7. Call by value & Call by reference, with and without arguments
8. Functions, Recursion & Strings
9. Structures & Union
10. Command Line Argument
11. Structure using Pointers
12. Handling Stress
13. Handling Peer pressure
14. Resume progress check

Total P: 30 Periods

REFERENCES:

1. Gayle Laakmann McDowell, '*Cracking the Coding Interview: 150 Programming Questions and Solutions*'. 5th Edition, Chand Publishing, New Delhi, 2015.
2. John Mongan, Noah Kindler and Eric Giguère, '*Programming Interviews Exposed: Secrets to Landing Your Next Job*'. 5th Edition, Wrox, New Delhi, 2018.

SEMESTER VII

25EE701 POWER SYSTEM PROTECTION AND SWITCHGEAR

3 1 0 4

PROTECTIVE RELAYS: Switchgears: essential features and equipment – types of fault - short circuit MVA – Protective scheme -Universal relay torque equation - IDMT characteristics –Over current relay – directional relay – R-X diagram - Distance and Differential protection scheme - Negative sequence relays - Pilot (Translay) relay – Carrier current protection scheme. **(9+3)**

APPARATUS AND LINE PROTECTION: Alternator, transformer and Busbar protection schemes – Feeder Protection: radial and ring main system – 3 stage distance protection scheme – Current limiting Reactor: location and design **(9+3)**

CIRCUIT BREAKERS: Arc phenomenon – principles and methods of arc extinction - Recovery and re-striking voltage - classification of circuit breakers – Problems and solution of circuit interruption – circuit breaker ratings - curves– selection of circuit breakers – IEC standards for MCB, MCCB. **(9+3)**

SURGE PROTECTION AND NEUTRAL GROUNDING: Lightning phenomena – Traveling waves on transmission lines –- Protections against lightning – neutral grounding – methods and Advantages –Arc suppression coil - Concept of insulation co-ordination – BIL – Indian Electicity rules. **(9+3)**

STATIC RELAYS AND NUMERICAL PROTECTION: Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, distant protection of transmission lines – Microprocessor based Protective schemes. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. Sunil S. Rao, '*Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)*'. Khanna Publishers; 14th edition, January 2019.
2. Badri Ram D, Vishwakarma, '*Power System Protection and Switchgear*'. 2nd Edition published by Tata McGraw Hill Education Private Limited, New Delhi, 2nd Edition, July 2017.

REFERENCES:

1. Soni M L, Gupta P V, Bhatnagar U S, Chakrabarti A, *'A Text Book on Power Systems Engineering*'. Dhanpat Rai & Co., New Delhi, 2013.
2. Sunil S Rao, '*Switchgear Protection and Power Systems*'. Khanna Publishers, New Delhi, 2012.
3. Y. G. Paithankar, S. R. Bhide, *'Fundamentals of Power System Protection*'. PHI Learning Private Limited, New Delhi, 2010.
4. Ravindra P. Singh, '*Switchgear and Power System Protection*'. PHI Learning Private Ltd, New Delhi, 2009.
5. Bhuvanesh Oza, Nirmal Kumar Nair, Rashesh Mehta, & Vijay Makwana, '*Power System Protection & Switchgear*'. 1st edition, July 2017, TMH publishers.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the different protection zones, relays, circuit breakers and need for protection in power systems	**K2**
CO2	Apply the knowledge of circuit breaker and relays for protection of electrical apparatus.	**K3**
CO3	Analyse suitable protection schemes, appropriate earthing techniques in power systems and present the findings through peer presentations based on field visits.	**K4**
CO4	Design and simulate a protection scheme for electrical apparatus using simulation tools and validate the behaviour of relays using hardware modules.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											3	
CO3		3										3	
CO4			2	2	2			1	1		2	2	
	3	**3**	**2**	**2**	**2**			1	1		2	3	

1 – low, 2 – medium, 3 - high

25EE702 ELECTRICAL MACHINE DESIGN

3 1 0 4

SELECTION OF MATERIALS: Design factors and limitations – Materials for electrical machines – properties - Modes of heat transfer – Temperature rise-time relation - heating and cooling curves – Types of rating – selection of motor capacity**.** **(9+3)**

DC MACHINES: Output equation - choice of specific electric and magnetic loadings -Magnetic circuit design- MMF calculation- Choice of number of poles –length of air gap – Armature and Field design – Design of commutator and brushes –Permanent Magnet – Selection – De-magnetization – design procedure. **(9+3)**

TRANSFORMERS: Output equation – Design of core and winding – Window and Yoke dimensions – Overall dimensions – No load current calculation -Temperature rise of Transformers- Design of tanks and cooling tubes. **(9+3)**

INDUCTION MOTORS: Output equation - choice of specific electric and magnetic loadings- Length of air-gap – Magnetic circuit design- MMF calculation- Stator design – Design of cage and wound rotor – No-load current calculation – Stator and rotor resistance –leakage reactance calculation **(9+3)**

SYNCHRONOUS MACHINES: Output equation - choice of specific electric and magnetic loadings - Pole construction – Runaway speed – Armature design – Short circuit ratio – Air-gap length – Design of rotor and field winding. **(9+3)**

Total L: 45 + T: 15 = 60 Periods

TEXT BOOKS:

1. A. K. Sawhney, '*A Course in Electrical Machine Design*'. Dhanpat Rai & Co. (P) Limited, 2016
2. Dr. N. K. Datta, '*Theory & Practice of Electrical Machine Design*'. S. K. Kataria & Sons, 2016

REFERENCE:

1. V. Rajini, V. S. Nagarajan '*Electrical Machine Design (with motor solve and Matlab)*'. Pearson Education, 2018.
2. R. K. Agarwal, '*Principles of Electrical Machine Design*'. S. K Kataria and Sons; 2012.
3. Sen S K, '*Principle of Electrical Machine Design with C++'*. Windows and Linux., Oxf-Ibh, 2012.
4. K. G. Upadhyay, '*Design of Electrical Machines'*. New Age International limited, Edition: 2010

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the design procedure, selection, rating, properties of materials and thermodynamics of DC and AC electrical machines.	**K2**
CO2	Apply the knowledge of electrodynamics to determine the design parameters of DC and AC electrical machines.	**K3**
CO3	Analyse DC and AC electrical machines for the given design constraints.	**K4**
CO4	Assess and Interpret the design of AC and DC electrical machines using C / C++/ Python code.	**K5**
CO5	Design and develop an electrical machine for the given specification.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		3										3	
CO4				2	2	1						2	
CO5			2		2	1		1			2	1	1
	3	**3**	**2**	**2**	**2**	**1**		**1**			**2**	**3**	**1**

1 – low, 2 – medium, 3 - high

25EE711 POWER SYSTEM LABORATORY

0 0 2 1

LIST OF EXPERIMENTS:

1. Modelling and performance analysis of transmission lines using network matrices.
2. Testing of instrumentation transformers and relays
3. Load flow analysis by Newton-Rapson method.
4. Short circuit analysis of power system network.
5. Transient stability analysis of power system network.
6. Load frequency dynamics of single area and two area systems
7. Analysis of AVR system in synchronous generator.
8. Reactive power compensation using SVC.
9. Measurement of breakdown voltage of transformer oil
10. Characteristics of solar PV system using solar PV emulator

Total P: 30 Periods

REFERENCES

1. Hadi Saadat, '*Power System Analysis*'. Tata McGraw-Hill, New Delhi, 2011.
2. Laboratory Manual prepared by Department of Electrical and Electronics Engineering, PSG iTech, Coimbatore - 641062.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the principles of protection strategies applicable for voltage and frequency stable system under different transmission line configurations with renewable energy resources	**K3**
CO2	Apply engineering knowledge to model the power system network for various line configurations and design compensators for stability enhancement	**K3**
CO3	Analyze the impact of reactive power compensation devices on bus-voltages under steady state and dynamic conditions considering the actual system model using modern engineering tools	**K4**
CO4	Develop the differential relay for transformer protection using instrumentation transformers and validate the performance at different load conditions by working as an individual or as a member of a team	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3							2	2			3	
CO3		3						2	2			3	
CO4			2	2	2			2	2			2	
	3	**3**	**2**	**2**	**2**			**2**	**2**			**3**	

1 – low, 2 – medium, 3 - high

25EEE05 PROJECT WORK I

0 0 4 2

Students will do the following:

- Identification of project
- Define the objectives of the project
- Literature Survey
- Finalization of System Requirements and Specifications
- Development of software / Hardware Model
- Testing/Validating and obtaining Results
- Future Trends/Extension of the project
- Consolidated Report Preparation

Total P: 60 Periods

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the prevailing engineering solutions and methodology adopted through literature review / field-survey and identify the project objectives and outcomes	**K2**
CO2	Apply an appropriate design methodology, simulation tools, and experimental techniques for developing a hardware prototype / simulation model of the proposed system	**K3**
CO3	Analyze the system performance with respect to feasibility of implementation, effectiveness and consistency with initial objectives on comparing with existing solutions	**K4**
CO4	Justify the appropriateness of the proposed solution through validation, interpret results, and critically assess the outcomes against expected performance metrics and sustainability	**K5**
CO5	Create the prototype hardware model with provisions for future enhancement and exhibit the project outcomes effectively through well-structured reports and presentations.	**K6**
CO6	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.	-

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3								
CO3		3			3								
CO4			3		3								
CO5				3	3				3		3	3	3
CO6						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 - high

25EEE06 INTENSHIP -II

0 0 0 1

OBJECTIVES:

- To expose students to industrial practices and work culture
- To apply classroom concepts in real-time scenarios
- To enhance technical, communication, and teamwork skills
- To understand professional ethics and responsibilities
- To work under the guidance of an industry mentor
- To Understand organizational structure and workflow
- To contribute Involvement in assigned tasks/projects
- To Consolidated report preparation of the above

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Apply engineering knowledge in real-time industrial environments to perform assigned tasks under guidance, analyze and solve practical problems using appropriate tools, adapt to organizational work culture, demonstrate technical, teamwork, and communication skills, follow professional ethics, and document and present the work effectively while engaging in continuous learning.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 - high

SEMESTER VIII
25EEE07 PROJECT WORK II

0 0 8 4

Students will do the following:

- Identification of project
- Define the objectives of the project
- Literature Survey
- Finalisation of System Requirements and Specifications
- Development of software / Hardware Model
- Testing/Validating and obtaining Results
- Future Trends/Extension of the project
- Consolidated Report Preparation

Total P: 120 Periods

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the prevailing engineering solutions and methodology adopted through literature review / field-survey and identify the project objectives and outcomes	**K2**
CO2	Apply an appropriate technique or modern tools to design and develop the hardware or software components to solve the complex engineering problem	**K3**
CO3	Analyze the system performance with respect to feasibility of implementation, effectiveness and consistency with initial objectives on comparing with the existing solutions	**K4**
CO4	Justify the appropriateness of the proposed solution through validation, interpret results, and critically assess the outcomes against expected performance metrics and sustainability	**K5**
CO5	Create the prototype hardware model with provisions for future enhancement and exhibit the project outcomes effectively through well-structured reports and presentations.	**K6**
CO6	Demonstrate teamwork, ethical responsibility, and project management skills in executing the project.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				3								
CO3		3			3								
CO4			3		3								
CO5				3	3			3	3		3	3	3
CO6						3	3	3	3	3	3		
	3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – low, 2 – medium, 3 - high

PROFESSIONAL ELECTIVE COURSES

25EEP01 EMBEDDED SYSTEM DESIGN

3 0 0 3

INTRODUCTION TO EMBEDDED SYSTEMS: Introduction to Embedded Systems – Functional building blocks of embedded systems, Applications, Embedded hardware units, Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Real Time Clock**.** **(9)**

EMBEDDED NETWORKING: Serial Bus communication protocols RS232 standard – CAN Bus- Serial Peripheral Interface (SPI) – Inter- Integrated Circuits (I2C), ZigBee Network Overview - ZigBee Protocol, Modbus. **(9)**

INTERRUPTS THE SERVICE MECHANISM AND DEVICE DRIVER: Programmed-I/O busy-wait approach without interrupt service mechanism-ISR concept-interrupt sources – multiple interrupts – context and periods for context switching, interrupt latency and deadline – Introduction to Device Drivers**.** **(9)**

RTOS-BASED EMBEDDED SYSTEM DESIGN: Introduction to basic concepts of RTOS- Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Task communication- shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores, Design example using open source RTOS**.** **(9)**

EMBEDDED SYSTEM APPLICATION DEVELOPMENT: Embedded Product Development Life Cycle - Case Study: Precision Agriculture, Washing Machine, Automotive Systems, Smart Card system, Auto-focusing digital camera, Air-conditioner, Elevator Control System, ATM System. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Rajkamal, '*Embedded System-Architecture, Programming, Design'*. McGraw-Hill Edu, 3rd edition 2017
2. Peckol, '*Embedded system Design*'. John Wiley & Sons,2010

REFERENCE:

1. Shibu. K. V, '*Introduction to Embedded Systems*'. Tata McGraw Hill, 2nd edition 2017.
2. Lya B. Das, '*Embedded Systems*'. Pearson Education, 1st edition, 2012.
3. Parag H. Dave, Himanshu B. Dave, '*Embedded Systems-Concepts, Design and Programming*'. Pearson Education, 1st edition, 2015.
4. Elicia White, '*Making Embedded Systems*'. O'Reilly Series, SPD, 1st edition, 2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the basic components and techniques required for the design of an embedded system.	**K2**
CO2	Apply the knowledge of processor, Memory and peripheral interfacing techniques for designing an embedded product.	**K3**
CO3	Analyze the scheduling algorithms, Interrupt Service Routine and task management techniques for real time embedded systems.	**K4**
CO4	Develop a solution for embedded system concepts related to societal/real time problems.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			1	1	1	1		1		1			1
	3	**3**	**1**	**1**	**1**	**1**		**1**		**1**			**3**

1 – low, 2 – medium, 3 – high

25EEP02 EMBEDDED PROGRAMMING

3 0 0 3

BASIC C PROGRAMMING: Overview of C program development, structured programming, data types, operators, and program control. Functions, arrays, and fundamentals for building embedded applications. **(9)**

EMBEDDED C: Structured coding practices, modular development using headers and ports, and object-oriented features in C. Real-time constraints handling through delays, loop/hardware timeouts, and timing mechanisms. **(9)**

C PROGRAMMING TOOL-CHAIN IN LINUX: Compilation stages, preprocessing, and GCC usage. Debugging with GDB, build automation using Make, profiling with gprof, GNU binary utilities, and libraries for efficient development. **(9)**

PYTHON PROGRAMMING: Introduction, Parts of Python Programming Language, Control Flow Statements, Functions, Strings, Lists, Dictionaries, Tuples and Sets. **(9)**

MODULES, PACKAGES AND LIBRARIES IN PYTHON: Creating and using modules/packages. Practical applications using Python libraries for math, plotting, GUI, imaging, and networking to support embedded solutions**.** **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Deitel, P., & Deitel, H, '*C how to program*'. Pearson Education Limited,8th edition, 2016.
2. Pont, M. J, '*Embedded C'*. Addison-Wesley (an imprint of Pearson Education), 2002
3. Mueller, J. P, 'Beginning *programming with Python for dummies*'. John Wiley & Sons Inc., 2nd edition, 2018.

REFERENCES:

1. Von Hagen, W., '*The definitive guide to GCC*'. Apress Inc., 2nd edition, 2006.
2. Gowrishankar, S & Veena, 'Introduction *to Python programming*'. CRC Press, Taylor & Francis Group, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain structured programming and modular design concepts in embedded systems development.	**K2**
CO2	Apply C, Embedded C, Python, and Linux tools to develop programs for embedded systems.	**K3**
CO3	Analyze performance, timing, and debugging aspects in embedded systems programs.	**K4**
CO4	Design and develop applications for embedded systems using C/Embedded C and Python.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			1	1	1	1		1		1			1
	3	**3**	**1**	**1**	**1**	**1**		**1**		**1**			**3**

1 – low, 2 – medium, 3 - high

25EEP03 INTERNET OF THINGS (IoT) AND ITS APPLICATIONS
(Common to EEE and ICE)

3 0 0 3

INTRODUCTION TO INTERNET OF THINGS: 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. **(9)**

COMPONENTS IN INTERNET OF THINGS: Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee, Wi-Fi, GPS, GSM Modules). **(9)**

PROTOCOLS AND TECHNOLOGIES BEHIND IoT: IoT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, Big Data Analytics, Cloud Computing, Embedded Systems. **(9)**

OPEN PLATFORMS AND PROGRAMMING: IoT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud. **(9)**

IoT APPLICATIONS: 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. **(9)**

Total L: 45 Periods

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 Greengard, '*The Internet of Things'*. The MIT Press, 2015

REFERENCES

1. Perry Lea, '*Internet of things for architects*'. Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , '*The Internet of Things – Key applications and Protocols*'. Wiley, 2012
3. David Etter, '*IOT (Internet of Things) Programming: A Simple and Fast Way of Learning'*. IOT Kindle Edition. 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the operation of sensors, actuators, communication modules, and IoT communication protocols.	**K2**
CO2	Apply various protocols, device discovery and cloud services in resource constraint network for IoT applications.	**K3**
CO3	Analyse the various IoT architectural components in real-time application.	**K4**
CO4	Develop IoT solutions for smart city, healthcare, industrial, environmental monitoring, home automation, and agricultural applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			2		2	2	2	1	1		2		1
	3	**3**	**2**		**2**	**2**	**2**	**1**	**1**		**2**		**3**

1 – low, 2 – medium, 3 - high

25EEP04 OPERATING SYSTEMS

3 0 0 3

INTRODUCTION: Computer System - Elements and organization; Operating System Overview - Objectives and Functions - Evolution of Operating System; Operating System Structures – Operating System Services - User Operating System Interface - System Calls – System Programs - Design and Implementation - Structuring methods. **(9)**

PROCESS MANAGEMENT: Processes - Process Concept - Process Scheduling - Operations on Processes - Inter-process Communication; CPU Scheduling - Scheduling criteria - Scheduling algorithms: Threads - Multithread Models – Threading issues; Process Synchronization - The Critical-Section problem - Synchronization hardware – Semaphores – Mutex - Classical problems of synchronization - Monitors; Deadlock - Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock**.** **(9)**

MEMORY MANAGEMENT: Main Memory - Swapping - Contiguous Memory Allocation – Paging - Structure of the Page Table - Segmentation, Segmentation with paging; Virtual Memory - Demand Paging – Copy on Write – Page Replacement - Allocation of Frames –Thrashing – Cache memory mapping techniques. **(9)**

STORAGE MANAGEMENT: Mass Storage system – Disk Structure - Disk Scheduling and Management; File-System Interface - File concept - Access methods - Directory Structure - Directory organization - File system mounting - File Sharing and Protection; File System Implementation - File System Structure – Directory implementation - Allocation Methods - Free Space Management; I/O Systems – I/O Hardware, Application I/O interface, Kernel I/O subsystem. **(9)**

VIRTUAL MACHINES AND MOBILE OS: Virtual Machines – History, Benefits and Features, Building Blocks, Types of Virtual Machines and their Implementations, Virtualization and Operating-System Components; Mobile OS - iOS and Android**.** **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, '*Operating System Concepts*'. 10th Edition, John Wiley and Sons Inc., 2018.
2. Andrew S Tanenbaum, '*Modern Operating Systems*'. Pearson, 5th Edition, New Delhi, 2022.

REFERENCES

1. Ramaz Elmasri, A. Gil Carrick, David Levine, '*Operating Systems – A Spiral Approach*'. Tata McGraw Hill Edition, 2010.
2. William Stallings, '*Operating Systems: Internals and Design Principles*'. 7th Edition, Prentice Hall, 2018.
3. Achyut S. Godbole, Atul Kahate, '*Operating Systems*'. McGraw Hill Education, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of operating systems, virtual machines and Mobile OS.	**K2**
CO2	Implement memory management techniques, such as paging and segmentation, to address allocation and protection challenges.	**K3**
CO3	Analyse various scheduling algorithms and process synchronization techniques.	**K4**
CO4	Assess various synchronization mechanisms, such as semaphores and monitors, to resolve critical-section problems and prevent deadlocks for a given real time scenario.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		3			2								
CO4				1				1	1				1
		3		**1**	**2**			**1**	**1**				**1**

1 – low, 2 – medium, 3 – high

25EEP05 COMPUTER ARCHITECTURE

3 0 0 3

MEMORY AND INPUT/OUTPUT SUBSYSTEMS: Introduction - Computer architectural classification: Flynn's classification – Data flow versus Control flow computers – Parallelism in uniprocessor systems –Parallel processing applications. Hierarchical Memory Structure: Memory hierarchy – Optimization –Addressing schemes for main memory –Memory interleaving – Virtual Memory System: Paged Memory System – Segmented memory System – Memory with Paged Segments – Memory allocation and Management: Memory Management Policies – Cache Memory and Management: Cache Memory Organization - Block Replacement Policies – Performance evaluation and enhancement – Input Output Subsystems: Interrupt Mechanisms and Special Hardware – I/O Processors and I/O Channels. **(9)**

PIPELINING AND VECTOR PROCESSING: Principles of pipelining – Instruction and Arithmetic pipelines – Instruction prefetch and branch handling – Data buffering and Busing structures – Internal forwarding and Register tagging – Hazard detection and resolution – Job sequencing and Collision prevention – Vector Processing: Characteristics – Pipelined Vector Processing methods – Vectorization and Optimization methods. **(9)**

ARRAY PROCESSING: SIMD Array Processors - Masking and data routing mechanisms - Inter PE communications – Interconnection networks – Parallel Algorithms for Array Processors – Associative Array Processing-Systolic array processing**.** **(9)**

MULTIPROCESSOR ARCHITECTURE: Functional structures: Loosely coupled multiprocessors – Tightly coupled multiprocessors – Processor characteristics for multiprocessing – Multiprocessor scheduling strategies – Interconnection networks– Parallel memory organization – Parallel Algorithms for Multiprocessors. **(9)**

INTRODUCTION TO RISC ARCHITECTURE: Instruction execution characteristics – Instruction execution charts – Register files – Register optimization – Reduced Instruction Set Architecture – RISC pipelining – RISC versus CISC **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Hwang K, and Briggs F A, '*Computer Architecture and Parallel Processing*'. Tata McGraw–Hill, New Delhi, 2016.
2. Stallings W, '*Computer Organization and Architecture: Designing for Performance*'. Pearson Education, Chennai, 2018.

REFERENCES:

1. David Patterson and John L Hennessy, '*Computer Organization and Design: The Hardware/Software Interface*'. Elsevier, Waltham, 2012.
2. Kai Hwang, Naresh Jotwani, '*Advanced Computer Architecture – Parallelism, Scalability and Programmability*'. Tata McGraw–Hil, New Delhi, 2013.
3. Jhon L Hennessey and David A Patterson, '*Computer Architecture a Quantitative Approach*'. 5th Edition, Elsevier, United States, 2012.
4. Sima D, Fountain T, Kacsuk P, '*Advanced Computer Architectures: A Design Space Approach*'. Addison Wesley, United States, 2000.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts of computer architecture.	**K2**
CO2	Examine the principles of pipelining and vector processing, including instruction prefetching, hazard resolution, and vector optimization techniques	**K3**
CO3	Analyse the functional structures of multiprocessor architectures, including loosely and tightly coupled systems, to identify suitable multiprocessing strategies for given applications.	**K4**
CO4	Compare and contrast RISC and CISC architectures, with an emphasis on instruction execution characteristics and RISC pipelining	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		3											
CO4			2										1
	3	**3**	**2**										**1**

1 – low, 2 – medium, 3 – high

25EEP06 SYSTEM DESIGN USING FPGA

3 0 0 3

FPGA DESIGN FLOW AND ARCHITECTURES: Digital IC design flow- The role of FPGAs in digital design - Goals and techniques–Hierarchical design – CAD Tools. FPGA architectures – Configurable logic blocks – configurable / Oblocks–Programmable interconnect – clock circuitry– Xilinx FPGA architecture–Programming Technologies: Antifuse, SRAM, EPROM, EEPROM. **(9)**

VERILOG HDL: HDL overview – Modules and ports – compiler directives – data types - operands and operators-gate level modeling – data flow modeling – behavioral modeling – structural modeling – primitives –Tasks and functions –Writing test bench. **(9)**

ARCHITECTING SPEED AND TIMING ISSUES: High Throughput - Low Latency - Timing - Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, reorder Paths. CLOCKING AND METASTABILITY: Setup time, hold time–setup time hold time violations – critical path – calculation of maximum clock frequency – metastability - synchronizers- design examples. **(9)**

ARCHITECTING AREA AND POWER: Architecting Area - Rolling Up the Pipeline - Control-Based Logic Reuse – Resource Sharing - Impact of Reset on Area - Resources Without Reset, Resources Without Set, Resources Without Asynchronous Reset, Resetting RAM, Utilizing Set/Reset Flip-Flop Pins. Architecting Power -Clock Control, Clock Skew, Managing Skew, Input Control, Reducing the Voltage Supply, Dual-Edge Triggered Flip-Flops, Modifying Terminations. **(9)**

EMBEDDED SYSTEM DESIGN WITH FPGA: Processors-Interfaces- Zynq System-on-chip Development-IP based Design Hardware-Software Co-design for Zynq – Software Development Tools - Real-time Applications. **(9)**

Total L: 45 Periods

TEXTBOOKS:

1. Michael D. Ciletti, '*Advanced Digital Design with the Verilog HDL*'. Second Edition, Pearson, 2011.
2. Steve Kilts, '*Advanced FPGA Design Architecture, Implementation, and Optimization*'. 1st Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2007.

REFERENCES:

1. Crockett H. Louise, Ross A. Elliot, Martin A. Enderwitz, '*The Zynq Book Embedded Processing with the ARM Cortex-A9 ontheXilinxZynq-7000All All Programmable SoC*'. 1st Edition, Strathclyde Academic Media, 2014.
2. Charlet H. Roth, Lizy Kurian John, Byeong Kil Lee, '*Digital Systems Design using Verilog*'. Cengage Learning, 2016.
3. Zainalabedin Navabi, '*Verilog Digital System Design*'. 2nd Edition, McGraw-Hill Education, 2005.
4. Ming-BoLin,'*Digital System Designs and Practices: Using Verilog HDL and FPGAs*'. 1st Edition, Wiley, 2008.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe FPGA architectures, design flow, Verilog HDL concepts, and embedded system design methodologies.	**K2**
CO2	Implement FPGA-based digital systems using Verilog HDL and CAD development tools.	**K3**
CO3	Examine timing, metastability, area utilization, and power optimization in FPGA designs.	**K4**
CO4	Design and develop FPGA-based embedded solutions using Verilog HDL, IP cores, and real-time system concepts.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			2	1	2			1					2
	3	**3**	**2**	**1**	**2**			**1**					**3**

1 – low, 2 – medium, 3 - high

25EEP07 DIGITAL IMAGE PROCESSING
(Common to EEE and ICE)

3 0 0 3

DIGITAL IMAGE FUNDAMENTALS & IMAGE TRANSFORMS: Introduction – Elements of visual perception – Image Sensing and Acquisition – Image sampling and Quantization – Basic relationships between pixels -Image Transforms: DFT – properties –DWT – properties. **(9)**

IMAGE ENHANCEMENT: Intensity transformation functions – Histogram processing - Spatial filtering: Correlation and convolution – Smoothing filters – Sharpening filters, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement. **(9)**

IMAGE RESTORATION: Noise models – Restoration in the presence of noise only: spatial filtering – Linear, position-invariant degradation – estimating the degradation function – Inverse filtering – Wiener filtering. **(9)**

IMAGE SEGMENTATION: Point detection- line detection - Edge detection - Thresholding - Region based segmentation: Region growing by pixel aggregation - Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm. **(9)**

IMAGE COMPRESSION: Image compression model – Redundancy-Lossless compression – Run-length coding – Huffman coding – Lossy compression – predictive coding – JPEG standards of Image Compression. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Gonzalez R. C, Woods R. E, '*Digital Image Processing'*. 4th Edition, Pearson, New Delhi, 2018.
2. Jayaraman S, Esakkirajan S, Veerakumar T, '*Digital Image Processing*'. Tata McGraw Hill, New Delhi, 2015.

REFERENCES:

1. Jain A.K, '*Fundamentals of Digital Image Processing*'. Prentice Hall of India, New Delhi, 2019.
2. Sridhar S, '*Digital Image Processing*'. Oxford University Press, New Delhi, 2013.
3. William K Pratt, '*Digital Image Processing*'. 4th Edition, Wiley India, New Delhi, 2011.
4. Munesh Chandra Trivedi, *'Digital Image Processing*'. 1st Edition, Khanna Publishing, New Delhi, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamental concepts of digital image processing.	**K2**
CO2	Apply the knowledge of image enhancement, image restoration and image segmentation techniques for both grayscale and color images.	**K3**
CO3	Analyze the performance of different image processing techniques	**K4**
CO4	Simulate the basic concepts of image processing techniques using MATLAB.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4					1								
	3	**2**			**1**								

1 – low, 2 – medium, 3 – high

25EEP08 AUTOMOTIVE ELECTRONICS

3 0 0 3

INTRODUCTION: Current Trends in Modern Automobiles – Drive-by-Wire Systems – Vehicle Functional Domains. Evolution of Vehicle E/E Architectures – Distributed, Domain and Zonal Architectures. Introduction to Software Defined Vehicles (SDVs). Overview of Electronic Control Units (ECUs) and AUTOSAR Software Architecture. **(9)**

AUTOMOBILE ELECTRICALS AND ELECTRONICS: Basic Electrical Components in an Automobile – Battery, Fuses and Relays. Starting and Charging Systems – Overview. High Voltage Architectures (400V/800V), DC-DC Converters and Smart Fuses (e-Fuses). Vehicle Instrumentation Systems – Instrument Cluster, Warning and Display Systems. **(9)**

AUTOMOTIVE EMBEDDED AND POWERTRAIN SYSTEMS: Architecture of Automotive Embedded Systems. Powertrain Control Systems – Engine Management Systems (Overview), Battery Management Systems (BMS) and Electric Powertrain Architecture. Body, Infotainment and Connected Vehicle Systems. Environmental Legislation and Emission Standards – Euro and Bharat Standards. **(9)**

ELECTRONIC CONTROL UNITS AND VEHICLE SAFETY SYSTEMS: Electronic Control Units (ECUs) – Architecture and Functions. Vehicle Safety Systems – Anti-lock Braking System (ABS), Airbag System and Electronic Stability Control (ESC). Advanced Driver Assistance Systems (ADAS) – Overview and Applications. Introduction to Functional Safety (ISO 26262). **(9)**

DIAGNOSTICS AND AUTOMOTIVE NETWORKING PROTOCOLS: Introduction to Diagnostics – Diagnostics Theory – On-board and Off-board Diagnostics – Introduction to Unified Diagnostic Services (UDS). Automotive Communication Networks: CAN, CAN-FD, LIN and Automotive Ethernet – Overview and Protocols. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Tom Denton, '*Automobile Electrical and Electronics systems*'. Routledge Taylor & Francis Group, London & New York, 2002.
2. Nicolas Navet and Francoise Simonot-Lion, '*Automotive Embedded Systems Handbook'*. CRC Press, USA, 2013.

REFERENCES

1. Michel Parent & Furnio Harshima, Ljubo vlacic, '*Intelligent Vehicle Technologies: Theory and Applications*'. 1st Edition, Butterworth-Heinemann publications, New Delhi, 2001.
2. Ronald K. J, '*Automotive Electronics Handbook*'. 2nd Edition, McGraw Hill Publications, Columbus, 2009.
3. Norman P. Mansour, William Ribbens, '*Understanding of Automotive Electronics'*. 5th Edition, Butterworth-Heinemann, United Kingdom, 2014.
4. Robert Bosch, '*Automotive Electrics Automotive Electronics*'. 5th Edition, Springer, Germany, 2010

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the functions of electrical and electronic components used in automobiles and uses of diagnostics procedure for automobile applications	**K2**
CO2	Apply diagnostic techniques and automotive networking protocols for vehicle communication and fault analysis.	**K3**
CO3	Analyze the structure and function of electronic control units in powertrain, chassis and body subsystems of automobile	**K4**
CO4	Develop an embedded control system for effectively controlling the power train sub-system of electric vehicle under various input drive cycle sources using MATLAB tools	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			2		2								2
	3	**2**	**2**		**2**								**2**

1 – low, 2 – medium, 3 – high

25EEP09 MODELING AND SIMULATION OF POWER CONVERTERS

3 0 0 3

MODELING OF POWER ELECTRONIC CONVERTERS: Requirements of Modeling and Control of Power Electronic Converters - Types of model - State Space Averaging - Circuit Averaging and Averaged Switch Modeling – State space modelling – transfer function from state space model-Converter Transfer Functions for Buck - Boost and Buck-Boost Topologies. **(9)**

LINEAR CONTROL APPROACHES FOR DC-DC POWER CONVERTERS: General Control Principles Control Goals and Control Issues of Power Electronic Converters - Indirect Output Control: Two-Loop Cascaded Control Structure for DC-DC Converters. **(9)**

LINEAR CONTROL APPROACHES FOR DC-AC AND AC-DC POWER CONVERTERS: Control issues in DC-AC and AC-DC conversion - Control in Rotating dq Frame - Resonant Controllers: Necessity of Resonant Control - Proportional Resonant Control. **(9)**

LINEAR CONTROL APPROACHES FOR AC-AC POWER CONVERTERS: Overview of AC-AC converter types and applications-Modelling and Simulation of different AC to AC converters with R, R-L and R-L-E Load-high-frequency PWM control techniques. **(9)**

NONLINEAR CONTROL: Need for Nonlinear control - Lyapunov Approach - Overview of Nonlinear Control Methods for Power Electronic Converters. Basic sliding mode control theory- PWM-based sliding mode control schemes for DC/DC power converters: PWM-based Sliding Mode Voltage and Current Control. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Farret, Felix A, Simoes, M.Godoy, '*Control of Power Electronic Converters and Systems*'. Vol. 3, Academic Press, 2018.
2. Miguel Castilla, '*Control Circuits in Power Electronics-Practical Issues in Design and Implementation*'. Institution of Engineering and Technology, 2016.
3. Seddik Bacha, Iulian Munteanu, Antonetaluliana Bratchu, '*Power Electronic Converters Modeling and Control with Case Studies*'. Springer London 2014.

REFERENCES

1. ByungchoChoi, '*Pulsewidth Modulated DC-to-DC Power Conversion Circuits, Dynamics, and Control Designs*'. IEEE Press, John Wiley & Sons. Inc, 2013.
2. TeuvoSuntio, TuomasMesso, JoonasPuukko, '*Power Electronic Converters Dynamics and Control in Conventional and Renewable Energy Applications*'. Wiley, 2017.
3. M.H.Rashid, '*SPICE for circuits and Electronics using PSPICE*'. Prentice Hall,2011

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the modeling principles and linear and nonlinear control strategies applicable to power electronic converters topologies.	**K2**
CO2	Apply appropriate modeling techniques and control strategies to evaluate the performance of power electronic converters under different operating conditions.	**K3**
CO3	Analyze the dynamic behavior and control performance of power electronic converters by comparing different modeling approaches and control techniques under varying load and operating conditions.	**K4**
CO4	Develop control strategies for power electronic converters by utilizing modeling techniques, configuring control loops, and integrating nonlinear control schemes to optimize system performance and stability in real-world applications.	**K5**

COs-POs & PSOs MAPPING

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

1 – low, 2 – medium, 3 – high

25EEP10 SWITCHED MODE POWER CONVERSION

3 0 0 3

INTRODUCTION TO SWITCH MODE POWER CONVERTERS: Switch Mode Power Conversion, SMPS requirements - Cuk converters – and their principles of operation; continuous and discontinuous modes of operation. **(9)**

THYRISTOR COMMUTATION TECHNIQUES: Review of recent developments in power devices for switch mode power supplies. Selection of devices, Commutation: Load Commutation, Resonant Pulse Commutation, Complementary Commutation, Impulse Commutation, External Pulse Commutation. **(9)**

TRANSFORMER-ISOLATED CONVERTERS: Single-switch and multi-switch transformer-isolated DC-DC converters. Flyback and forward converters; transformer isolated half-bridge, full- bridge converters. Push-pull converters. Voltage fed and current-fed converters. **(9)**

MAGNETIC COMPONENT DESIGN: Magnetic core materials and performance; basic inductor and transformer design; practical magnetic design; design aspects to be considered for designing transformers for specific applications – flyback, push-pull converters. **(9)**

SWITCHING REGULATOR CONTROL: Soft-Switched DC-DC Power Converters Small-signal models for switching regulators. Performance analysis and design of closed-loop systems under different control methods, and operating modes. Measurement of small signal transfer functions. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. N Mohan, T M Undeland and W P Robbins, '*Power Electronics: Converters, Applications and Design*'. Wiley, 3rd Edition,2007.
2. Abraham Pressman, Keith Billings, Taylor Morey, '*Switching Power Supply Design*'. McGraw-Hill, 3rd Edition, 2009.

REFERENCES:

1. K. Kit Sum, *'Switch Mode Power Conversion: Basic Theory and Design*'. 1st Edition, Kindle Edition,2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the operating principles and components of switched mode power converters and power supplies.	**K2**
CO2	Apply SMPS design principles to select suitable converter topologies, devices, and control techniques.	**K3**
CO3	Analyze the performance of switched mode power converters under various operating conditions.	**K4**
CO4	Design switched mode power supply systems, including magnetic components and control strategies.	**-**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		3											
CO4			1	1	1						1	1	
	3	**3**	**1**	**1**	**1**						**1**	**1**	

1 – low, 2 – medium, 3 - high

25EEP11 CONTROL OF POWER ELECTRONIC CIRCUITS

3 0 0 3

CONTROL SYSTEMS SIMULATION: 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. **(9)**

SYMBOLIC CALCULATIONS: 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. **(9)**

SLIDING MODE CONTROL: Introduction to non-linear control, Sliding-Mode Control- Basics of Sliding-Mode Theory- Application of Sliding-Mode Control to DC-DC Converters—Principle-Sliding mode control of buck converter. **(9)**

POWER FACTOR CORRECTION: 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. **(9)**

CONTROLLER DESIGN FOR PFC CIRCUITS: Power factor correction circuit using other SMPS topologies: Cuk and SEPIC converter – PFC circuits employing bridgeless topologies. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Dean Frederick and Joe Chow, '*Feedback Control problems using MATLAB and the Control system tool box*'.
   1st Edition, Cengage Learning. 2000.
2. Ned Mohan,*'Power Electronics: A First Course*'. Johnwiley, 1st Edition, 2013.
3. Marian K. Kazimierczuk and Agasthya Ayachit,'*Laboratory Manual for Pulse-Width Modulated DC-DC Power Converters'*. Wiley, 1st Edition. 2016.
4. S.K.Varenina, '*Power Electronics Handbook*'. Industrial Electronics series, CRC press, 1st Edition, 2002.

REFERENCES:

1. Slew-Chong Tan, Yuk Ming Lai Chi-Kong Tse, '*Sliding mode control for Switching Power Converters, Techniques and Implementation*'. 1st Edition, CRC Press, 2018.
2. Andre Kislovski, '*Dynamic Analysis of Switching-Mode DC/DC Converters*'. Springer 1991.
3. Lopez Cesar, '*MATLAB Symbolic Algebra and Calculus Tools*'. Apress, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of control system simulation, transfer functions, Bode plots, power factor correction, sliding mode control and symbolic computation techniques used in power electronic systems.	**K2**
CO2	Apply symbolic calculations and matrix operations to derive and manipulate transfer functions and control equations for power electronic circuits.	**K3**
CO3	Analyze the operation and control of power converters using sliding mode control and power factor correction techniques.	**K4**
CO4	Design and simulate sliding mode controllers for buck converters and power factor correction circuits using conventional and bridgeless topologies.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		3		2	2							3	
CO4			1	1	1						1	1	
	3	**3**	**1**	**2**	**2**						**1**	**3**	

1 – low, 2 – medium, 3 - high

25EEP12 SPECIAL ELECTRICAL MACHINES

3 0 0 3

STEPPER MOTORS: Types - Constructional features - principle of operation - variable reluctance motor - Single and Multi-stack configurations - Permanent Magnet Stepper motor - Hybrid stepper motor - Different modes of Excitation - theory of torque predictions - Speed-Torque Characteristics - Drive systems and circuit for open-loop and closed-loop control of stepper motor - NEMA Frame size - Selection of Stepper motor. **(9)**

SWITCHED RELUCTANCE MOTORS: Constructional features and configurations - principle of operation - Inductance Profile - Torque Equation - Power Converters for SR Motor - Rotor Sensing Mechanism – Sensor less Control of SR motor – Applications. **(9)**

PERMANENT MAGNET MOTORS: Types - PMDC - BLDC - PMSM - Construction - Principle of operation - EMF and torque equations - Torque speed characteristics - Magnetic circuit analysis - BH curve - Magnet - Lamination - Power controllers - Applications. **(9)**

SYNCHRONOUS RELUCTANCE MOTORS (SYNRM): Construction - Principle of operation - Rotor Configurations - Phasor diagram and torque equation - Control system for SynRM Drive - Applications of SynRM. **(9)**

LINEAR AND SERVO MOTORS: Linear Induction Motor (LIM) classification - construction - Principle of operation - DC Linear Motor (DCLM) types - control applications - Linear Synchronous Motor (LSM) - Types and Applications. Servomotor - Types - Constructional features, principle of operation - Servo Drives. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1.T. Kenjo , '*Stepping Motors and their Microprocessor Controls*'. Clarendon Press, London, 2003.
2. K. Venkataratnam, '*Special Electrical Machines*'. University Press, India, 2009.

REFERENCES:

1. Berker Biglin, James Weisheng Jiang, Ali Emadi, '*Switched reluctance Motor drives: Fundamentals to Applications*'. CRC Press, New York, 2019.
2. Ion Boldea, Lucian Tutelea, '*Reluctance Electric machines: design and control*'. CRC Press, New York, 2019.
3. J. R. Hendershot, T. J. E. Miller, '*Design of Brushless Permanent -magnet Machines*'. Motor Design Books, 2010.
4. T. J. E. Miller, '*Brushless Permanent Magnet and Reluctance Motor Drives*'. Clarendon Press, Oxford, New Delhi, 1989.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the construction, working, types, torque equation and characteristics of special electrical machines along with its drive circuits.	**K2**
CO2	Apply the knowledge of Electro dynamics to determine performance parameters of special electrical machines.	**K3**
CO3	Analyse the performance of special electrical machines and choose a machine for a given application.	**K4**
C04	Simulate the working of special electrical machines using software tools such as MATLAB/Simulink.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		1										1	
CO4				1	1						1	1	
	3	**1**		**1**	**1**						**1**	**3**	

1 – low, 2 – medium, 3 - high

25EEP13 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

3 0 0 3

INTRODUCTION TO RENEWABLE ENERGY SYSTEMS: 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. **(9)**

ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS): Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG). **(9)**

POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS: Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. 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. **(9)**

POWER CONVERTERS FOR WIND SYSTEMS: Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter. **(9)**

HYBRID RENEWABLE ENERGY SYSTEMS: Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind- PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT). **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. S. N. Bhadra, D. Kastha, & S. Banerjee, '*Wind Electrical Systems*'. Oxford University Press, 7th impression, 2009.
2. Rai. G.D, '*Non-conventional energy sources'*. Khanna publishers, 6th Edition, 2017.
3. Rashid. M. H, '*Power electronics Hand book*'. Academic press, 4th 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, 3rd Edition, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the construction, working, types, characteristics of renewable energy systems along with power electronic converters associated with it.	**K2**
CO2	Apply the knowledge of Electro dynamics and power electronics to determine performance parameters of renewable energy system.	**K3**
CO3	Analyse the performance of renewable energy system and choose a combination of renewable energy system for a given application.	**K4**
CO4	Simulate the working of renewable energy system with power converters using software tools such as MATLAB/Simulink.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	
CO3		3				1						1	
CO4				1		1					1	1	
	3	**3**		**1**		**1**					**1**	**1**	

1 – low, 2 – medium, 3 – high

25EEP14 MULTILEVEL POWER CONVERTERS

3 0 0 3

MULTILEVEL TOPOLOGIES INTRODUCTION: Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology. **(9)**

DIODE CLAMPED MULTILEVEL CONVERTER: Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters. **(9)**

FLYING CAPACITOR MULTILEVEL CONVERTER: Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC. **(9)**

CASCADED H-BRIDGE MULTILEVEL INVERTERS: Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H- ridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation. **(9)**

MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNTS: Multilevel inverter with reduced switch count - structures, working principles and pulse generation methods. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Rashid M. H, 'P*ower Electronics Circuits, Devices and Applications*'. Prentice Hall India, Third Edition, New Delhi, Pearson 4th edition, 2014.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla, '*Multilevel Converters for Industrial Applications*'. CRC Press, 1st Edition, 2017.
3. BinWu, Mehdi Narimani, '*High Power Converters and AC drives*'. IEEE press, 2nd Edition, 2017.

REFERENCES:

1. Thomas A. Lipo, '*Pulse Width Modulation for Power Converters: Principles and Practice, D. Grahame Holmes, John Wiley & Sons'*. 1st Edition, 2003.
2. Fang Lin Luo, Hong Ye, *'Advanced DC/AC Inverters: Applications in Renewable Energy'*. CRC Press, 1st Edition, 2017.
3. Hani Vahedi, Mohamed Trabelsi, *'Single-DC-Source Multilevel Inverters'*. Springer, 1st Edition, 2019.
4. Ersan Kabalcı, *'Multilevel Inverters Introduction and Emergent Topologies'*. Academic Press Inc, 1st Edition, 2021.
5. Iftekhar Maswood, Dehghani Tafti, *'Advanced Multilevel Converters and Applications in Grid Integration'*. Wiley, 1st Edition, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of Pulse Width Modulation (PWM) control techniques and working of different multilevel converter topologies.	**K2**
CO2	Apply the generalized structure of a multilevel converter to develop different multilevel converter topologies along with the control techniques.	**K3**
CO3	Examine the output voltage, current ripples and THD of different MLPC topologies with various load conditions.	**K4**
CO4	Design and experiment various multilevel power converters for a three-phase system	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										1	1	
CO3		3									1	1	
CO4			2	2	2			1	1	1	1	1	
	3	**3**	**2**	**2**	**2**			**1**	**1**	**1**	**1**	**1**	

1 – low, 2 – medium, 3 – high

25EEP15 DYNAMIC MODELLING, ANALYSIS AND DESIGN OF DRIVES

3 0 0 3

DYNAMIC MODELLING OF ELECTROMECHANICAL DRIVE SYSTEMS: Review of electromechanical energy conversion – Dynamic equations of electrical drives – Mechanical system modelling – Load modelling (constant torque, fan, pump and traction loads) – Coupled electromechanical system modelling – Per unit representation – Linearization of nonlinear drive systems – Small signal modelling – State-space representation of drive systems. **(9)**

DYNAMIC ANALYSIS OF DC AND AC DRIVES: Dynamic modelling of separately excited DC motor – Eigenvalue and transient response analysis – Dynamic model of induction motor using dq reference frame – Dynamic model of synchronous machine and PMSM – Numerical solution of drive equations – Dynamic performance during starting, braking and load disturbances – Comparative dynamic characteristics. **(9)**

CONTROL SYSTEM DESIGN FOR ELECTRIC DRIVES: Control objectives and performance indices – Cascaded current, speed and position control loops – PI and PID controller design – Controller tuning techniques – Feed-forward and decoupling control – State feedback control – Observer-based control – Disturbance rejection – Stability analysis using root locus and frequency response. **(9)**

ADVANCED CONTROL AND DIGITAL IMPLEMENTATION: Discrete-time modelling of drive systems – Digital controller implementation – Space vector based control implementation concepts – Model Predictive Control (MPC): introduction – Sliding Mode Control: fundamentals – Adaptive control concepts – State observers and speed estimation – Real-time implementation issues – DSP and FPGA based drive controllers. **(9)**

DRIVE PERFORMANCE ANALYSIS USING SIMULATION TOOLS: Mechanical dynamics of drive systems – Equivalent inertia referred to motor shaft – Flexible shaft dynamics – Resonance and torsional oscillations – Steady-state and transient stability – Dynamic response under step, ramp and cyclic loading – Performance evaluation using MATLAB/Simulink or equivalent simulation platform – Parameter sensitivity analysis – Design case studies of electric vehicle, renewable energy systems and industrial drive systems. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. R. Krishnan, '*Electric Motor Drives: Modeling, Analysis and Control'*. Prentice Hall, New Delhi, 2001.
2. Bimal K. Bose, '*Modern Power Electronics and AC Drives'*. Pearson Education, India, 2002.
3. Ned Mohan and Siddharth Raju, *'Analysis and Control of Electric Drives: Simulations and Laboratory Implementation'*. John Wiley & Sons, Hoboken, NJ, 2021.

REFERENCES:

1. Juha Pyrhönen, Valeria Hrabovcova and R. Scott Semken, *'Electrical Machine Drives Control: An Introduction'*. John Wiley & Sons, United Kingdom, 2016.
2. Peter Vas, *'Vector Control of AC Machines'*. Oxford University Press, Oxford, 1990.
3. Ramu Krishnan, *'Permanent Magnet Synchronous and Brushless DC Motor Drives'*. CRC Press, Boca Raton, Florida, 2017.
4. Leonhard, W., *'Control of Electrical Drives'*. Springer-Verlag, Berlin, 2001.
5. Bimal K. Bose, *'Power Electronics and Motor Drives: Advances and Trends'*. Academic Press (Elsevier), Burlington, MA, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the dynamic modelling principles and state-space representation of electromechanical drive systems.	**K2**
CO2	Apply dynamic modelling and control techniques to improve the transient and steady-state performance of DC and AC electric drive systems.	**K3**
CO3	Analyze the dynamic performance and stability of electric drive systems using simulation tools under various operating conditions.	**K4**
CO4	Design and develop electric drive systems using suitable converters, control methods, and feedback techniques for industrial applications.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				1								2
CO3		2			1								2
CO4			2		2						2		2
	2	**2**	**2**		**2**						**2**		**2**

1 – low, 2 – medium, 3 – high

25EEP16 EMBEDDED CONTROL OF ELECTRIC DRIVES

3 0 0 3

INTRODUCTION TO ELECTRICAL DRIVES: Electric drives and classifications – Four quadrant operation – Load torque characteristics – Dynamics of motor-load systems – Solid state control of electric drives – Introduction to IoT and AI applications in electric drives. **(9)**

EMBEDDED PROCESSORS FOR DRIVE APPLICATIONS: Embedded system architecture – ARM processor overview – Timers, ADC and PWM modules – Basics of RTOS – Sensor and gate driver interfacing – Embedded programming for motor control applications. **(9)**

I**NDUCTION MOTOR CONTROL:** Speed control methods of induction motor – VSI fed induction motor drive – PWM techniques for induction motor control – Closed loop speed control – Embedded implementation of induction motor control – Introduction to fuzzy logic-based induction motor control. **(9)**

BLDC MOTOR CONTROL: Overview of BLDC motor – Speed control methods – PWM techniques for BLDC motor control – ARM/microcontroller-based BLDC motor control – Sensor interfacing and commutation techniques – Introduction to intelligent control methods for BLDC motor drives. **(9)**

SRM MOTOR CONTROL: Overview of SRM motor – Speed control methods – PWM techniques for SRM drives – Embedded implementation of SRM motor control – Sensor-less control concepts – Introduction to machine learning applications in SRM drives. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. R.Krishnan, '*Electric Motor Drives – Modeling, Analysis and Control'*. Prentice-Hall of India Pvt. Ltd., New Delhi, 1st Edition, 2010.
2. Steve Kilts, '*Advanced FPGA Design: Architecture, Implementation, and Optimization'*. Willey, 1st Edition, 2007.
3. Vedam Subramanyam, '*Electric Drives – Concepts and Applications'*. Tata McGraw- Hill publishing company Ltd., New Delhi, 2nd Edition, 2002.

REFERENCES:

1. K. Venkataratnam, '*Special Electrical Machines'*. Universities Press, 1st Edition, 2014.
2. Steve Furber, '*ARM system on chip architecture'*. Addision Wesley, 2nd Edition 2015.
3. Ron Sass and Andrew G. Schmidt, '*Embedded System design with platform FPGAs: Principles and Practices*'. Elsevier, 1st Edition, 2010.
4. Tim Wescott, *'Applied Control Theory for Embedded Systems'.* Elsevier, 1st Edition, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of electric drives, embedded motor control systems, and different motor types (Induction, BLDC, SRM) along with their control techniques.	**K2**
CO2	Apply control methods, PWM techniques, and embedded system concepts to design basic motor drive systems for real-world applications.	**K3**
CO3	Analyze the performance of different motor drives and control strategies, including intelligent techniques, for efficiency, speed control, and application suitability.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	2
CO3		2			2							2	2
	3	**2**			**2**							**2**	**2**

1 – low, 2 – medium, 3 - high

25EEP17 ELECTRIC VEHICLE ARCHITECTURE

3 0 0 3

VEHICLE ARCHITECTURE and SIZING: Electric Vehicle History, and Evolution of Electric Vehicles – Basic block diagram of Electric vehicle -Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike – Motorcycle - Electric Cars and Heavy Duty EVs. - Details and Specifications. **(9)**

VEHICLE MECHANICS: Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design. **(9)**

POWER COMPONENTS AND BRAKES: Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example. **(9)**

HYBRID VEHICLE CONTROL STRATEGY: Homogeneous Vehicle supervisory control, Mode selection strategy and its Control strategies. **(9)**

PLUG-IN HYBRID ELECTRIC VEHICLE: Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, '*Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*'. CRC Press, 2004.
2. Mark Warner, '*The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles*'. HP Books, 2011.

REFERENCES

1. Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, '*Heavy-duty Electric Vehicles from Concept to Reality*'. Elsevier Science, 2021
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, *'Electric Vehicles Modern Technologies and Trends'*. Springer. 2020.
3. Rogelio Leon, Christian Montaleza, Jose Luis Maldonado, Marcos Tostado-Veliz and Francisco Jurado, Thermo, '*Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles*'. 2021.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the architecture, mechanics and components of electric and hybrid vehicles.	**K2**
CO2	Apply vehicle mechanics, to size components and implement control strategies for different configurations	**K3**
CO3	Analyse vehicle control strategies for different modes	**K4**
CO4	Model and simulate electric and hybrid vehicle for various scenarios	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		2										2	
CO4				2	2						2	2	
	3	**2**		**2**	**2**						**2**	**2**	

1 – low, 2 – medium, 3 – high

25EEP18 DESIGN OF MOTORS AND CONVERTERS FOR ELECTRIC VEHICLE

3 0 0 3

ELECTRIC VEHICLE DYNAMICS: Standard drive cycles-Dynamics of Electric Vehicles-Tractive Force-Maximum speed, torque, power, energy requirements of EVs. **(9)**

MOTORS FOR ELECTRIC VEHICLES: Introduction – Speed and Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs. **(9)**

BASICS OF SIMULATION IN CONTROL SYSTEMS: 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. **(9)**

MODELING OF DC-DC CONVERTERS: 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. **(9)**

POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS: 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. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, '*Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control*'. CRC Press, 1st Edition. 2021
2. Iqbal Hussain, '*Electric and Hybrid Vehicles: Design Fundamentals, Second Edition*'. CRC Press, Taylor & Francis Group, 3rd Edition 2021.

REFERENCES:

1. Teuvo Suntio, Tuomas Messo, Joonas Puukko, '*Power Electronic Converters*'. Wiley-VCH Verlag GmbH & Co. 1st Edition 2017.
2. Randall Shaffer, '*Fundamentals of Power Electronics with MATLAB*'. Lakshmi publications,2nd Edition, 2013,
3. Dean Frederick and Joe Cho, '*Feedback Control problems using MATLAB and the Control system tool box*'. Cengage learning, 1st Edition, 2000.
4. Ali Emadi, '*Handbook of Automotive Power Electronics and Motor Drives*'. Taylor & Francis,1st Edition, 2005,
5. Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, *'Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK'*. Wiley,1st Edition, 2021.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the motor characteristics and control of drives used in the Electric Vehicle.	**K2**
CO2	Apply Electric Vehicle dynamics to develop transfer function from state space models of power converters and electric motors of electric vehicles and compute its performance parameters.	**K3**
CO3	Analyse the performance of an electric vehicle, and select electric motors, power converters based on power rating, torque, speed, characteristics and efficiency.	**K4**
CO4	Design of motors, power converters and control of electric vehicle for a given application.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	1
CO3		2										1	1
CO4			2		2						2	1	1
	2	**2**	**2**		**2**						**2**	**1**	**1**

1 – low, 2 – medium, 3 - high

25EEP19 INTELLIGENT CONTROL OF ELECTRIC VEHICLES

3 0 0 3

MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR: BLDC Motor Construction – Drive Circuits -. Modelling BLDC motor at different fidelities. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching - Commutation Transients. **(9)**

SPEED CONTROL FOR ELECTRIC DRIVES: Introduction -PID Control Principle, Anti windup Controller. Vector Control applied to BLDC motor-.RBF Neural network-based Speed Control of BLDC Motor – Sensorless Control of BLDC motor – Back EMF Method. **(9)**

FUZZY LOGIC: Classical sets vs fuzzy set – Fuzzy set– Types of Membership Functions – Membership Value Assignment methods – Features of Membership functions – Forms of membership functions- – Fuzzy set Operations- Fuzzy rule-based system – Mamdani and TSK model – Implication and Aggregation of Fuzzy rules - Defuzzification Methods- Fuzzy Inference System – Fuzzy PI based hybrid Speed Control. **(9)**

FPGA AND VHDL BASICS: Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics – CAD System –VHDL Language Modelling Features – Data Types – Operators – Statements – Programs – Arithmetic operations – PWM Generation – Speed Detection. **(9)**

REAL TIME IMPLEMENTATION: Microcontroller/FPGA based Open/Closed loop BLDC Motor Control System – Three phase Inverter design – MOSFET Driver Circuit - Rotor Position Sensor Circuit. **(9)**

Total L: 45 Periods

TEXT BOOK

1. Chang-liang Xia, '*Permanent Magnet Brushless DC Motor Drives and Controls'*. Wiley,1st Edition, 2012.
2. Jayaram Bhasker A, '*VHDL Primer*'. Prentice Hall, 3rd Edition, 2015.
3. Timothy J. Ross '*Fuzzy Logic with Engineering Applications*'. Wiley - 4th Edition, 2017.

REFERENCES

1. John G. Hayes, G. Abas Goodarzi, '*Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles*'. Wiley 1st Edition, 2018.
2. Iqbal Hussain, '*Electric and Hybrid Vehicles: Design Fundamentals*'. Third Edition, CRC Press, Taylor & Francis Group, 1st Edition, 2021.
3. M. N. Cirstea, A. Dinu, J. G. Khor,M. McCormick, '*Neural and Fuzzy Logic Control of Drives and Power Systems*'. Newnes publications, 1st Edition, 2002.
4. Wei Liu, '*Hybrid Electric Vehicle System Modelling and Control*'. General Motors, USA, John Wiley & Sons, Inc., 2017.

COURSE OUTCOMES

At the end of the course, students will be able to		**Bloom's Level**
CO1	Explain the characteristics, speed control techniques, fuzzy inference systems, VHDL programming concepts, and hardware implementation of BLDC motor control systems.	**K2**
CO2	Develop the mathematical model of a BLDC motor drive using differential equations, transfer function representation, and state-space analysis.	**K3**
CO3	Analyze the performance of BLDC motor speed and torque control using intelligent control algorithms.	**K4**
CO4	Develop FPGA based open-loop and closed-loop BLDC motor control systems incorporating intelligent speed control techniques.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	3
CO3		2			2							1	2
CO4			2		2							1	2
	3	**2**	**2**		**2**							**1**	**3**

1 – low, 2 – medium, 3 - high

25EEP20 BATTERY MANAGEMENT SYSTEM

3 0 0 3

BATTERIES: Battery parameters- Cell and Battery Voltages, Charge (or Amp hour) Capacity, Energy Stored, Specific Energy, Energy Density, Specific Power, Energy Efficiency, Self-discharge Rates, Battery Geometry, Battery Temperature, Heating and Cooling Needs - Battery Life and Number of Deep Cycles - Approximate Battery Sizing, Battery Pack- design, sizing, calculations, flow chart, real and simulation Model - Functions of BMS**.** **(9)**

BMS DESIGN REQUIREMENTS: BMS protection functions - System integration - Interfacing with system components - State of Charge (SOC) estimation - State of Health (SOH) estimation - Energy and power computation (cell & pack level)-BMS diagnostics -Design requirements - Functional role of BMS in battery systems. **(9)**

SOC PREDICTION: Battery State of Charge Estimation – Types of SoC Prediction – Model-Based Methods: Coulomb Counting (Ah Counting) - Open Circuit Voltage (OCV) Method- Electrochemical Models- Equivalent Circuit Models (ECM) - Data-Driven Methods: Neural Networks (e.g., ANN, CNN, RNN, LSTM) - Support Vector Machines (SVM)- Kalman Filtering (EKF, UKF, etc.) - Gaussian Process Regression (GPR)- Hybrid Methods - Need – Application – software packages. **(9)**

SOH PREDICTION: Battery State of Health Estimation – Types of SoH Prediction – Model based methods: Capacity Fade Models- Electrochemical Models- Equivalent Circuit Models (ECM) - Impedance-Based Methods (EIS) - Data-Driven Methods: Neural Networks - Support Vector Regression- Gradient Boosting - Gaussian Process Regression (GPR) - Prognostics Based Methods - Hybrid Methods Need – Application – software packages. **(9)**

OTHER FUNCTIONS OF BMS: Cell balancing – types – passive and active cell balancing – IoT and cloud interface – Range prediction – protection – communication protocols - types of Faults – Losses. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Dell, Ronald M. Rand and A. J. David, '*Understanding Batteries*'. Royal Society of Chemistry, 2001.
2. Davide Andrea, '*Battery Management Systems for Large Lithium-Ion Battery Packs*'. ARTECH House, 2010.

REFERENCES

1. Jiuchun Jiang and Caiping Zhang, '*Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles*'. Wiley, 2015.
2. D Kiehne H. A., '*Battery Technology Handbook*'. 2nd edition, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the concepts of battery parameters, SoC/SoH prediction, and BMS functionalities for energy storage systems.	**K2**
CO2	Apply battery and BMS design principles to size, simulate, and configure safe and efficient energy storage systems.	**K3**
CO3	Analyze battery performance and BMS diagnostics using model-based and data-driven SoC/SoH prediction techniques.	**K4**
CO4	Simulate and compute different SOC and SOH estimation methods of battery.	-

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3					1						2	2
CO3		3				1						2	2
CO4			1		1	1						2	2
	3	**3**	**1**		**1**	**1**						**2**	**2**

1 – low, 2 – medium, 3 - high

25EEP21 DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM

3 0 0 3

CHARGING STATIONS AND STANDARDS : Introduction - Types of Electric Vehicles - Charging technologies- Types of charging - AC charging - DC charging systems - Conductive charging, EV charging infrastructure - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, International standards, and regulations. **(9)**

POWER ELECTRONICS FOR EV CHARGING: Layouts of EV Battery Charging Systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - power factor correction in charging system- 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. – Isolated converters Vs Non-isolated converters for an electric vehicle application - Bidirectional DC–DC Converters – software packages. **(9)**

EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS: 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**. (9)**

WIRELESS POWER TRANSFER: Introduction - Inductive, Magnetic Resonance, Capacitive types – Design of Wireless Chargers for Electric Vehicles - Benefits of WPT. WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363. **(9)**

BATTERIES AND MANAGEMENT SYSTEM: Introduction to batteries - Construction and working – History and its types - Battery Technology in EVs - Charging Modes in EVs – Comparison of various battery chemistries - Role of battery management system in Electric vehicle. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Robert W. Erickson, '*Fundamentals of Power Electronics*'. 2nd Edition, 2000.
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, '*Electric Vehicles Modern Technologies and Trends*'. Springer Publisher 1st Edition, 2021.
3. Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, '*Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration*'. 1st Edition, IET 2021.

REFERENCES

1. Miao Wang Ran, Zhang Xuemin (Sherman) Shen, '*Mobile Electric Vehicles Online Charging and Discharging*'. Springer 2016, 1st Edition.
2. Alicia Trivino-Cabrera, Jose M. Gonzalez-Gonzalez, Jose A. Aguado, '*Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach'.* Springer Publisher 1st Edition, 2020.
3. James D Halderman, '*Electric and Hybrid Electric Vehicles*'. Pearson, 1st Edition, 2022.
4. Ali Emadi, '*Handbook of Automotive Power Electronics and Motor Drives'.* Taylor & Francis, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the EV charging technologies, power electronic converters, renewable energy integration, wireless power transfer, and power factor correction.	**K2**
CO2	Apply the working principles of power electronic converters and its topologies for charging systems and to integrate renewable energy sources for electric vehicles.	**K3**
CO3	Analyze different EV charger topologies and its control strategies for integrating renewable energy sources and storage systems.	**K4**
CO4	Develop the power converters, renewable energy-EV integration and wireless power transfer circuits using MATLAB-Simulink	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	1
CO3		2										1	1
CO4			1		1						1	1	1
	3	**3**	**1**		**1**						**1**	**1**	**1**

1 – low, 2 – medium, 3 - high

25EEP22 TESTING OF ELECTRIC VEHICLES

3 0 0 3

EV STANDARDIZATION: 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. **(9)**

TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES: 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. **(9)**

FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC: Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability- Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles. **(9)**

EMC IN ELECTRIC VEHICLES: 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**. (9)**

EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM: 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**. (9)**

Total L: 45 Periods

TEXT BOOKS

1. Ali Emadi, '*Handbook of Automotive Power Electronics and Motor Drives*'. Taylor & Francis, 1st Edition, 2005.
2. Kai Borgeest, '*EMC and Functional Safety of Automotive Electronics*'. 1st Edition, IET 2018.

REFERENCES

1. Li Zhai, '*Electromagnetic Compatibility of Electric Vehicle*'. 1st Edition, Springer 2021.
2. Druce Archam beault, colin branch, Omar M.Ramachi, '*EMI/EMC Computational Modeling Handbook*'. 2nd Edition, Springer 2012.
3. Mark Steffika, '*Automotive EMC*'. 1st Edition, Springer 2013.
4. Beate Müller, Gereon Meyer, '*Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative*'. 1st Edition, Springer 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the standardization process, functional safety considerations, and EMI/EMC challenges in electric vehicles (EVs).	**K2**
CO2	Apply test procedures to determine the performance of electric motors and Controllers in EVs and hybrid electric vehicles (HEVs).	**K3**
CO3	Analyse the safety lifecycle, along with EMI and EMC issues associated with EV systems.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											1	
CO3		3										1	
	3	**3**										**1**	

1 – low, 2 – medium, 3 - high

25EEP23 GRID INTEGRATION OF ELECTRIC VEHICLES

3 0 0 3

FUNDAMENTALS OF VEHICLE TO GRID (V2G) TECHNOLOGY: Electric Vehicles and the Environment - Fundamentals of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) – Interdisciplinary Nature of EVs – Challenges and Key Technologies of EVs – Challenges for EV Industry in India - History and Development of V2G - Incorporating V2G to the EV - Electricity Markets and V2G Suitability. **(9)**

BENEFITS OF V2G AND CHALLENGES: Benefits of V2G - Technical Benefits, Economic Benefits, Environment and Health Benefits and Other Benefits. Challenges to V2G - Technical Challenges, Economic and Business Challenges and Regulatory, Political Challenges and Legal Challenges. **(9)**

IMPACT OF V2G ON SMART GRID: 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. **(9)**

GRID INTEGRATION AND MANAGEMENT OF EVs: Introduction to 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. **(9)**

ADVANCEMENTS IN GRID INTEGRATED EV: Recent Electric vehicles, Design and control aspects of electric drives and chargers for EVs and HEVs, Battery Charger Topologies, and Infrastructure for Plug-In-Electric and Hybrid Vehicles – Impact of Plug-in Hybrid Electric Vehicles on smart Grid / Distribution Networks – Sizing Ultra-capacitors for Hybrid Electric Vehicles, concept of vehicle to Home (V2H), Effect of charging infrastructure on grid protection and control, Role of AMI/Smart Meters in EV Management. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Lance Noel, Gerardo Zarazua de Rubens, Johannes Kester, Benjamin K. Sovacool, '*Vehicle To Grid: A Socio-technical Transition Beyond Electric Mobility*'. Springer Nature, Switzerland AG, 1st Edition, 2019.
2. Junwei Lu and Jahangir Hossain, '*Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid*'. The Institution of Engineering and Technology, United Kingdom, 1st Edition, 2015.
3. N Kishor, & J Fraile-Ardanuy, '*ICT for Electric Vehicle Integration with the Smart Grid'.* The Institution of Engineering and Technology, United Kingdom, 1st Edition, 2020.

REFERENCES

1. James Larminie, John Lowry, '*Electric Vehicle Technology Explained'*. Wiley-Blackwell, 2nd Edition, 2012.
2. Sheldon S. Williamson, '*Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles'*. Springer, 1st Edition, 2016.
3. Ali Emadi, '*Advanced Electric Drive Vehicles*'. CRC Press, 1st Edition, 2017.
4. Sumedha Rajakaruna, Farhad Shahnia and Arindam Ghosh, '*Plug in Electric Vehicles in Smart Grids, Charging Strategies'*. Springer, 1st Edition, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the electricity market trends, challenges and effects of grid-integrated electric vehicle and grid suitability for V2G implementation	**K2**
CO2	Apply grid integration, communication, and energy management concepts to EV charging and V2G applications.	**K3**
CO3	Analyze the impact of V1G / V2G enabled electric vehicles on power networks, smart grids, and distributed energy management systems.	**K4**
CO4	Develop MATLAB model for analyzing the impact of V2G on the power quality of smart grid and renewable energy systems	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		2										2	
CO4			2		2	2	1	1				2	
	3	**2**	**2**		**2**	**2**	**1**	**1**				**2**	

1 – low, 2 – medium, 3 - high

25EEP24 ARTIFICIAL INTELLIGENCE FOR AUTONOMOUS VEHICLES

3 0 0 3

INTRODUCTION TO NEURAL NETWORK: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks. Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Adaption, Statistical Nature of the Learning Process. **(9)**

SINGLE LAYER PERCEPTRONS: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection. **(9)**

BACK PROPAGATION: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning. **(9)**

SELF-ORGANIZATION MAPS (SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification. **(9)**

NEURO DYNAMICS: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted Boltzmann machine. **(9)**

Total L: 45 Periods

TEXTBOOK

1. Cheng and H. He, '*Neural Networks for Autonomous Vehicles: Fundamentals and Applications'*. Cham, Switzerland: Springer, 2020.
2. S. Siddharth, '*Deep Learning for Autonomous Vehicles: Driving the Future*'. Birmingham UK. Packt Publishing, 2020.
3. B. Li and R. Shapovalov, '*Hands-On Machine Learning for Autonomous Vehicles: Develop and Implement Machine Learning Models for Self-Driving Cars using TensorFlow and Keras*'. Birmingham, UK: Packt Publishing, 2020.

REFERENCES

1. Maurer, J. C. Gerdes, B. Lenz, and H. Winner, Eds., '*Autonomous Driving: Technical, Legal and Social Aspects*'. Cham, Switzerland: Springer, 2016.
2. K. P. Murphy, '*Machine Learning: A Probabilistic Perspective*'. Cambridge, MA: MIT Press, 2012.
3. W. Ritter and C. Stiller, '*Artificial Intelligence for Autonomous Driving: How Neural Networks Enable Autonomous Vehicles'*. Cham, Switzerland: Springer, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the structure, components, and learning mechanisms of basic neural network models, including their relation to artificial intelligence.	**K2**
CO2	Apply learning algorithms to solve linear classification and filtering problems.	**K3**
CO3	Analyze the performance, convergence, and generalization characteristics of neural network learning models.	**K4**
CO4	Evaluate self-organizing maps, neuro-dynamical models, Hopfield networks, and restricted Boltzmann machines for autonomous system applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								3
CO3		2			2								2
CO4			1		1								1
	3	**2**	**1**		**2**								**3**

1 – low, 2 – medium, 3 – high

25EEP25 POWER SYSTEM OPERATION AND CONTROL

3 0 0 3

INTRODUCTION: Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation – real power vs frequency and reactive power vs voltage control loops - System load variation, load curves – Load forecasting – Computational methods in load forecasting – Load shedding and Islanding – deregulation - Basics of electrical energy tariff. **(9)**

REAL POWER FREQUENCY CONTROL: Basics of speed governing mechanisms and modelling – Speed regulation of two generators in parallel Load Frequency Control (LFC) of single area system – Static and dynamic analysis – LFC of two area system –Tie line modelling – Block diagram representation of two area system – Static and dynamic analysis – Tie line with frequency bias control – State variable model – Integration of economic dispatch control with LFC**.** **(9)**

REACTIVE POWER – VOLTAGE CONTROL: Generation and absorption of reactive power – Basics of reactive power control – Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop static and dynamic analysis – Stability compensation – Voltage drop in transmission line – Methods of reactive power injection – Tap changing transformer, SVC and STATCOM for voltage control. **(9)**

ECONOMIC OPERATION OF POWER SYSTEM: 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 – Special aspects of short term and long-term hydrothermal scheduling problems. **(9)**

COMPUTER AIDED CONTROL OF POWER SYSTEM: Need of computer control of power system – Concept of energy control centers and functions – PMU system monitoring, Data acquisition and controls – System hardware configurations – SCADA and EMS functions – State estimation – Measurements and errors – Weighted least square estimation – Various operating states – State transition diagram. **(9)**

Total L: 45 Periods

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, 4th Edition, 2018

REFERENCES:

1. Kothari D.P. and Nagrath I.J., '*Power System Engineering*'. Tata McGraw– Hill Education, 2nd 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, 5th Edition, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the structure and operation of power systems, including load dispatch centers, load characteristics, and the fundamentals of real power–frequency and reactive power–voltage control.	**K2**
CO2	Apply load frequency control and voltage control mechanisms to solve power system problems related to stability, regulation, and economic operation.	**K3**
CO3	Analyze the performance of single and multi-area power systems, including tie-line control and reactive power management under dynamic conditions.	**K4**
CO4	Evaluate computer-aided power system monitoring and control concepts, including SCADA, EMS, PMU, and state estimation for reliable system operation.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2										2	
CO4			1		1						1	1	
	3	**2**	**1**		**1**						**1**	**3**	

1 – low, 2 – medium, 3 - high

25EEP26 RENEWABLE ENERGY SYSTEMS

3 0 0 3

INTRODUCTION: Energy sources and their availability – Yield Energy ratio: Classification of Energy sources, Trends in energy consumption - Energy Scenario in India, Sector-wise Energy Consumption in India - potential for renewable energy - Need for Renewable Energy Sources. **(9)**

SOLAR ENERGY SYSTEMS: Introduction to solar radiation- Solar Thermal Systems: Principle and operation – Low, medium and high temperature systems. Solar Photovoltaic Systems: Solar cells and their characteristics - Influence of insolation and temperature - PV arrays – Maximum Power Point Tracking Algorithms – Grid Connected PV System - Concentrated Solar PV systems - Standalone PV system. **(9)**

WIND ENERGY SYSTEMS: Nature and Power in the wind - Wind Energy Conversion System (WECS) - Components and Classification of a WECS - Wind Turbines - Types - Horizontal and vertical axis wind turbines - Yaw and Pitch Control - Betz model - Generators for WECS - Types - Selection of Generators - Operation and Control of Grid-connected and Self-excited Induction Generator - Permanent Magnet Synchronous Generators - Schemes for Fixed and Variable Speed Wind Turbines. **(9)**

ENERGY STORAGE SYSTEMS : Fuel Cells - Principle and operation, Types - Alkaline, Direct Methanol, Molten Carbonate, SOFC, PEMFC - Efficiency - Effect of Polarization on Efficiency - Hydrogen Production and Storage: Reforming types - Solid state, Gas phase, Cryogenic Liquid phase hydrogen storage - Batteries for Renewable energy applications - Types - Lead acid and Lithium ion batteries - Sizing of Batteries – Ultra Capacitors - Superconducting Magnetic Energy Storage (SMES). **(9)**

MISCELLANEOUS ENERGY SOURCES: Energy from Ocean – Tidal Energy, Wave Energy, Ocean Thermal Energy Conversion Systems - Geo-thermal Energy Systems - Magneto Hydro Dynamic Systems – Energy from Biomass – Waste to Energy. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. B. H. Khan, '*Non-Conventional Energy Resources*'. 3rd Edition, Tata McGraw-Hill, New Delhi 2016.
2. Mukund R Patel,'*Wind and Solar Power Systems*'. CRC Press, New York, 2013.

REFERENCES:

1. C. S. Solanki, '*Solar Photovoltaic: Fundamentals, technologies & Applications*'. PHI Publishers, 2019.
2. ShobhNath Singh, '*Non-conventional Energy resources*'. Pearson Education, 2015.
3. Bhadra S. N, Banerjee. S, Kastha.D, '*Wind Electrical Systems*'. Oxford University Press, New Delhi, 2015
4. F. A. Farret, M. G. Simoes, '*Integration of Renewable Sources of Energy*'. Wiley, 2nd Edition, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principle, construction, working, types, usage, potential and applications of renewable energy systems.	**K2**
CO2	Apply engineering fundamentals to determine performance parameters of C.	**K3**
CO3	Analyze and compute the payback period of the given renewable energy installation.	**K4**
CO4	Design a renewable energy system for a residential home.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		1				1						1	
CO4			2		2	2						2	
	3	**1**	**2**		**2**	**2**						**3**	

1 – low, 2 – medium, 3 - high

25EEP27 SMART GRID

3 0 0 3

INTRODUCTION TO SMART GRID: Evolution of Electric Grid – Need for Smart Grid – Difference between conventional & smart grid – Overview of enabling technologies – International experience in Smart Grid deployment efforts – Smart Grid road map for India – Smart Grid Architecture. **(9)**

WIDE AREA MONITORING SYSTEM: Fundamentals of Synchro-phasor Technology – concept and benefits of Wide Area Monitoring System – Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC) – Road Map for Synchro-phasor applications (NAPSI) – Operational experience and Blackout analysis using PMU - Case study on PMU. **(9)**

SMART METERS: Features and functions of Smart Meters – Functional specification – category of Smart Meters – Automatic Meter Reading (AMR) and Advanced Metering Infrastructure (AMI) drivers and benefits – AMI protocol – Demand Side Integration: Peak load, Outage and Power Quality management. **(9)**

INFORMATION AND COMMUNICATION TECHNOLOGY: Overview of Smart Grid Communication system – Modulation and Demodulation Techniques: Radio Communication – Mobile Communication – Power Line Communication – Optical Fibre Communication – Communication Protocol for Smart Grid. **(9)**

SMART GRID APPLICATIONS AND CYBER SECURITY: Overview and concept of Renewable Integration – Introduction to distributed generation - Role of Protective Relaying in Smart Grid – House Area Network – Advanced Energy Storage Technology: Flow battery – Fuel cell – SMES – Super capacitors – Plug–in Hybrid electric Vehicles - Cyber Security: Security issues in DG, Distribution Automation, AMI, Electric Vehicle Management Systems – Approach to assessment of smart grid cyber security risks – Methodologies. Cyber Security requirements – Smart Grid Information Model. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. James Momoh, '*SMART GRID: Fundamentals of Design and Analysis*'. John Wiley and Sons, New York, 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, '*Smart Grid: Technology and Applications*'. John Wiley & Sons, New Jersey, 2012.
3. Anurag K. Srivastava, '*Cyber Infrastructure for the Smart Electric Grid'*. Springer, 2016.

REFERENCES

1. Power Grid Corporation of India Limited, '*Smart Grid Primer*'. 1st Edition, Power Grid Corporation of India Limited, Bangalore, India, 2013.
2. Fereidoon.P.Sioshansi, '*Smart Grid – Integrating Renewable, Distributed and Efficient Energy*'. 1st Edition, Academic Press, USA, 2011.
3. Stuart Borlase, '*Smart Grids: Infrastructure, Technology and Solutions*'. 1st Edition, CRC Press Publication, England, 2013.
4. Phadke A G, Thorp J S, '*Synchronized Phasor Measurements and Their Applications*'. 1st Edition, Springer, New York, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the wide-area monitoring and smart metering features of smart grid system embedded with Information and communication technology and cyber security issues in smart grid	**K2**
CO2	Apply smart grid technologies and communication systems in modern power system applications.	**K3**
CO3	Analyze various communication protocols, cyber security issues and risk assessment methodologies for ensuring the reliable operation of smart grid system	**K4**
CO4	Demonstrate the concept of demand side management for satisfying the energy balance in smart grid by suitably selecting the sensors and control algorithms	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3					1	1					3	
CO3		2			2	1	1					2	
CO4			1	1	1	1	1					1	
	3	**2**	**1**	**1**	**2**	**1**	**1**					**3**	

1 – low, 2 – medium, 3 – high

25EEP28 ENERGY MANAGEMENT AND AUDITING

3 0 0 3

INTRODUCTION: Basics of Energy – Need for energy management – Energy Conservation (Amendment) Act, 2010, and its features - Energy accounting - Energy monitoring, targeting, and reporting – Methodology of measurement and verification – Methodology for audit report writing. **(9)**

ENERGY MANAGEMENT FOR MOTORS AND COGENERATION: Energy management for electric motors – Rewinding and motor replacement issues - Energy saving opportunities with energy efficient motors - Transformer losses - Performance assessment of PF capacitors - automatic power factor controllers - Energy management by cogeneration – Cogeneration: classification and saving potentials. **(9)**

ENERGY MANAGEMENT IN COMPRESSED AIR SYSTEM AND LIGHTING SYSTEMS: Compressed Air System: Types of air compressors - Refrigeration System: Vapour compression and absorption refrigeration cycle - Saving opportunities in HVAC systems - Energy management in lighting systems – Task and the working space - Light sources – Ballasts – Lighting controls – Optimizing lighting energy – Energy audit for lighting systems. **(9)**

DEMAND SIDE MANAGEMENT: Basic concepts and objectives of Demand Side Management – Role of DSM in modern power systems - Load profiling and consumer behavior analysis - Importance of DSM in peak load reduction - DSM Techniques - Transmission and Distribution losses - Role of DSM in loss minimization and improving system efficiency - Utility monitoring and control systems. **(9)**

ECONOMIC ANALYSIS AND MODELS: Cost Analysis of Energy Projects - Life Cycle Cost Analysis - Time value of money - Economic Evaluation Techniques - Energy Costing and Tariff Analysis – HVAC and energy management – Economic justification. **(9)**

TOTAL L: 45 Periods

TEXT BOOKS

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, *'Guide to Energy Management*'. The Fairmont Press, Inc., 2006.
2. Eastop T.D & Croft D.R, *'Energy Efficiency for Engineers, and Technologists'.* Logman Scientific & Technical, ISBN-0-582-03184, 1990.

REFERENCES

1. Reay D.A, *'Industrial Energy Conservation'.* Pergamon Press, 1977.
2. *'IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities'.* IEEE, 196.
3. Amit K. Tyagi, *'Handbook on Energy Audits and Management'*. TERI, 2003.
4. *'Electricity in buildings good practice guide'.* McGraw-Hill Education, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of energy management, energy conservation policies, and audit methodologies.	**K2**
CO2	Apply energy management techniques to electrical systems such as motors, transformers, compressed air systems, lighting systems, and cogeneration to improve energy efficiency.	**K3**
CO3	Analyse demand side management strategies, load patterns, system losses, and energy performance in electrical and utility systems.	**K4**
CO4	Evaluate the economic feasibility of energy management solutions using economic models and cost analysis for load management.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		3				2	2						
CO4				2		2	2				2	2	
	3	**3**		**2**		**2**	**2**				**2**	**2**	

1 – low, 2 – medium, 3 - high

25EEP29 UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY

3 0 0 3

ELECTRIC TRACTION: Requirements of traction system - Systems of traction - Systems of track electrification - Speed-Time curves - Tractive effort - Power of traction motor - Specific energy consumption – Block Diagram of Modern Locomotive – Main and Auxiliary Power supply circuits – Current Collection Systems -Motors for traction - Starting and speed control – Electric braking – Case Study Metro Rail System. **(9)**

ELECTRIC HEATING AND WELDING: Advantages of electric heating – Types of Heating - Resistance heating – Temperature control, Induction heating – induction furnace - Dielectric heating - Choice of voltage and frequencies for Dielectric heating. Equipment's for Welding - Resistance welding - Arc welding - Laser welding – Ultrasonic Welding. **(9)**

ILLUMINATION: Nature of light - Luminous intensity - Illumination - Brightness - Lamp efficiency - Luminous efficiency – Laws of illumination - Electrical sources of light - fluorescent lamp, Sodium Vapour lamp, Mercury Vapour lamp – CFL – LED Lighting systems - Polar curves - Calculation of illumination - Indoor and outdoor Lighting schemes. **(9)**

REFRIGERATION AND AIR CONDITIONING: Refrigeration Systems – Refrigerants – Types of Refrigeration Systems – Electrical Circuit of a Domestic Refrigerator – Trouble shooting of Refrigerator. Air Conditioning Systems – Types Electrical circuit of window and Central Air Conditioning Systems. **(9)**

ECONOMIC ASPECTS OF UTILISATION: PF and its improvement - Load curves - Load factors - Its improvement – Depreciation – Types. Introduction to Availability based Tariff - Demand side Management –Peak clipping – Peak shifting – valley filling - Use of off-peak energy - Trends in Conservation: Green Buildings. Introduction to Energy conservation and Energy auditing - Case studies on Energy efficiency in thermal & electrical utilities. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Garg G C, '*Utilisation of Electric Power and Electric Traction*'. Khanna Publishers, New Delhi, 2004.
2. Openshaw Taylor E, '*Utilisation of Electric Energy in SI Units*'. Universities Press, Hyderabad, 2011.

REFERENCES

1. Wadhwa C L, '*Generation, Distribution and Utilisation of Electrical Energy*'. New Age International Publishers, New Delhi, 2012.
2. Tripathy S.C, '*Electric Energy Utilisation and Conservation*'. Tata Mc Graw-Hill, New Delhi, 1993.
3. Suryanarayana N.V, '*Utilisation of Electric Power Including Electric Drives and Electric Traction*'. New Age International Publishers, New Delhi, 2010.
4. Abbi Y P, Shashank Jain, '*Handbook on Energy Audit and Environment Management*'. Teri Press, New Delhi, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the working principles and applications of electric traction, electric heating and welding systems.	**K2**
CO2	Calculate illumination levels for indoor and outdoor lighting schemes using laws of illumination and polar curves.	**K3**
CO3	Analyse the electrical circuits of domestic refrigeration and air conditioning systems and identify possible faults for troubleshooting.	**K4**
CO4	Evaluate different methods of power factor improvement, load management, and energy conservation, based on economic and environmental factors.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2										2	
CO4				1		1						1	
	3	**2**		**1**		**1**						**3**	

1 – low, 2 – medium, 3 – high

25EEP30 HVDC and FACTS

3 0 0 3

INTRODUCTION: Reactive power control in electrical power transmission lines–load & system compensation, Uncompensated transmission line–shunt and series compensation. Need for HVDC Transmission, Comparison between AC & DC Transmission, Types of HVDC transmission System. **(9)**

STATIC VAR COMPENSATOR (SVC) AND THYRISTOR CONTROLLED SERIES COMPENSATOR (TCSC): VI characteristics of FC+TSR, TSC+TSR, Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator, Thyristor Controlled Series Compensator (TCSC), Concept of TCSC, Operation of the TCSC– Different modes of operation, Applications. **(9)**

VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS: Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC VI characteristics, Enhancement in Power transfer capability –, UPSC – Operation Principle Applications**.** **(9)**

LINE COMMUTATED HVDC TRANSMISSION: Operation of Gratz bridge - Effect of delay in Firing Angle – Effect of commutation overlap - Equivalent circuit, Basic concept of HVDC transmission. Model of operations and control of power flow CC and CIA mode of operation. **(9)**

VSC BASED HVDC TRANSMISSION: Basic 2 level IGBT inverter operation- 4 Quadrant operation- phase angle control- dq control- Control of power flow in VSC based HVDC Transmission, Topologies of MTDC system. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. R. Mohan Mathur, Rajiv K.Varma, '*Thyristor–Based Facts Controllers for Electrical Transmission Systems*'. IEEE press and John Wiley & Sons, Inc, 2002.
2. Narain G.Hingorani, '*Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems*'. Standard Publishers Distributors, Delhi, 2011.

REFERENCES

1. K.R.Padiyar, '*FACTS Controllers in Power Transmission and Distribution*'. New Age International (P) Ltd. Publishers, New Delhi, 2008
2. A.T.John, '*Flexible AC.Transmission Systems*'. Institution of Electrical and Electronic Engineers (IEEE), 1999.
3. V.K.Sood, '*HVDC and FACTS controllers–Applications of Static Converters in Power System'.* Kluwer Academic Publishers, 2004.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the types of AC, DC, HVDC transmission system and the role of various FACTS devices on the reactive power compensation in electrical power network	**K2**
CO2	Apply FACTS device for different modes of operation and suitable harmonic filters to solve power quality issues in the power system network	**K3**
CO3	Analyze power flow control issues and the harmonics present in the transmission lines and identify specific FACTS controllers for the line compensation	**K4**
CO4	Evaluate the performance of SVC on voltage compensation of a sample power system network by suitably modelling the system using appropriate tools and analyse its impacts on real-world scenarios.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											3	
CO3		2										2	
CO4				2	2							2	
	3	**2**		**2**	**2**							**3**	

1 – low, 2 – medium, 3 – high

25EEP31 POWER QUALITY AND MANAGEMENT

3 0 0 3

INTRODUCTION: Definition of power quality – Power quality- Voltage quality. Terms and definitions: General Classes of Power Quality Problems- Concepts of transients – Short duration voltage variations - Long duration voltage variation. Voltage imbalance - Waveform distortion- Voltage Fluctuation-Power frequency variation- Power quality terms - International standards of power quality- IEEE-IEC and Computer Business Equipment Manufacturers Associations (CBEMA) curve. **(9)**

VOLTAGE SAGS AND INTERRUPTIONS: Sources of sags and interruptions - Estimating voltage sag performance. Thevenin's equivalent source - Analysis and calculation of various faulted conditions. Voltage sag due to induction motor starting - Mitigation of voltage sags, Compensators. Static transfer switches and fast transfer switches. **(9)**

OVER VOLTAGES: Sources of over voltages - Capacitor switching – Lightning - Ferro resonance. Mitigation of voltage swells - Surge arresters - Low pass filters - Power conditioners. Lightning protection – Shielding – Line arresters - Protection of transformers and cables. An introduction to computer analysis tools for transients. **(9)**

REACTIVE POWER COMPENSATION AND HARMONICS: Effect of load pattern on reactive power and power factor correction-Harmonic distortion- Voltage and current distortion- Harmonics versus Transients, Power System Quantities under Non-sinusoidal Conditions. Harmonic indices, Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics. Effect of harmonics, Inter-harmonics – Resonance, Harmonic distortion evaluation - Devices for controlling harmonic distortion – Passive and active. **(9)**

POWER QUALITY MANAGEMENT AND MITIGATION EQUIPMENT: Compensation Devices: Shunt active/passive filters, DSTATCOM, DVR (Dynamic Voltage Restorer), and Unified Power Quality Compensators (UPQC). Monitoring: State-of-the-art PQ monitoring, data acquisition, and signal processing (Fourier and Wavelet transform). **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Roger. C. Dugan, Mark. F. Mc Granagham, Surya Santoso, H.Wayne Beaty, '*Electrical Power Systems Quality'*. McGraw Hill, 2003.
2. Arindam Ghosh, Gerard Ledwich, '*Power Quality Enhancement Using Custom Power Devices'*. Springer 2002.
3. M.H.J Bollen, '*Understanding Power Quality Problems: Voltage Sags and Interruptions'*. (New York: IEEE Press, 1999). (For Chapters 1, 2 and 5)

REFERENCES

1. Eswald.F.Fudis and M.A.S.Masoum, '*Power Quality in Power System and Electrical Machines'*. Elseviar Academic Press, 2013.
2. J. Arrillaga, N.R. Watson, S. Chen, '*Power System Quality Assessment*'. Wiley, 2011.
3. G.T. Heydt, '*Electric Power Quality*'. 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994). (For Chapter 1, 2, 3 and 5)

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the causes, effects and mitigation techniques associated with power quality problems and its monitoring instruments.	**K2**
CO2	Build the suitable power quality mitigation techniques for the given power quality issues.	**K3**
CO3	Analyse the performance of various mitigation techniques for enhancing power quality.	**K4**
CO4	Interpret power quality data and formulate data-driven solutions for the quality improvement.	-

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											2	
CO3		2										2	
CO4				1		1	1					1	
	3	**2**		**1**		**1**	**1**					**2**	

1 – low, 2 – medium, 3 – high

25EEP32 HIGH VOLTAGE ENGINEERING

3 0 0 3

OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS: Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of Travelling waves- protection against over voltages_ Insulation Coordination. **(9)**

DIELECTRIC BREAKDOWN: Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields –Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment**.** **(9)**

GENERATION AND MEASUREMENTS OF HIGH VOLTAGES AND HIGH CURRENTS: Generation of High DC, AC, impulse voltages and currents - Analysis of DC/AC and Impulse generator circuits - Tripping and control of impulse generators, Measurement of High voltages and High currents – High Resistance with series ammeter – Dividers - Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, High current shunts, Digital techniques in high voltage measurement. **(9)**

HIGH VOLTAGE TESTING & INSULATION COORDINATION: High voltage testing of electrical power apparatus- International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers - Insulation Coordination. **(9)**

APPLICATION IN INDUSTRY: Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. M. S. Naidu and V. Kamaraju, '*High Voltage Engineering*'. Tata McGraw Hill, 5th Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, '*High voltage Engineering fundamentals'*. Newnes, 2nd Edition, Elsevier, New Delhi, 2005.
3. C.L. Wadhwa, '*High voltage Engineering*'. New Age International Publishers, 4th Edition, 2020.

REFERENCES

1. L. L. Alston, '*High Voltage Technology*'. Oxford University Press, 1st Indian Edition, 2006.
2. C. L. Wadhwa, '*High voltage Engineering*'. New Age International Publishers, 4th Edition, 2020.
3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, '*High Voltage Engineering – Theory &Practice'*. Taylor & Francis Gourp, 2nd Edition, 2019.
4. Subir Ray. '*An Introduction to High Voltage Engineering*'. PHI Learning Private Limited, New Delhi, 2nd Edition-2011.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the causes of over-voltages in power systems (lightning, switching, temporary surges) and their effects, including the concepts of reflection, refraction, and insulation coordination.	**K2**
CO2	Apply the principles of dielectric breakdown to different media such as gases, liquids, solids, and vacuum in high voltage applications.	**K3**
CO3	Analyze various methods for the generation and measurement of high DC, AC, and impulse voltages and currents.	**K4**
CO4	Evaluate high voltage testing methods of electrical equipment (insulators, transformers, circuit breakers, bushings) as per international and Indian standards.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2											2
CO4				1							1		1
	3	**2**		**1**							**1**		**3**

1 – low, 2 – medium, 3 - high

25EEP33 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS

3 0 0 3

INTELLIGENT AGENT AND UNINFORMED SEARCH: Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search. **(9)**

PROBLEM SOLVING WITH SEARCH TECHNIQUES: Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - Constraint Satisfaction Problems (CSP) - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP. **(9)**

LEARNING: Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression. **(9)**

SUPERVISED LEARNING: Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM). **(9)**

UNSUPERVISED LEARNING: Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm. **(9)**

Total L: 45 Periods

TEXT BOOK:

1. S. Russell and P. Norvig, '*Artificial Intelligence: A Modern Approach*'. Prentice Hall, 4th Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, '*Principles of soft computing*'. Wiley India, 3rd Edition, 2018.

REFERENCES:

1. Tom Mitchell, '*Machine Learning*'. 1st Edition, McGraw- Hill, 1997.
2. I. Bratko, '*Prolog: Programming for Artificial Intelligence*'. 4th Edition, Addison-Wesley Educational Publishers Inc., 2011.
3. C. Muller & Sarah Alpaydin, Ethem. '*Introduction to machine learning*'. MIT press, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental principles of artificial intelligence and machine learning.	**K2**
CO2	Implement search algorithms and machine learning models for real world problems.	**K3**
CO3	Examine the performance and effectiveness of machine learning models.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								2
CO3		3			2								2
	3	**3**			**2**								**2**

1 – low, 2 – medium, 3 - high

25EEP34 DATA ANALYTICS
(Common to EEE and ICE)

3 0 0 3

INTRODUCTION: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data. **(9)**

DATA MANIPULATION: Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data –Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance. **(9)**

MACHINE LEARNING: The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis. **(9)**

DATA VISUALIZATION: Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three-dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn. **(9)**

HANDLING LARGE DATA: Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, '*Introducing Data Science*'. Manning Publications, 2016.
2. Jake VanderPlas, '*Python Data Science Handbook*'. O'Reilly, 2016.
3. Juuso Koponen, Jonatan Hildén, '*Data Visualization Handbook*'. Aalto University Publication, 2019.

REFERENCES

1. Allen B. Downey, '*Think Stats: Exploratory Data Analysis in Python*'. Green Tea Press, 2014.
2. Kieran Healy, '*Data Visualization: A Practical Introduction*'. Princeton University Press, 2018.
3. Cole Nussbaumer Knaflic, '*Storytelling with Data: A Data Visualization Guide for Business Professionals*'. John Wiley, 2015.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain fundamental principles of information visualization, human perception, and to interpret and communicate data effectively through visual representations.	**K2**
CO2	Estimate statistical functions or parameters by selecting and implementing appropriate computational statistics techniques	**K3**
CO3	Analyze a given problem/ large data set by comparing the computational statistics technique using their performance parameters	**K4**
CO4	Design and implement data analysis on datasets using R and Python programming.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								2
CO3		2			2								2
CO4			2		2	2					2		2
	3	**2**	**2**		**2**	**2**					**2**		**2**

1 – low, 2 – medium, 3 - high

25EEP35 VLSI DESIGN TECHNIQUES
(Common to EEE and ICE)

3 0 0 3

OVERVIEW OF VLSI DESIGN AND BASIC ELECTRICAL PROPERTIES OF CMOS CIRCUITS : VLSI design process - Architectural design - Logical design - Physical design - Layout styles – Full-custom – Semi-custom approaches- Basic Electrical Properties of CMOS Circuits **:** MOS Transistor – Threshold voltage - Pass transistor - Transmission gate - Basic DC equations - Second order effects - MOS modules - Small signal AC characteristics - CMOS inverter - DC characteristics -Inverter delay – Power consumption in CMOS gates – Static dissipation Dynamic dissipation. **(9)**

VLSI FABRICATION TECHNIQUES: An overview of wafer fabrication - Wafer processing - Oxidation - Patterning - Diffusion - Ion implantation - Deposition - CMOS processes – Nwell - Pwell - Twintub - Silicon on Insulator – CMOS process enhancements - Interconnect - Circuit elements - Latchup - Latchup prevention techniques. **(9)**

LAYOUT DESIGN RULES & PARAMETERS ESTIMATION: Layer representations - Stick diagrams- CMOS design style - Design rules - Need for design rules - Mead Conway design rules - CMOS n-well / p-well lambda-based design rules - Simple layout examples. Sheet resistance - Resistance estimation - Capacitance estimation - Driving large capacitive loads. **(9)**

CMOS CIRCUIT COMBINATIONAL AND SEQUENTIAL LOGIC DESIGN: CMOS circuit families- Static CMOS -Ratioed circuits- Pseudo nMOS - Cascade voltage switch Logic-Dynamic circuits; Domino Logic-Pass transistor circuits- CMOS Transmission gates-Structured design - Simple combinational logic design examples - Parity generator – Multiplexers. Sequential logic design**:** Clocked sequential circuits –Single phase clocking -Max-delay Constraints- Min-delay Constraints -Two-phase clocking - Charge storage - clock skew- Clocked - Logic-CMOS Dynamic register element -Dynamic shift register – Semi-static register – CMOS Latches- D- flip-flop. **(9)**

SUBSYSTEM DESIGN PROCESS: General arrangement of a 4-bit arithmetic processor - Design of a 4-bit shifter - Design of an ALU subsystem - Implementation of ALU functions with an adder - Carry look ahead adder – Multipliers – Serial-parallel multipliers - Pipelined multiplier array – Design for testability. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Douglas A Pucknell, and Kamran Eshraghian, '*Basic VLSI design*'. Prentice Hall of India, New Delhi, 2015.
2. Neil H E Weste, David Harris, '*CMOS VLSI design: Circuits and System Perspective*'. Pearson Education, New Delhi, 2015.

REFERENCES:

1. Jan M Rabaey, Chandrakasan A, Nikolic B, '*Digital Integrated Circuits*'. PHI Learning, NewDelhi, 2013.
2. Amar Mukherjee, *'Introduction to nMOS and CMOS VLSI System Design*'. Prentice Hall, New Jersey, 1986.
3. Wayne Wolf, '*Modern VLSI Design: Systems on Chip Design*'. Pearson Education, New Delhi, 2008.
4. John P. Uyemura, '*Chip Design for Submicron VLSI Design: CMOS Layout and Simulation*'. Cengage Learning, New Delhi, 2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the VLSI design process, CMOS circuit properties, and fabrication techniques.	**K2**
CO2	Apply layout design rules and estimate parameters (resistance, capacitance) for CMOS circuits.	**K3**
CO3	Design combinational and sequential CMOS logic circuits using static/dynamic techniques.	**K4**
CO4	Implement basic VLSI subsystems (e.g., ALU, shifters, adders) using structured design methods.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		2			1								2
CO4			1	1	1								2
	3	**3**	**1**	**1**	**1**								**3**

1 – low, 2 – medium, 3 - high

25EEP36 CYBER SECURITY
(Common to EEE and ICE)

3 0 0 3

FUNDAMENTALS OF CYBER SECURITY: Introduction to Cyber Security – Importance and Challenges – CIA Triad (Confidentiality, Integrity, Availability) – Threats, Vulnerabilities and Attacks – Types of Attackers – Risk Assessment and Management – Cyber Security in Critical Infrastructure – Overview of Security Policies and Standards – Cyber Hygiene Practices. **(9)**

CRYPTOGRAPHY AND SECURE COMMUNICATION: Basics of Cryptography – Symmetric and Asymmetric Encryption – Public Key Infrastructure (PKI) – Hash Functions and Digital Signatures – Key Management Techniques – Secure Communication Protocols – SSL/TLS Basics – Authentication and Authorization Methods. **(9)**

NETWORK SECURITY AND INDUSTRIAL SYSTEMS: Network Fundamentals – Network Vulnerabilities – Types of Attacks (DoS, MITM, Spoofing) – Firewalls – Intrusion Detection and Prevention Systems (IDS/IPS) – Wireless Network Security – Industrial Communication Protocols – SCADA Systems – Security Issues in Industrial Control Systems (ICS). **(9)**

EMBEDDED SYSTEMS AND HARDWARE SECURITY: CMOS circuit families- Static CMOS -Ratioed circuits- Pseudo nMOS - Cascode voltage switch Logic-Dynamic circuits; Domino Introduction to Embedded System Security – Hardware Vulnerabilities – Side Channel Attacks – Secure Boot Techniques – Trusted Hardware – IoT Security Fundamentals – Firmware Security – Device Authentication and Access Control. **(9)**

ETHICAL HACKING, FORENSICS AND CYBER LAWS: Ethical Hacking Concepts – Penetration Testing – Malware (Virus, Worms, Trojans) – Digital Forensics – Incident Response and Recovery – Cyber Laws and Regulations – IT Act – Ethical and Legal Issues in Cyber Security – Risk Management Strategies. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. William Stallings, Lawrie Brown, '*Computer Security: Principles and Practice'*. *Pearson*, 2023.
2. Charles P. Pfleeger, Shari Lawrence P fleeger, Jonathan Margulies, '*Security in Computing'*. *Pearson*, 2022.
3. Behrouz A. Forouzan, Debdeep Mukhopadhyay, '*Cryptography and Network Security'*. *McGraw-Hill*, 2021.
4. Anurag K. Srivastava, '*Cyber Infrastructure for the Smart Electric Grid'*. Springer, 2016.

REFERENCES:

1. Bruce Schneier, '*Applied Cryptography: Protocols, Algorithms, and Source Code in C'*. *Wiley*, 2015.
2. Nina Godbole, Sunit Belapure, '*Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*'. *Wiley India*, 2019.
3. William Stallings, '*Cryptography and Network Security: Principles and Practice'*. *Pearson*, 2022.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain fundamentals of cyber security concepts and threats.	**K2**
CO2	Apply cryptographic techniques for secure communication.	**K3**
CO3	Analyze vulnerabilities in networks and industrial systems.	**K4**
CO4	Implement ethical hacking concepts and manage cyber risks.	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		2											
CO4				1	1	1	1						
	3	**2**		**1**	**1**	**1**	**1**						

1 – low, 2 – medium, 3 - high

25ICP12 VIRTUAL INSTRUMENTATION
(Common to EEE and ICE)

3 0 0 3

INTRODUCTION: Building front panel and block diagram, tools and palettes, VI and Sub VI, Editing and Debugging VI. **(9)**

LABVIEW PROGRAMMING: Controlling program flow – Loops, structures, shift registers, local and global variables, data types- Numeric, digital, strings, arrays, clusters, waveform, data presentation elements, graphs and charts. **(9)**

ANALYSIS AND FILTERING TOOLS: Time and frequency domain analysis – digital filter - FFT spectrum - Power spectrum - Windowing and filtering tools. **(9)**

CONCEPT OF DATA ACQUISITION: Generation of signals, analog I/O and digital I/O signal acquisition- different types of data acquisition system – study of DAQ card. **(9)**

DAQ INTERFACING: Interfacing of DAQ system with LabVIEW, Building VIs for analog read and write, digital read and write. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Jovitha Jerome, *'Virtual Instrumentation using LabVIEW'*. PHI Learning Pvt Ltd, New Delhi, 2010.
2. Steve Mackay, Edwin Wright, John Park, and Deon Reynders, *'Industrial Data Networks'*. Elsevier, Boston, 2004.

REFERENCES:

1. Wells Lisa K and Travis Jeffrey, *'LabVIEW for everyone'*. Prentice Hall (1997).
2. Gupta S and Gupta J P, *'PC Interfacing for data acquisition of process control'*. Instrument Society of America (1994).
3. Wells LK, *'LabVIEW for everyone – Graphical Programming made even easier'*. Prentice Hall, 2011.
4. Gupta S and Joseph J, *'Virtual Instrumentation using LabVIEW'*. Tata McGraw Hill, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamentals of LabVIEW programming, including front panel, block diagram, tools, palettes, Virtual Instruments (VI), SubVIs, and debugging techniques.	**K2**
CO2	Apply time and frequency domain analysis tools such as FFT, power spectrum, digital filters, and windowing techniques using LabVIEW for signal analysis.	**K3**
CO3	Analyse and develop LabVIEW-based applications by interfacing DAQ systems for real-time analog and digital input/output operations and evaluate system performance.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				2								3
CO3		3			2								3
CO4	3	3			2								3
	3	**3**			**2**								**3**

1 – low, 2 – medium, 3 – high

25EEP37 PLC AND SCADA

3 0 0 3

PLC INTRODUCTION: Contactors - Hardwired relay control circuits, DOL Starter, star-delta starter, forward reverse control of motors, PLC Vs hardwired control circuit, PLC Architecture, PLC types, Input and output modules in PLC, memory, sourcing and sinking input, PLC programming types, logical operations in PLC using ladder logic. **(9)**

PLC PROGRAMMING: IEC 61131-3 standard, latching circuit, programming timer, programming counter, math and data manipulation instructions in PLC programming, Analog I/O module, Subroutines, Multipath Programming, Sequencer instructions- PID functions, Application examples using ladder logic and FBD. **(9)**

PLC NETWORKING: Protocols, Serial interface, Ethernet TCP / IP, EtherCAT, Profinet, Modbus, Proprietary protocol, OPC protocol, DeviceNet, Profibus, CC link, CAN Bus. Networking topologies, Networking Adapters. **(9)**

SCADA & HMI: Elements of SCADA system, Remote Terminal Unit, Master Terminal Unit, Operator interface, Discrete control, Analog control, Creation of tags, Alarm management, data logging and reporting, HMI - Types, Configuring input/output in HMI, Screen navigation. **(9)**

ADVANCES IN AUTOMATION: Open PLC, C programming in PLC, Configurable and high-end programming user interface, Introduction to DCS, Differences between DCS and SCADA, Barcode Interface, IIoT and edge devices interface, Motion control using PLC, Safety PLC- Functional safety standards: IEC61508 / IEC61511 standard. **(9)**

Total L: 45 Periods

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

REFERENCES

1. John W. Webb & Ronald A. Reis, '*Programmable Logic Controllers: Principals and Applications*'. Prentice-Hall, Inc., 1994.
2. Fanuc PMC Programming manual
3. Siemens PLC Programming Manual
4. Beckhoff Controller Programming manual

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the architecture, networking and working of a PLC and SCADA based automation systems.	**K2**
CO2	Apply the knowledge of basic concepts of PLC programming and write programs for automation systems.	**K3**
CO3	Analyze and choose a suitable PLC, networking protocol to build an PLC Program logic in any of the programming languages from IEC- 61131- 3 standard.	**K4**
CO4	Design and develop PLC based automation system using PLC program.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												3
CO3		3											3
CO4			1		1								1
	3	**3**	**1**		**1**								**3**

1 – low, 2 – medium, 3 - high

25EEP38 ELECTRICAL SYSTEM ESTIMATION AND COSTING

3 0 0 3

INTRODUCTION TO ESTIMATION & COSTING: Basics of estimation – Purpose and importance – Types of estimates – Electrical symbols and standards – Types of wiring systems - Load calculations - Estimation of materials and labour – Tools used for estimation – Introduction to costing – Elements of cost – Overhead charges – Preparation of cost sheet – Safety regulations and standards. **(9)**

ESTIMATION OF RESIDENTIAL AND COMMERCIAL BUILDINGS: Electrical installation in residential and commercial buildings – Load calculations - Selection of rating of main switch, distributions board, protective switchgear ELCB and MCB and wiring accessories – Lighting and power circuits – Sub-circuits – Preparation of wiring layout -– Earthing and its estimation. **(9)**

ESTIMATION OF INDUSTRIAL ELECTRICAL INSTALLATIONS: Electrical installation in small industries – Motor current calculations – Selection of cables, switchgear, and protection devices – Estimation of materials for motor circuits – Schematic and wiring diagrams for motor control circuits – Power factor improvement – Energy-efficient practices in industrial estimation**.** **(9)**

ESTIMATION OF OVERHEAD AND UNDERGROUND DISTRIBUTION SYSTEMS: Components of overhead and underground distribution lines – Estimation of materials for HT and LT lines – Poles, insulators, conductors, and accessories – Underground cable laying – Cable sizing – Estimation for underground systems – Street lighting systems. **(9)**

COSTING, TENDERING AND PROJECT MANAGEMENT: Detailed costing – Rate analysis – Preparation of tender documents – Types of tenders – Tender evaluation – Contracts and agreements – Billing and valuation – Project scheduling basics – Introduction to electrical project management tools. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. K. B. Raina, S K Bhattacharya, *'Electrical Design Estimating and Costing'*. New Age International Pvt Ltd, New Delhi, 2024.
2. J. B. Gupta, '*A Course in Electrical Installation Estimating & Costing'*. S. K. Kataria & Sons Pearson, Hounslow, United Kingdom, 2013.
3. Surjit Singh, '*Electric Estimating and Costing'*. Dhanpat Rai & Co. (P) Limited, India, 2016.

REFERENCES:

1. S. L. Uppal, G.C. Garg, '*Electrical Wiring, Estimating & Costing'*. Khanna Publishers, India, 1987.
2. W S Ibbetson, '*Electrical Wiring'*. Legare Street Press, India, 2023.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of electrical estimation and costing, load calculations, wiring systems, cost elements, and safety standards.	**K2**
CO2	Apply estimation techniques to design and prepare material and labor requirements for residential, commercial, and industrial electrical installations.	**K3**
CO3	Analyze electrical systems to select appropriate cables, switchgear, protection devices, and distribution components for efficient and safe operation	**K4**
CO4	Evaluate project costs and prepare tender documents by performing rate analysis, cost estimation, and assessing economic feasibility of electrical projects.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3										2	2	
CO3		3									2	2	
CO4			2		2		2			2	2	2	
	3	**3**	**2**		**2**		**2**			**2**	**2**	**2**	

1 – low, 2 – medium, 3 - high

25EEP39 MODEL BASED SYSTEMS

3 0 0 3

INTRODUCTION TO MIMO CONTROL: Introduction to MIMO Systems-Multivariable control-Multiloop Control-Multivariable IMC, IMCPID-Case studies. **(9)**

MODEL PREDICTIVE CONTROL: 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. **(9)**

STATE SPACE MODEL BASED PREDICTIVE CONTROL SCHEME: State Space Model Based Predictive Control Scheme - Review of Kalman Update based filters – State Observer Based Model Predictive Control Schemes – Case Studies. **(9)**

CONSTRAINED MODEL PREDICTIVE CONTROL: Constraints Handling: Amplitude Constraints and Rate Constraints – Constraints and Optimization – Constrained Model Predictive Control Scheme – Case Studies. **(9)**

ADAPTIVE CONTROL SCHEME: Introduction to Adaptive Control-Gain Scheduling-Self tuning regulators– MARS-Adaptive Model Predictive Control Scheme –Case Studies. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Coleman Brosilow, Babu Joseph, '*Techniques of Model-Based Control'*. Prentice Hall PTR Pub, 2002.
2. E. F. Camacho, C. Bordons, '*Model Predictive Control'*. 2nd Edition, Springer-Verlag London Limited, 2007.
3. K.J. Astrom and B. J. Wittenmark, '*Adaptive Control'*. 2nd Edition, Pearson Education Inc., 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.
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.
3. J.A. Rossiter '*Model-Based Predictive Control A Practical Approach'*. Taylor & Francis eLibrary, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the different control schemes employed on MIMO systems.	**K2**
CO2	Apply and select suitable control schemes for MIMO processes and distinguish between multivariable and multiloop control strategies.	**K3**
CO3	Analyze the performance of industrial processes employing the advanced control strategies.	**K4**
CO4	Design Model Predictive Controllers and Adaptive controllers for practical problems occurring in industrial processes.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3											3	
CO3		2										2	
CO4			1		1							1	
	3	**2**	**1**		**1**							**3**	

1 – low, 2 – medium, 3 - high

MINOR DEGREE PROGRAMME IN ELECTRIC VEHICLE

25EEM01 BASICS OF ELECTRIC VEHICLE

3 0 0 3

ELECTRIC VEHICLES: History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs, Overview of Tesla car. **(9)**

VEHICLE MECHANICS: History of Vehicle Development, General Configuration of Automobile, Body and Chassis Fundamentals: General Packaging, Types of Structural System, Backbone Construction; Body and Chassis Materials. Automotive Powertrain Mechanical, Suspensions system, Steering System, NVH, Control System Integration and Implementation. Front-Wheel Drive (FWD) Powertrains, Rear-Wheel Drive Powertrains (RWD), Multi-Wheel Drive Powertrains (AWD and 4WD). **(9)**

TRANSMISSION SYSTEMS: Transmission gears, Manual Transmission (MT), Automatic Transmission (AT), Automated Manual Transmissions (AMT) and Continuously Variable Transmissions (CVT); Manual Transmissions Powertrain Layout and Manual Transmission Structure, Power Flows and Gear Ratios, Manual Transmission Clutch and its structure. Drivetrain and Differential. **(9)**

VEHICLE FUNDAMENTALS: Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating the acceleration force, maximum speed, finding the total tractive effort, Torque Required on the Drive Wheel, Transmission: Differential, clutch &gear box, Braking performance. **(9)**

CONVERSIONS AND MOTORS: Introduction of DC-DC, AC-AC, AC-DC, DC-AC, four-quadrant operation, Driver circuits. Principle and working of DC motor, Characteristics and Types of DC Motors, overview (Speed torque characteristics) of Permanent Magnet motor, BLDC Motor, Induction motor. Comparison of all motors. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Joseph Katz, *'Automotive Aerodynamics*'. John Wiley & Sons Inc, 2016.
2. James Larminie, John Lowry, '*Electric Vehicle Technology Explained'*. John Wiley, 2012.

REFERENCES

1. Zongxuan Sun, Guoming Zhu, *'Design and Control of Automotive Propulsion Systems'*. CRC Press, 2015
2. Robert Fischer, Ferit Kucukay, Gunter Jürgens, Rolf Najork, Burkhard Pollak, *'The Automotive Transmission'. Springer*, 2015

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of electric vehicles, history of vehicle development, vehicle mechanics, classifications of electric vehicles and the characteristics of different electric motors and power converters used in EVs.	**K2**
CO2	Determine the vehicle performance by evaluating resistances, tractive effort, torque requirements and braking performance.	**K3**
CO3	Analyze various powertrain and transmission systems employed in EVs and examine their suitability for different vehicle applications.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2									2		
	3	**2**									**2**		

1 – low, 2 – medium, 3 - high

25EEM02 HYBRID ELECTRIC VEHICLES

3 0 0 3

VEHICLE FUNDAMENTALS: Vehicle movement - Vehicle resistance - Dynamic equation - Power train tractive effort and vehicle speed - Vehicle power plant and transmission characteristics - Vehicle performance - Operating fuel economy - Braking performance. **(9)**

ELECTRIC AND HYBRID ELECTRIC VEHICLES: History - Environmental impact - Configurations of electric vehicles - Performance of electric vehicles - Tractive effort in normal driving - Energy consumption - Concept and architecture of hybrid electric drive trains. **(9)**

ELECTRIC PROPULSION SYSTEMS: Principle of operation and performance of DC motor drives - Induction motor drives- Permanent Magnetic Brushless DC Motor Drives - Switched Reluctance Motor Drives - Electric drive train design-Case study. **(9)**

ENERGY STORAGE SYSTEMS: Electrochemical batteries - Ultra capacitors - Ultrahigh-speed flywheels – Hybrid sources - Storage system design aspects. **(9)**

FUEL CELL VEHICLES: Operating principle and characteristics - Fuel Cell Technologies - Fuel Supply - Fuel Cell Hybrid Electric Drive Train Design. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, '*Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*'. CRC Press, New York, 2009.
2. Iqbal Husain, '*Electric and Hybrid Vehicles: Design Fundamentals*'. CRC Press, New York, 2011.

REFERENCES:

1. Ali Emadi, '*Advanced Electric Drive Vehicles*'. CRC Press, Taylor & Francis Corp, New York, 2015.
2. Seref Soylu, '*Electric Vehicles - The Benefits and Barriers*'. InTech Publishers, Croatia, 2011.
3. Aulice Scibioh M. and Viswanathan B, '*Fuel Cells – Principles and Applications'*. University Press, India, 2006.
4. Barbir. F, '*PEM Fuel Cells: Theory and Practic*e'. Elsevier, London, 2005.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics of HEVs, including their architecture, energy storage systems and technologies.	**K2**
CO2	Apply the knowledge of power electronics and drives to identify the proper drive scheme for developing HEVs.	**K3**
CO3	Analyze the design considerations for the propulsion system and develop the propulsion and its control unit as per the application.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
	3	**2**											

1 – low, 2 – medium, 3 - high

25EEM03 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS

3 0 0 3

INTRODUCTION: Current trends in modern automobiles - Drive by wire Systems -Vehicle functional domains and their requirements - Components of an Automobile Electronic system and their functions: Sensors, Actuators, Control Units and Software structure of Control units. **(9)**

AUTOMOBILE ELECTRICALS AND ELECTRONICS: Basic Electrical Components in an automobile - Starting system (Battery, Ignition Switch, Solenoid, Starter, Neutral Safety Switch), Charging system (Alternator Drive Belt, Alternator, Voltage Regulator), Fuses. Overview of Vehicle Electronic system - Driver - Vehicle - Environment system (Control and monitoring systems, electronic systems of the vehicle and the environment) - General instrumentation block diagram - Typical instrumentation cluster lay out**.** **(9)**

EMBEDDED SYSTEM IN AUTOMOTIVE CONTEXT: Embedded systems in typical modern automobile - Distributed systems, Embedded components -- Engine Management system - Diesel / Gasoline system, Components, System architecture (H/W, S/W) - Body electronics systems, - Infotainment systems – Navigation, Car radio. (**9)**

ELECTRONICS CONTROL UNITS (ECUS): ECUs and vehicle subsystems - Electronic systems of Power train subsystem, electronic systems of Chassis subsystem, electronic systems of Body subsystems (Comfort and Passive safety), Multimedia subsystems. Automobile sensors and actuators, Engine management system, Vehicle safety systems, Environmental legislation (Pollution Norms - Euro / Bharat standards**).** **(9)**

DIAGNOSTICS AND AUTOMOTIVE NETWORKING PROTOCOLS: Diagnostics procedure: Introduction – Diagnostics theory – on board and off board diagnostics – Diagnostics Link Connector (DLC) - CAN bus topology – Data transmission – CAN protocol – Over view of CAN controller - LIN bus: overview – Data transmission system - LIN protocol. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Tom Denton, '*Automobile Electrical and Electronics systems'*. Routledge Taylor & Francis Group, London & New York, 2002.
2. Nicolas Navet and Francoise Simonot-Lion, '*Automotive Embedded Systems Handbook'*. CRC Press, USA, 2013.

REFERENCES

1. Michel Parent &Furnio Harshima, Ljubo vlacic, '*Intelligent Vehicle Technologies: Theory and Applications*'. 1st Edition, Butterworth-Heinemann publications, New Delhi, 2001.
2. Ronald k.J, *'Automotive Electronics Handbook'.* 2ndEdition, McGraw Hill Publications, Columbus, 2009.
3. Norman P. Mansour, William Ribbens, *'Understanding of Automotive Electronics*'. 5th Edition, Butterworth-Heinemann, United Kingdom, 2014.
4. Robert Bosch, '*Automotive Electrics Automotive Electronics*'. 5th Edition, Springer, Germany, 2010.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the basic components, techniques and networking protocols required for the design of an embedded system for automotive applications.	**K2**
CO2	Apply the knowledge of embedded processor, sensors, actuators and interfacing techniques for design an automotive system.	**K3**
CO3	Analyse the automotive networking protocols for better communication and control of different systems in modern automobiles.	**K4**
CO4	Simulate the basic concepts of embedded system for automotive applications.	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4				2	2	1	1						
	3	**3**		**2**	**2**	**1**	**1**						

1 – low, 2 – medium, 3 – high

25EEM04 ENERGY STORAGE SYSTEMS

3 0 0 3

INTRODUCTION TO ENERGY STORAGE SYSTEMS : Introduction - Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications. **(9)**

BATTERIES: Battery characteristics - voltage, current, capacity, volumetric energy density, specific energy density, charge rate, cycle life, internal resistance, energy efficiency, shelf life, battery management system – Types of battery – primary battery – secondary battery – advanced battery – construction - characteristics – working – applications - software packages. **(9)**

FUEL CELLS: History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages – applications – software packages. **(9)**

ALTERNATE ENERGY STORAGE TECHNOLOGIES: Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications. **(9)**

STORAGE FOR RENEWABLE ENERGY SYSTEMS: Solar energy, Wind energy, pumped hydro energy, Energy storage in Micro-grid and Smart grid, Energy Management with storage systems, Battery SCADA, increase of energy conversion efficiencies by introducing energy storage. Special energy storage systems - Superconducting Magnetic Energy Storage (SMES), charging methodologies, Photo galvanic cells, semiconductor solar batteries (SC-SB), thermo-ionic converters, dye-sensitized solar cells (DSSC). **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Vladimir S. Bagotsky, Alexander M. Skundin, Yurij VM. Volfkovich., '*Electrochemical power sources: Batteries, fuel cells, and super capacitors*'. John Wiley & Sons, Inc.,2015.
2. AuliceScibioh M. and Viswanathan B. '*Fuel Cells – Principles and Applications'*. University Press, 2006.
3. Dell, Ronald M. Rand and David A. J. '*Understanding Batteries'*. Royal Society of Chemistry, 2001.

REFERENCES

1. D Kiehne H. A., '*Battery Technology Handbook'*. Expert Verlag, Renningen Malsheim, 2003.
2. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, '*Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach*'. Springer Publisher 1st Edition, 2020.
3. Ru-shi Liu, Lei Zhang and Xueliang sun, '*Electrochemical technologies for energy storage and conversion'*, Wiley publications, 2nd Volume set, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics and various types of energy storage systems.	**K2**
CO2	Apply the knowledge of energy storage systems for different applications.	**K3**
CO3	Analyze energy storage technologies and their impact on efficiency, reliability, and grid integration in renewable energy systems.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3					2							
CO3		2				2							
	3	**2**				**2**							

1 – low, 2 – medium, 3 - high

25EEM05 ELECTRICAL MACHINES for EVs

3 0 0 3

INTRODUCTION TO ELECTRIC VEHICLES AND DRIVE: Overview of Electric Vehicles (EVs): Types (BEV, HEV, PHEV, FCEV) - EV architecture and powertrain components - Vehicle dynamics: tractive effort, rolling resistance, aerodynamic drag - Torque-speed requirements for EV propulsion - Drive cycle analysis - Converters for motor drives. **(9)**

BRUSHLESS DC (BLDC) MOTORS FOR EV APPLICATIONS: Construction and working principle of BLDC motors - Electronic commutation and Hall sensors - Torque-speed characteristics of BLDC motors - Control methods - Applications in e-bikes, scooters, and light EVs. **(9)**

INDUCTION MOTORS FOR EV APPLICATIONS: Construction and working principle of three phase induction motors - Torque-speed characteristics – Basics of Vector control (Field Oriented Control - FOC) - Advantages and limitations of three phase induction motor in EVs. **(9)**

PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM): Construction and working principle of PMSM - Torque production and back EMF - Control strategies - Efficiency, power density, and thermal considerations - Comparison with BLDC and induction motors - Applications in modern EVs. **(9)**

SWITCHED RELUCTANCE MOTORS (SRM) AND ADVANCED MACHINES: Construction and working principle of SRM -Torque production and control – Advantages & limitations in EV – Axial flux motors – Comparison of Axial flux motors with PMSM and BLDC - Emerging trends in EV motor technology. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. K.C.Jain, Amit R.Patil, Arvind J. Bhosale, S.S. Raghuvanshi**, '***Fundamentals of Hybrid and Electric Vehicles'*. Khanna Publishers, India, 2024.
2. Sunil R. Pawar, *'Electrical Vehicle Technology: The Future Towards Eco-Friendly Technology'*. Notion Press, India, 2021.
3. Kwang Hee Nam, *'AC Motor Control and Electric Vehicle Applications'*. CRC Press, USA, 2010.

REFERENCES

1. John G. Hayes, G. Abas Goodarzi, '*Electrical Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles'*. John Wiley & Sons Inc, New Delhi, 2018.
2. P. K. Tripathi, *'Handbook on Electric Vehicles Manufacturing'*. NIIR Project Consultancy Services, India, 2022.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of electric vehicles, drive requirements, and the operating principles of BLDC, induction, PMSM, and SRM motors used in EV applications.	**K2**
CO2	Apply appropriate motor control strategies for different EV applications.	**K3**
CO3	Analyze and compare the performance, efficiency, and suitability of various electric machines (BLDC, induction, PMSM, SRM, and axial flux motors) for EV propulsion under different operating conditions.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
	3	**2**											

1 – low, 2 – medium, 3 - high

25EEM06 EV DATA ANALYTICS AND CYBER SECURITY

3 0 0 3

INTRODUCTION TO AUTOMOTIVE SYSTEMS AND CYBERSECURITY: Introduction to the automotive industry - automotive megatrends - automotive development process - automotive electrical and electronics - automotive software technology - connected cars - automotive cybersecurity. **(9)**

MOBILE CONNECTIVITY AND AUTONOMOUS VEHICLE SYSTEMS: Mobile apps for connected cars - car hailing and ride sharing - connected parking - automated valet parking - Advanced Driver-Assistance Systems (ADAS) - autonomous driving technologies - sensors and AI integration in self-driving cars. **(9)**

INTRODUCTION TO DATA ANALYTICS: Introduction to data analytics - application in automotive and EV industries - data analytics pipeline - data analytics tools and techniques - data collection in electric vehicles (EVs) - sensors in EVs - data acquisition and pre-processing. **(9)**

DATA ANALYSIS AND TECHNIQUES FOR AUTOMOTIVE SYSTEMS: Statistical analysis of EV and automotive system data - regression, classification, and clustering methods - Principal Component Analysis (PCA) - Linear Discriminant Analysis (LDA) - data collection in automotive systems (engines, transmissions, brakes) - sensor-based data analysis. **(9)**

PREDICTIVE ANALYTICS AND BIG DATA IN AUTOMOTIVE SYSTEMS: Predictive maintenance techniques - fault detection and diagnosis - Remaining Useful Life (RUL) prediction - big data platforms (Hadoop, Spark, Kafka) - processing and analyzing large-scale automotive data - real-time decision-making and predictive insights. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Moller, Dietmar PF, and Roland E. Haas, '*Guide to automotive connectivity and cybersecurity: trends, technologies, innovations and applications'*. *Springer Publishing Company*, Incorporated, 2019.
2. Nasser, Ahmad MK, '*Automotive Cybersecurity Engineering Handbook: The automotive engineer's roadmap to cyber-resilient vehicles*'. *Packt Publishing Ltd*, 2023.

REFERENCES

1. D'Anna, Gloria, '*Cybersecurity for Commercial Vehicles'*. *SAE International*, 2018.
2. Pascale, Francesco, Ennio Andrea Adinolfi, Simone Coppola, and Emanuele Santonicola, '*Cybersecurity in automotive: An intrusion detection system in connected vehicles'*. *Electronics*, vol. 10, no. 15, 2021.
3. Oka, Dennis Kengo, *'Building secure cars: assuring the automotive software development lifecycle'*. *John Wiley & Sons*, 2021.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the key concepts in automotive systems, connected vehicles, cybersecurity, and data analytics for electric and conventional vehicles.	**K2**
CO2	Apply concepts of automotive systems, and data analytics to analyze and solve real-world problems in electric and conventional vehicle systems.	**K3**
CO3	Analyze the challenges in automotive systems for the given scenario, and evaluate their impact on performance, safety, and maintenance in electric and conventional vehicles using data analytic techniques.	**K4**
CO4	Develop machine learning models to analyze automotive and EV datasets, train and test the models, and accurately predict key performance parameters for vehicle systems.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2		1	1								
CO4			1	1	1								
	3	**2**	**1**	**1**	**1**								

1 – low, 2 – medium, 3 - high

25EEM07 DESIGN MODELLING AND SIMULATION OF ELECTRIC VEHICLE

3 0 0 3

CONVENTIONAL POWERTRAIN SYSTEMS: IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions. **(9)**

ELECTRIC VEHICLE MECHANICS: Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics. **(9)**

BATTERY MODELING, TYPES AND CHARGING: Batteries in Electric and Hybrid Vehicles - Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Battery Modelling, Electric Circuit Models, Simulation of Battery Modelling and thermal analysis of Li-Ion Battery. **(9)**

CONTROL OF AC MACHINES: Introduction- Reference frame theory, basics-modelling of induction and synchronous machine in various frames-Vector control- Direct torque control, Simulation of vector control of induction motor. **(9)**

CONTROL SYSTEM DYNAMICS: 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, Simulation of boost converter and calculating gain and phase margin from the transfer function. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Iqbal Husain, '*Electric and Hybrid Vehicles, Design Fundamentals'*. 3rd Edition, CRC Press, 2021.
2. Teuvo Suntio, Tuomas Messo, Joonas Puukko, '*Power Electronic Converters, Dynamics and Control in Conventional and Renewable Energy Application*s'. 1st Edition, Wiley – VCH, 2017.
3. C.C. Chan and K.T. Chau, *'Modern Electric Vehicle Technology'*. OXFORD University Press,1st Edition, 2001.
4. Chee Mun Ong, '*Dynamic Simulation of Electric Machinery using MATLAB'*. Prentice Hall, 1st Edition 1997.

REFERENCES:

1. Ali Emadi, Mehrdad Ehsani, John M.Miller, '*Vehicular Electric Power Systems'*. Special Indian Edition, Marcel dekker, Inc 2003, 1st Edition.
2. Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, '*Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK'*. Wiley, 1st Edition, 2021.
3. Wie Liu, '*Hybrid Electric Vehicle System Modeling and Control'*. John Wiley & Sons, 2nd Edition, 2017.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the principles of conventional and electric powertrain systems, Vehicle Mechanics, battery technologies and fundamentals of control relevant to electric vehicle design.	**K2**
CO2	Apply concepts of electric vehicle mechanics and AC machine control to simulate performance and torque characteristics under varying load conditions.	**K3**
CO3	Analyze battery models, powertrain efficiency, and control system stability for the given specification.	**K4**
CO4	Design and simulate a basic electric propulsion system integrating battery models and vector-controlled AC machines with power electronic converters.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3				1								
CO3		1			1								
CO4			1		1								
	3	**1**	**1**		**1**								

1 – low, 2 – medium, 3 - high

25EEM08 UNMANNED AERIAL VEHICLES

3 0 0 3

INTRODUCTION TO DRONE TECHNOLOGY: 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. **(9)**

DRONE DESIGN, FABRICATION AND PROGRAMMING: 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. **(9)**

DRONE FLYING AND OPERATION: 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. **(9)**

DRONE COMMERCIAL APPLICATIONS: 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. **(9)**

FUTURE DRONES AND SAFETY: 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**.** **(9)**

TOTAL L: 45 Periods

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'*. John Wiley & Sons, Inc., 2001.
2. Terry Kilby 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: Legal and Social Implications for Security and Surveillance*'. Springer, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain concepts, classifications, components, and applications of drones in engineering and embedded systems contexts.	**K2**
CO2	Apply programming, and operational techniques for drones in practical environments.	**K3**
CO3	Analyze drone performance, flight operations, sensor integration, and control mechanisms.	**K4**
CO4	Design drone-based solutions considering safety, regulations, and future technological advancements.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			1		1								
	3	**2**	**1**		**1**								

1 – low, 2 – medium, 3 – high

OPEN ELECTIVES
25EEO01 INDUSTRIAL AUTOMATION

3 0 0 3

INTRODUCTION TO FACTORY & PROCESS AUTOMATION: Industrial Versions - Introduction to Architecture of Totally Integrated Automation (TIA) - Components of TIA and its Functions - Industrial Automation Control Elements IEC/ ISA symbols and Utilization category of Control Elements - Relay Ladder logic using control elements. **(9)**

PROGRAMMABLE LOGIC CONTROLLERS: Architecture of PLC - Types of PLC - PLC Configuration - PLC modules -Selection criteria for PLC - PLC Wiring - Installation of PLC and its modules. **(9)**

PROGRAMMING OF PLC: Types of Programming - Bit Instructions - Timers and counters - PLC arithmetic functions PTO / PWM generation - High Speed Counter - Analog Scaling - Encoder Interfacing - Servo drive control -Stepper Motor Control. **(9)**

HMI SYSTEMS: Need for HMI in Industrial Automation, - Types of HMI - Configuration of HMI, Screen development and navigation - Configuration of HMI elements / objects and Interfacing with PLC. **(9)**

SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA): Architecture - Tools - Tags - Graphics – Alarm logging - Tag logging - Trends - History - Report generation, Global Scripts for SCADA application. **(9)**

INDUSTRIAL NETWORKING: Types and comparison of Industrial Buses - Proprietary and open Protocols - OLE/OPC Networking standards & IEEE Standard - Introduction to Ether CAT - Applications of Various industrial Buses. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. W. Bolton, *'Programmable logic controllers'*. Elsevier Ltd, 2015.
2. Gordon Clarke, Deon Reyneders, Edwin Wright, *'Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems'.* Newnes Publishing, 2004.

REFERENCES:

1. John R Hackworth and Fredrick D Hackworth Jr, *'Programmable Logic Controllers: Programming Methods and Applications*'. Pearson Education, India, 2006.
2. SIEMENS, *'SIMATIC Programming with STEP 7'*. SIEMENS Manual, 2014.
3. SIEMENS, *'SIMATIC STEP 7 in the Totally Integrated Automation Portal'*. SIEMENS AG, 2012.
4. William T Shaw, *'Cybersecurity for SCADA systems'.* PennWell, USA, 2006.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the process of Totally Integrated Automation (TIA), PLC architecture, HMI, SCADA systems, and industrial networking concepts.	**K2**
CO2	Apply PLC programming techniques to control industrial processes.	**K3**
CO3	Analyse user-friendly HMI interfaces and SCADA operations for monitoring and controlling processes	**K4**
CO4	Design and implement automation systems for integrating PLC, HMI and SCADA.	**K6**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4			1										
	3	**2**	**1**										

1 – low, 2 – medium, 3 - high

25EEO02 EMBEDDED SYSTEM AND INTERNET OF THINGS

3 0 0 3

FUNDAMENTALS OF EMBEDDED SYSTEMS: Basic Terminologies – Characteristics of Embedded Computing Applications– Embedded Software Development Process – Challenges in Embedded System Design – Compiler Optimization Techniques – Performance Optimization – UML Diagrams – Examples. **(9)**

EMBEDDED SYSTEM DESIGN USING MIXED SIGNAL PROCESSORS: GPIO- Interrupts –Timers – Watchdog Timers – Analog to Digital Converter – Serial Communication – Low Power Modes. **(9)**

REAL-TIME OPERATING SYSTEMS: Concept of OS-based Software Development – Real-Time Operating Systems: Definition, Characteristics and Structure – Task Management: Classification, Structure, States, and Scheduling – Concept of Pseudo Multitasking and True Multitasking – Task Synchronization – Inter-task Communication – Features of FreeRTOS. **(9)**

INTERNET OF THINGS: Introduction to Industry 4.0 – Machine to Machine (M2M) – Evolution of IoT - Consumer IoT vs Industrial IoT - Functional Components of a typical IoT System – Fog Computing - Introduction to Cloud Computing. **(9)**

IOT PROTOCOLS: Physical and Data Link Layer Protocols: RFID: NFC, FFC, ZigBEE, Bluetooth Low Energy, Z- Wave, Wi-Fi, Wireless HART - Network Layer Protocols: IPv4, IPv6, TCP & UDP, 6LoWPAN - Application Layer Protocols: COAP, MQTT – Security Issues – serial communication protocols: SPI, I2C, CAN - IoT Applications: Health Care, Connected Vehicles, Smart Grid, Smart Home, and Smart City. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. K V Shibu, '*Introduction to Embedded Systems'*. 2nd Edition, McGraw Hill Education India Private Limited, India, 2017.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, '*The Internet of Things: Key Applications and Protocols'*. 2nd Edition, John Wiley and Sons Ltd, United Kingdom, 2012.

REFERENCES

1. David A. Simon, '*An Embedded Software Primer*'. 1st Edition, Pearson Education, India, 2002.
2. Qing Li, '*Real-Time Concepts for Embedded Systems*'. 1st Edition, CRC Press, US, 2003.
3. Wayne Wolf, '*Computers as Components: Principles of Embedded Computer Systems Design*'. Reed Elsevier Publications, Gurgaon, Haryana, 2009.
4. Adrian McEwen, Hakim Cassimally, '*Designing the Internet of Things'.* John Wiley and Sons Ltd, UK, 2014.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamentals of embedded systems, design challenges, and optimization techniques.	**K2**
CO2	Apply mixed-signal processor features (GPIO, ADC, timers) to design basic embedded applications.	**K3**
CO3	Analyze IoT protocols (BLE, Zigbee, MQTT) and their roles in consumer/industrial IoT systems.	**K4**
CO4	Evaluate embedded system architectures, RTOS features, IoT protocols, and communication technologies for developing efficient IoT-based applications.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4				1									
	3	**2**		**1**									

1 – low, 2 – medium, 3 - high

25EEO03 ENERGY TECHNOLOGIES

3 0 0 3

INTRODUCTION: 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**.** **(9)**

CONVENTIONAL ENERGY: 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. **(9)**

NON-CONVENTIONAL ENERGY: 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. **(9)**

BIOMASS ENERGY: Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification. **(9)**

ENERGY CONSERVATION: Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management**.** **(9)**

Total L: 45 Periods

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*'. Tata McGraw Hill, 1990.
4. Nagpal, G.R., '*Power Plant Engineering*'. Khanna Publishers, 2008.

REFERENCES

1. Nejat Vezirog, '*Alternate Energy Sources*'. Hemisphere Publishing Corporation, 1978.
2. El. Wakil,'*Power Plant Technology*'. Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., '*Solar Energy - Thermal Collection and Storage*'. Tata McGraw hill, New Delhi, 1981.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Describe the fundamentals and main characteristics of renewable energy sources.	**K2**
CO2	Apply renewable energy technologies such as solar, wind, ocean, geothermal, and biomass for sustainable energy applications.	**K3**
CO3	Analyze the performance and suitability of solar, wind, ocean, geothermal, and biomass energy systems.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	2												
CO3		1				1							
	2	**1**				**1**							

1 – low, 2 – medium, 3 - high

25EEO04 SENSORS AND ACTUATORS

3 0 0 3

SENSORS: Difference between sensor, transmitter and transducer - Primary measuring elements - selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, impedance, backlash, Response time, Dead band. Signal transmission - Types of signal: Pneumatic signal; Hydraulic signal; Electronic Signal. Principle of operation, construction details, characteristics and applications of potentiometer, Proving Rings, Strain Gauges, Resistance thermometer, Thermistor, Hot-wire anemometer, Resistance Hygrometer, Photo-resistive sensor. **(9)**

INDUCTIVE AND CAPACITIVE TRANSDUCER: Inductive transducers: - Principle of operation, construction details, characteristics and applications of LVDT, Induction potentiometer, variable reluctance transducer, synchros, microsyn. Capacitive transducers: - Principle of operation, construction details, characteristics of Capacitive transducers – different types & signal conditioning- Applications: capacitor microphone, capacitive pressure sensor, proximity sensor. **(9)**

ACTUATORS: Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator- Electro-Pneumatic actuator; cylinder, rotary actuators, Mechanical actuating system: Hydraulic actuator - Control valves; Construction, Characteristics and Types, Selection criteria. Electrical actuating systems: Solid-state switches, Solenoids, Electric Motors- Principle of operation and its application: D.C motors - AC motors - Single phase & 3 Phase Induction Motor; Synchronous Motor; Stepper motors - Piezoelectric Actuator. **(9)**

MICRO SENSORS AND MICRO ACTUATORS: Micro Sensors: Principles and examples, Force and pressure micro sensors, position and speed micro sensors, acceleration micro sensors, chemical sensors, biosensors, temperature micro sensors and flow micro sensors. Micro Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, other principles. **(9)**

SENSOR MATERIALS AND PROCESSING TECHNIQUES: Materials for sensors: Silicon, Plastics, metals, ceramics, glasses, nano materials Processing techniques: Vacuum deposition, sputtering, chemical vapour deposition, electro plating, photolithography, silicon micro machining, Bulk silicon micro machining, Surface silicon micro machining, LIGA process. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Patranabis.D, '*Sensors and Transducers'*. Wheeler publisher, 1994.
2. Sergej Fatikow and Ulrich Rembold, '*Microsystem Technology and Microbotics'*. 1st edition, Springer –Verlag Newyork, Inc, 1997.

REFERENCES:

1. Thomas. G. Bekwith and Lewis Buck.N, '*Mechanical Measurements'*. Oxford and IBH publishing Co. Pvt. Ltd., 2007.
2. Massood Tabib and Azar, '*Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures'*. 1st edition, Kluwer academic publishers, Springer, 1997.
3. Manfred Kohl, '*Shape Memory Actuators'*. 1st edition, Springer, 2004.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the fundamental concepts of sensors, transducers, transmitters, their characteristics, and signal transmission methods.	**K2**
CO2	Apply the principles of resistive, inductive, and capacitive transducers for measurement of physical parameters in practical systems.	**K3**
CO3	Analyze the performance and selection of actuators including pneumatic, hydraulic, and electrical actuating systems based on application requirements.	**K4**
CO4	Evaluate the operation and effectiveness of micro sensors and micro actuators, including MEMS-based devices and smart materials.	**K5**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		2											
CO4				1									
	3	**2**		**1**									

1 – low, 2 – medium, 3 - high

25EEO05 ELECTRICAL DRIVES

3 0 0 3

DRIVE CHARACTERISTICS: Electric drive - Equations governing motor load dynamics - steady state stability - multi quadrant Dynamics: acceleration, deceleration, starting & stopping - typical load torque characteristics- Selection of motor. **(9)**

CONVERTER / CHOPPER FED DC MOTOR DRIVES: Steady state analysis of the single and three phase converter fed separately excited DC motor drive - continuous and discontinuous conduction - Time ratio and current limit control - 4 quadrant operation of converter / chopper fed drive. **(9)**

AC MOTOR DRIVES: Induction Motor Drives - Stator voltage control-energy efficient drive-v/f control-constant airgap flux-field weakening mode - voltage / current fed inverter - closed loop control. Synchronous Motor Drives V/f control and self-control of synchronous motor: Margin angle control and power factor control**.** **(9)**

SPECIAL MACHINE DRIVES: PMSM: Types - Principle-Field Oriented Control of PMSM – Field weakening - BLDC motor – Trapezoidal Drive scheme – Sensor less Control scheme. Stepper motor: principle of operation – Bipolar & Unipolar Drive schemes - SRM drive: principle of operation - Introduction to SynRM drive. **(9)**

DIGITAL CONTROLLERS FOR DRIVES: Digital techniques in speed control - Microprocessor/Microcontroller & PLC based control of drives- networking of drives - Selection of drives and control schemes for Steel rolling mills, Paper mills, Cement mills, Machine tools, Lifts and Cranes. Robot - AGVs. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Dubey G K, *'Fundamentals of Electrical Drives'*. Narosa Publishing House, New Delhi, 2012.
2. Vedam Subramanyam, *'Electric Drives: Concepts and Applications'*. Tata McGraw-Hill, New Delhi, 2011.

REFERENCES

1. Ramu Krishnan R, '*Permanent-Magnet Synchronous and Brushless DC Motor Drives'*. CRC Press, 2017
2. Ned Mohan, Siddharth Raju, '*Analysis and Control of Electric Drives: Simulations and Laboratory Implementation*'. Wiley, 2021
3. JuhaPyrhonen, Valeria Hrabovcova, R. Scott Semken, '*Electrical Machine Drives Control: An Introduction*'. Wiley, 2016.
4. Peter, Vas, '*Vector control of AC machines'*. Oxford University Press,1990.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the motor load characteristics, power converters and controllers for electric drives.	**K2**
CO2	Compute the performance parameters for converter fed DC/AC & special drives.	**K3**
CO3	Analyse the working of different digital controllers employed for an electric drive application.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3												
CO3		1			1								
	3	1			1								

1 – low, 2 – medium, 3 - high

25EEO06 ELECTRIC VEHICLE TECHNOLOGY

3 0 0 3

VEHICLE ARCHITECTURE AND SIZING: Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications**.** **(9)**

VEHICLE MECHANICS: Vehicle mechanics - Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire – Road mechanics, Propulsion System Design. **(9)**

POWER COMPONENTS AND BRAKES: Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing. **(9)**

HYBRID VEHICLE CONTROL STRATEGY: Vehicle supervisory control, Mode selection strategy, Modal Control strategies. **(9)**

PLUG-IN HYBRID ELECTRIC VEHICLE: Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs. **(9)**

Total L: 45 Periods

TEXT BOOKS

1. Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, *'Heavy-duty Electric Vehicles from Concept to Reality'.* Elsevier Science, 2021
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, *'Electric Vehicles Modern Technologies and Trends'.* Springer, 2020
3. Rogelio León, Christian Montaleza , José Luis Maldonado , Marcos Tostado-Véliz and Francisco Jurado, *'Hybrid Electric Vehicles: A Review of Existing Configurations and Thermodynamic Cycles'*. Thermo, 2021.

REFERENCES

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, *'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals'.* Theory and Design', CRC Press, 2004.
2. Seth Leitman & Bob Brant, '*Build Your Own Electric Vehicle'*. Mc Graw Hill, 3rd Edition 2013.
3. Ali Emadi, '*Advanced Electric Drive Vehicles'*. CRC Press, 1st edition 2017.
4. Mark Warner, '*The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles*'. HP Books, 2011.

COURSE OUTCOMES

Upon completion of the course, students will be able to:		**Bloom's Level**
CO1	Explain the architecture, evolution, and classification of electric and hybrid electric vehicles.	**K2**
CO2	Apply vehicle mechanics principles to evaluate vehicle performance, propulsion requirements, and road load characteristics.	**K3**
CO3	Analyze the sizing and selection of powertrain components, transmission systems, and braking systems for EVs and HEVs.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3		1											
	2	1											

1 – low, 2 – medium, 3 - high

25EEO07 BIOMEDICAL INSTRUMENTATION

3 0 0 3

BIOELECTRIC POTENTIALS AND ELECTRODES: Cells and their structures - Transport of ions through cell membrane - Electrode-electrolyte interface, electrode– skin Interface - Origin of bio potential and its propagation - action and resting potential - Bioelectric potential - Bio potential electrodes – Types of electrodes: surface, needle and microelectrodes**.** **(9)**

CARDIO SYSTEM AND MEASUREMENTS: Heart and cardiovascular system – ECG – 12 lead system - principle of vector cardiography - blood pressure and its measurement – Measurements of heart sounds – PCG - Defibrillator: principle and types -pacemakers: principle and types. **(9)**

NERVOUS SYSTEM AND MEASUREMENTS: Central and peripheral nervous system - parts of human brain- Action potential of brain - brain wave – EEG- 10-20 electrode system – Nerve stimulator. **(9)**

RESPIRATORY SYSTEM AND MEASUREMENTS: Physiology of respiratory system - Principle of pneumograph - Spirometer - ventilators: principle and types. **(9)**

MEDICAL IMAGING: X-ray imaging - Computed Tomography (CT) - Ultrasonic Scanner- Magnetic Resonance Imaging - Positron Emission Tomography (PET). **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Leslie Cromwell, Fred J Weibell, Erich A. Pfeiffer, '*Biomedical Instrumentation and Measurements'*. Pearson Education, India, 2nd Edition, 2018.
2. Khandpur R S, '*Handbook of Biomedical Instrumentation'*. McGraw Hill Education (I) P Ltd, Chennai, 5th Edition, 2018.

REFERENCES:

1. John G Webster, '*Medical Instrumentation: Application and Design'*. John Wiley and Sons, 5th Edition, 2020.
2. Joseph J Carr, John M Brown, '*Introduction to Biomedical Equipment Technology'*. Pearson Education, India, 4th Edition, 2006.
3. L.A.Geddes, L.E. Baker, '*Principles of Applied Biomedical Instrumentation'*. John Wiley and Sons, 3rd Edition, 2009.
4. Richard Aston, '*Principles of Biomedical Instrumentation and Measurement'*. Merril Publishing Company, New York,1St Edition, 1990.

COURSE OUTCOMES:

Upon successful completion of the course, the students should be able to:		**Bloom's Level**
CO1	Describe the origin and propagation of bioelectric potentials and explain the types and functions of biopotential electrodes	**K2**
CO2	Apply the principles of measurement techniques for monitoring cardiac, nervous, and respiratory system functions	**K3**
CO3	Analyse the operation and significance of biomedical instruments such as ECG, EEG, defibrillators, pacemakers, spirometers, and ventilators.	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3												
CO3		1											
	3	**1**											

1 – low, 2 – medium, 3 - high

25EEO08 ELECTRICAL SAFETY PRACTICES AND STANDARDS

3 0 0 3

INTRODUCTION TO ELECTRICAL SAFETY: Fundamentals of Electrical safety – Electric Shock – Physiological effects of electric current – Safety requirements – Hazards of electricity – Arc – Blast – Causes for electrical failure. **(9)**

SAFETY COMPONENTS: Introduction to conductors and insulators – Voltage classification – Safety against over voltages – Safety against static electricity – Electrical safety equipment – Fire extinguishers for electrical safety – Introduction to modern protective technologies including smart protection devices and IoT-enabled relays. **(9)**

GROUNDING: General requirements for grounding and bonding – Definitions – System grounding – Equipment grounding – The Earth – Earthing practices – Determining safe approach distance – Determining arc hazard category. **(9)**

SAFETY PRACTICES: General first aid – Safety in handling hand-held electrical appliances and tools – Electrical safety in train stations, swimming pools, external lighting installations, and medical locations – Safety practices in electric vehicle (EV) charging infrastructure – Case studies. **(9)**

STANDARDS FOR ELECTRICAL SAFETY: Electricity Acts – Rules & regulations – Electrical standards – NFPA 70E – OSHA standards – IEEE standards – National Electrical Code 2023 – National Electrical Safety Code (NESC) – Statutory requirements from Electrical Inspectorate. **(9)**

Total L: 45 Periods

TEXT BOOKS:

1. Dennis K. Neitzel, Mary Capelli-Schellpfeffer, Al Winfield, '*Electrical Safety Handbook'*. *McGraw-Hill*, USA, 2019.
2. National Fire Protection Association (NFPA), '*NFPA 70E: Handbook for Electrical Safety in the Workplace'*. *NFPA*, USA, 2024.
3. Charles R. Miller, '*Illustrated Guide to the National Electrical Code'*. *Cengage Learning*, USA, 2023.

REFERENCES:

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, '*Electrical Safety Handbook'*. *McGraw-Hill*, USA, 2012.
2. Dale R. Patrick, Stephen W. Fardo, '*Principles of Electrical Safety'*. *CRC Press*, Boca Raton, USA, 2020.
3. Richard A. Cox, '*Electrical Safety in the Workplace'*. *Jones & Bartlett Learning*, Burlington, USA, 2019.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand different types of electrical hazards, electrical safety standards and regulations	**K2**
CO2	Apply the knowledge of electrical safety standards and regulations like OSHA, IEEE and National Electrical Code during installation, testing and commissioning procedure	**K3**
CO3	Analyze electrical hazards and provide solutions to minimize risks of electrical accidents	**K4**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	3					2	2						
CO3		2				2	2						
	3	**2**				**2**	**2**						

1 – low, 2 – medium, 3 - high

ONE CREDIT COURSES

25EE901 PCB DESIGNING
(Common to EEE & ICE)

0 0 2 1

INTRODUCTION TO PCB DESIGN CONCEPTS: Introduction and Brief History – PCB Types: Single Sided and Multi-Layer – PCB Materials – Introduction to Electronic Design Automation (EDA). **(6)**

COMPONENT CATEGORIES AND PACKAGE TYPES: Active Components: Diode, Transistor, MOSFET, LED, SCR, Integrated Circuits – Passive Components: Resistor, Capacitor, Inductor, Transformer – Reading Component Package Types and Footprints from datasheet. **(6)**

PCB DESIGN: Introduction to PCB Software Platform – Schematic Drawing – Component Library and Footprint Assignment – PCB Layout Design– Gerber File Generation and Export. **(8)**

PCB LAYOUT DESIGN, FABRICATION AND ASSEMBLY: Prototype Design – Printing, Etching and Drilling – Component Assembly and Testing. **(10)**

Total P: 30 Periods

TEXT BOOKS:

1. R. S. Khandpur, '*Printed Circuit Boards: Design, Fabrication, and Assembly'*. McGraw-Hill, 2005
2. Walter C. Bosshart, '*Printed Circuit Boards: Design and Technology'*. McGraw-Hill, 1983

REFERENCES:

1. EasyEDA Documentation, Available: https://docs.easyeda.com/en/Introduction/PCB-Layout/
2. https://docs.kicad.org/

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of PCB design including types and materials.	**K2**
CO2	Apply knowledge of active and passive components and their package types in PCB design.	**K3**
CO3	Analyse different PCB design stages including schematic creation, net-listing, layout and prototype assembly.	**K4**
CO4	Design a complete PCB incorporating appropriate components, footprints and assembly techniques for the given application.	**K6**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3										3		3
CO3		1									1		1
CO4			3		3			2	2		3		3
	3	**3**	**3**		**3**			**2**	**2**		**3**		**3**

1 – low, 2 – medium, 3 - high

25EE902 MODELLING AND COMPUTATIONAL TOOLS FOR ELECTRICAL ENGINEERS

(Common to EEE & ICE)

0 0 2 1

MATLAB FOR ELECTRICAL ENGINEERS: Matrix Operations for KVL and KCL – Plotting: Time-domain Waveforms and Multi-plot Figures – User-defined Functions – Loops and Conditional Statements. **(6)**

DATA ACQUISITION, LOGGING AND PREDICTION: Serial Communication between Arduino and MATLAB – Real-time Data Capture and Plotting – Threshold-based Event Detection – Data Storage and CSV Export – Curve Fitting and Regression toolbox. **(6)**

SOLVING ODES IN MATLAB: RC Circuit: Analytical Solution – RC Circuit: Euler Method – RC Circuit: ODE45 – DC Motor: Equation and Problem Statement – DC Motor: Euler Method – DC Motor: ODE45. **(6)**

MODEL-BASED SYSTEM DESIGN (MBSD) USING SIMULINK: Introduction to Simulink Environment – Counter – Edge Detector – Latch – Windshield Wiper Model – Simple Vehicle Model: Equation to Simulink. **(6)**

DC MOTOR MODELLING AND MINI PROJECT: Introduction to Simscape Physical Modelling – DC Motor in Simscape: Comparison with Simulink Model – DC Motor Thermal Modelling – Closed-loop Speed Control – Mini Project: Simulation and Performance Analysis of an Electrical or Electromechanical System, MBSD for electromechanical system. **(6)**

Total P: 30 Period

TEXT BOOKS:

1. Rudra Pratap, '*Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers'*. Oxford University Press, 2019
2. Stormy Attaway, '*MATLAB: A Practical Introduction to Programming and Problem Solving'*. 5th Edition, Butterworth-Heinemann, 2022
3. MathWorks, '*Simulink Getting Started Guide'*. MathWorks Documentation, 2024, Available: https://www.mathworks.com/help/simulink

REFERENCES:

1. MathWorks, '*Simscape User's Guide'*. MathWorks Documentation, 2024, Available: https://www.mathworks.com/help/physmod/simscape
2. NPTEL Course '*MATLAB Programming for Numerical Computation'*.
3. Prof. Niket Kaisare, IIT Madras

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain MATLAB programming environment and matrix methods for electrical engineering problems.	**K2**
CO2	Apply MATLAB to acquire, log, analyse and predict from real-time engineering data.	**K3**
CO3	Analyse physical systems using Simulink and Simscape toolbox.	**K4**
CO4	Build	**K5**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3											1	1
CO3		3			3							1	1
CO4										3			
	3	**3**			**3**					**3**		**1**	**1**

1 – low, 2 – medium, 3 - high

25EE903 VHDL AND VERILOG PROGRAMMING

(Common to EEE & ICE)

0 0 2 1

COMBINATIONAL CIRCUIT DESIGN USING VERILOG/VHDL: Introduction to Verilog and VHDL – VHDL File Structure and Operators – How to Write Verilog Code – Hands-on using Simulation – Code Development for Combinational Circuits: Multiplexers, Demultiplexers, Adders, Subtractors, Encoders, Decoders, Code Converters. **(6)**

SEQUENTIAL CIRCUIT DESIGN AND TEST BENCH: Verilog/VHDL Code for Synchronous Sequential Circuits – Latches and Flip-flops – Counters and their Types – Shift Registers – Test Bench Development. **(6)**

FSM DESIGN AND IMPLEMENTATION: Finite State Machine: Mealy and Moore Models – Sequence Detector using FSM – Complete Memory Design – FPGA Board. **(6)**

DIGITAL SYSTEM DESIGN AND FPGA DEMONSTRATION: Smart Traffic Light Controller using FSM: Mealy/Moore, Counters, Multiplexers – Digital Voting Machine: Sequential Circuits, Shift Registers, Encoders – 4-bit Arithmetic Logic Unit: Combinational Logic, Adders, Subtractors – Automatic Vending Machine using FSM: Decoders, Counters – FPGA Board Implementation and Demonstration. **(12)**

Total P: 30 Periods

TEXT BOOKS:

1. M. G. Arnold, '*Verilog Digital Computer Design: Algorithms into Hardware'*. New York, NY, USA: McGraw-Hill Education, 1999.
2. J. Cavanagh, '*Digital Design and Verilog HDL Fundamentals'*. Boca Raton, FL, USA: CRC Press, 2008.

REFERENCES:

1. P. D. Minns and I. J. Elliott, '*Digital System Design Using FSMs: A Practical Learning Approach'*. Chichester, U.K.: Wiley, 2008.
2. D. Thomas, '*Digital VLSI Design Using Verilog'*. New York, NY, USA: Springer, 2008.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Write Verilog/VHDL code using software for combinational and sequential circuits including multiplexers, counters and FSMs.	**K2**
CO2	Develop and demonstrate a functional digital system on FPGA integrating FSM and combinational or sequential logic.	**K3**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3												
CO2			3		3						1		3
	3		**3**		**3**						**1**		**3**

1-low, 2-medium, 3-high

25EE904 ELECTRIC VEHICLE TECHNOLOGY

(Common to EEE & ICE)

0 0 2 1

BATTERY TECHNOLOGY FOR ELECTRIC VEHICLES: Introduction to Energy Storage Systems – Types of Batteries – Battery Characteristics – Thermal Effects in Batteries – Battery Packaging and Safety Considerations. **(6)**

EV CHARGING TECHNOLOGY: Types of EV Chargers – AC Charging – DC Fast Charging – Wireless Charging – Charging Standards and Protocols – Charging Infrastructure Requirements. **(6)**

BATTERY MANAGEMENT SYSTEM: Functions of BMS – Cell Balancing – SOC and SOH Estimation Techniques – Communication Protocols in BMS – Thermal Management in BMS – Fault Detection and Diagnostics. **(6)**

SUSTAINABILITY OF EVs: Life Cycle Assessment of EVs – Battery Cycler with Data Analytics – Policies and Regulations for EV Adoption. **(6)**

EV DRIVE TRAIN MODELLING AND SIMULATION: Components of EV Drive Train – Mathematical Modelling of EV Drive Train – Vehicle Dynamics and Load Modelling – Performance Analysis – Case Study and Mini Project on EV. **(6)**

Total P: 30 Periods

TEXT BOOKS:

1. Iqbal Husain, '*Electric and Hybrid Vehicles: Design Fundamentals'*. CRC Press, 2021.
2. Davide Andrea, '*Battery Management Systems for Large Lithium-Ion Battery Packs'*. ARTECH House, 2010.
3. Gregory L. Plett, '*Battery Management Systems, Volume I: Battery Modelling'*. Artech House, 2015.

REFERENCES:

1. Tom Denton, '*Automotive Electrical and Electronic Systems'*. 5th Edition, 2018
2. Phil Weicker, '*Battery Management Systems and SOC Development: A Hands-On Approach'*. SAE International, 2013

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics of battery and electric vehicle technology.	**K2**
CO2	Apply fundamental concepts of EV charging systems and battery charging characteristics.	**K3**
CO3	Analyse battery performance data, EV driveline performance and communication protocols for EV application.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				2							1	1
CO3		3			3							1	1
	3	**3**			**3**							**1**	**1**

1-low, 2-medium, 3-high

25EE905 DATA SCIENCE AND ANALYTICS FOR ELECTRICAL ENGINEERS

(Common to EEE & ICE)

0 0 2 1

INTRODUCTION TO DATA AND MACHINE LEARNING: Data Warehouse and Business Intelligence – Big Data – Machine Learning – Deep Learning – How these Technologies Evolved and Interconnected. **(6)**

REVIEW OF BASIC ANALYTICS METHODS: Phase 1: Discovery – Phase 2: Data Preparation – Phase 3: Model Planning – Phase 4: Model Building – Phase 5: Communicate Results and Visualization – Phase 6: Operationalize and Optimize Model – Demo and Lab Assignment. **(6)**

INTRODUCTION TO ADVANCED ANALYTICS: Unsupervised Learning: Basics of Unsupervised Learning – K-means Clustering – Association Rules – Regression Analysis: Linear and Logistic. **(6)**

INTRODUCTION TO ADVANCED ANALYTICS: Supervised Learning: Basics of Supervised Learning – Naive Bayesian Classifier – Decision Trees – Time Series Analysis – Text Analysis. **(6)**

USE CASES OF BIG DATA AND MACHINE LEARNING FOR ELECTRICAL ENGINEERS: Smart Meters and Smart Grid Applications. **(6)**

Total P: 30 Periods

TEXT BOOKS:

1. Ethem Alpaydin, '*Introduction to Machine Learning'*. 2nd Edition, PHI Learning Pvt. Ltd, New Delhi, 2020.
2. Vignesh Prajapati, '*Big Data Analytics with R and Hadoop'*. 1st Edition, Packt Publishing Ltd, Mumbai, 2013.
3. Zhou Shiyu and Yong Chen, '*Industrial Data Analytics for Diagnosis and Prognosis: A Random Effects Modelling Approach*'. John Wiley and Sons, 2021.

REFERENCES:

1. Lee Elisa T. and John Wang, '*Statistical Methods for Survival Data Analysis'*. Vol. 476, John Wiley and Sons, 2003.
2. Colin Ware, '*Information Visualization: Perception for Design'*. Elsevier, 2013.
3. Kieran Healy, '*Data Visualization: A Practical Introduction'*. Princeton University Press, 2018.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basics of data analytics and machine learning techniques.	**K2**
CO2	Apply data analytics and machine learning techniques to develop and implement prognostic models for electrical engineering applications.	**K3**
CO3	Analyse data from automotive and industrial systems to evaluate and compare machine learning models for real-time applications.	**K4**

COs-POs & PSOs MAPPING

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	3				2								2
CO3		3			3								2
	3	**3**			**3**								**2**

1-low, 2-medium, 3-high

LANGUAGE ELECTIVES

25HS211 COMMUNICATION SKILLS FOR ENGINEERS
(Common to all B.E./B.Tech. Programmes)

0 0 4 2

COMMUNICATION CONCEPTS: Process of Communication – Inter and Intrapersonal Communication – Essentials for effectiveness. **(9)**

ORAL COMMUNICATION: Oral presentations with visual aids and Group discussions. **(16)**

FOCUS ON SOFT SKILLS: Etiquette – Work Place etiquette – Telephone etiquette- Body Language – Critical Reasoning and Conflict Management based on Case Studies – Group Communication- Meetings -Interview Techniques. **(14)**

TECHNICAL WRITING: Technical Writing Principles - Style and Mechanics - Technical Definitions – Physical, Functional and Process Descriptions – Technical Report Writing – Preparing Instructions – Interpretation of Technical Data. **(14)**

BUSINESS CORRESPONDENCE: Writing Emails, Preparing Resumes. **(7)**

Total P: 60 periods

TEXT BOOKS

1. Course materials prepared by the Faculty, Department of English, PSG Institute of Technology and Applied Research, Neelambur, Coimbatore.

REFERENCES

1. Jeff Butterfield, '*Soft Skills for Everyone*'. Cengage Learning, New Delhi, 2020.
2. Sabina Pillai, and Agna Fernandez, '*Soft skills and Employability Skills*'. Cambridge University Press, New Delhi, 2019.
3. Prashant Sharma, '*Soft Skills Personality Development for Life Success*'. BPB Publications, New Delhi, 2021.
4. K. N. Shoba, and D. Praveen Sam, '*Technical English*'. Cambridge University Press, New York, 2020.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Produce clear and concise technical reports, compose professional and effective emails and develop well-structured and impactful resumes	**K2**
CO2	Plan, organize, and deliver engaging and informative presentations using appropriate visual aids and participate positively in group discussions	**K3**
CO3	Resolve disagreements constructively, embody professional conduct and a strong work ethic and apply critical thinking to generate effective solutions	**-**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1										2			
CO2										3			
CO3									3	3			
									3	**3**			

1-low, 2-medium, 3-high

25HS212 BASIC GERMAN
(Common to all B.E./B.Tech. Programmes)

0 0 4 2

GUTEN TAG! - LEARNING: To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages; **Vocabulary:** related to the topic; **Grammar:** W – Questions, Verbs & Personal pronouns I.

FREUNDE, KOLLEGEN UND ICH - LEARNING: To speak about hobbies, jobs, learn numbers from 20; **Vocabulary:** related to the topic; **Grammar:** Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural.
IN DER STADT – LEARNING: To know places, buildings, question, know transport systems, understand international words; **Vocabulary**: related to the topic; **Grammar:** Definite & indefinite articles, Negotiation, Imperative with Sie.
GUTEN APPETIT! – LEARNING: To speak about food, shop, converse; **Vocabulary:** related to the topic; **Grammar:** Sentence position, Accusative, Accusative with verbs.

TAG FŸR TAG AND ZEIT MIT FREUNDEN – LEARNING: To learn time related expressions, speak about family, ask excuse, fix appointments on phone, birthdays, understand & write invitations, converse in the restaurant; **Vocabulary:** related to the topic; **Grammar:** Preposition – am, im, um, von…bis, Possessive articles, Modal verbs.

Total P: 60 periods

TEXT BOOK:

1. Dengler, Stefanie et al., '*Netzwerk A1.1*'. Klett-Langenscheidt Gmbh, München, 2013.

REFERENCES:

1. Dengler, Stefanie et al., '*Netzwerk A1'.* Klett-Langenscheidt Gmbh München, 2013.
2. Sandra Evans, Angela Pude, and Franz Specht, '*Menschen A1*'. Hueber Verlag, 2012.
3. Hermann Funk, Christina Kuhn, and Silke Demme, '*Studio d A1*'. Goyal Publishers & Distributors Pvt. Ltd, 2009.
4. Rosa-Maria Dallapiazza, Eduard von Jan, '*Til Schönherr*'. Tangram Aktuell 1 (Deutsch als Fremdsprache), Max Hueber Verlag, 2004.

25HS213 BASIC JAPANESE
(Common to all BE/B. Tech Programmes)

0 0 4 2

Orientation Session, Geographic & Socio, economic perspective to Japan, Japanese people and culture and Basic greetings and responses.

Basic script, Method of writing hiragana and katakana, and Combination sounds and simple words.

Topic marker "wa", Desu / dewa arimasen cupolas, Interrogative particle "ka", Grammar particles "mo", "no", "Introducing someone: "Kochira wa ~" and Self introductions: Hajimemashite"

Demonstratives "Kore", "Sore", "Are", Demonstrative "Kono", "Sono", "Ano", Possessive noun particle "no" and Japanese apartments: Greeting your neighbor.

Place markers "Koko", "Soko", "Asoko", Direction markers "Kochira", "Sochira", "Achira" and Japanese department stores: Asking for and buying something.

Asking for and telling the time, Particle "ni (at)" for time, kara (from) ~ made (until), Particle "to (and)", Time periods: Days of the week, months, time of day, Verbs (Present / future and past tense) and Telephone enquiry: Asking for a phone no. And business hours.

Destination particle "e", Particles "de (mode of transportation)" and "to (with) and Japanese train station: Asking for Fare and track no. / types of trains.

Direct object particle "o", Particle "de (place of action)", Verbs ("~masen ka", "~mashou") and "Ohanami" Cherry blossom viewing.

Particle "de (by means of)", Particle "ni (to)", Aaemasu (give) and Moraimasu (receive) and Visiting a Japanese house.

Adjectives ("i" and "na" type), Adjectives (Positive and negative usage), Particle "ga (however, but), "Dore which?)" and Leaving a room, thanking someone for hospitality.

Likes and dislikes, Potential verbs (wakarimasu and dekimasu), "Kara (~ because)", Adverbs and Asking someone out over the phone.

Verbs denoting presence: "Imasu" and "arimasu", Particle "ni (in)", "Dare (who?)", Adverbs ("Chikaku ni ~ "), Particle "dare mo (negative ~ no one)" , Dare ka (anyone), dare ga (who) , Nani ka (anything) , nani ga (what) - ~ya (and) ~ nado (etc.) and Asking for directions.

Counters and Counting suffixes.

Introduction to Adjectives (na and ii type), Different usages of adjectives, Comparison, Likes and dislikes and Going to a trip.

Need and desire (ga hoshii), Wanting to … (Tabeti desu), Going for a certain purpose (mi –ni ikimasu) and Choosing from a menu.
Verb groups, I, II and III and Exercises to group verbs.

Please do (te kudasai), Present continuous tenses (te imasu), Shall I? (~ mashou ka) and Describing a natural phenomenon (It is raining).
To grant permission (~te mo ii desu), Asking for permission (~ te mo ii desu ka) and Should not do (~ te waikemasen) Describing a continuing state and Describing a habitual action.
Roleplays in Japanese.
A demonstration on usage of chopsticks and Japanese tea party. **Total P: 60 periods**

TEXT BOOK

1. '*Minna no nohongo'.* – Romaji ban (first 10 lessons of this book).

REFERENCE

1. '*Minna no Nihongo I Honsatsu Roma – ji ban (Main Textbook Romanized Version)'.* International publisher – 3A Corporation,Tokyo, Indian distributor – Goyal Publishers & Distributors, New Delhi

MANDATORY COURSES
25MC001 ENVIRONMENTAL SCIENCE
(Common to B.E./B.Tech. Programmes)

3 0 0 3

INTRODUCTION TO ENVIRONMENT: Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega-diversity nation, hotspots of biodiversity, endangered and endemic species of India, conservation of biodiversity. **(9)**

ENERGY RESOURCES: Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal, geothermal, hydroelectric. **(9)**

ENVIRONMENTAL POLLUTION: Definition, Sources, causes, impacts and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, RF hazards, Role of an individual in prevention of pollution. Disaster Management: Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures. **(9)**

WASTE MANAGEMENT: Waste water - Characteristics of domestic and industrial wastewater - COD and BOD, Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste (MSW), biomedical, automobile and e-wastes and their management, landfills, incineration, pyrolysis, gasification and composting**.** **(9)**

SOCIAL ISSUES AND THE ENVIRONMENT: Environmentally Sustainable work practices- Rain water harvesting, Role of non-governmental organizations. Human ethics and rights- impact on environment and human health, role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. **(9)**

Total L: 45 periods

TEXT BOOKS:

1. Gilbert M. Masters, '*Introduction to Environmental Engineering and Science*'. Pearson Education, New Delhi, 2004.
2. Deswal S and Deswal A, '*A Basic Course in Environmental Studies*'. Dhanpat Rai and Co, New Delhi, 2004.

REFERENCES:

1. Benny Joseph, '*Environmental Science and Engineering*'. Tata McGraw - Hill, New Delhi, 2006.
2. Koteswara Rao M V R, '*Energy Resources: Conventional & Non – Conventional*'. BSP Publications, New Delhi, 2006.
3. Botkin and Keller, '*Environmental Science*'. Wiley India Private Limited, New Delhi, 2013.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the basic concepts of environment, energy sources and waste management	**K2**
CO2	Use different renewable energy resources and environment protection measures for sustainable development	**K3**
CO3	Conduct a case study on real-time environmental issues and present findings as a team	**-**

COs-POs & PSOs MAPPING:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1													
CO2	1												
CO3						2	2	2			2		
	1					**2**	**2**	**2**			**2**		

1-low, 2-medium, 3-high

25MC002 INDIAN CONSTITUTION
(Common to B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION: Evolution of Indian Constitution; significance of constitution; Composition; Preamble and its Philosophy. **(4)**

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES: Fundamental Rights- Writs and Duties, Directive Principles of State Policy. **(5)**

UNION GOVERNMENT: Union Government, President and Vice President, Houses of the Parliament and their functions; Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. **(6)**

STATE GOVERNMENT AND FEDERALISM: Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States. **(8)**

JUDICIARY: Supreme Court, High Court; District Court and Lower Courts - Functions and Powers – Judges – Qualifications and Powers - Judicial Review. **(7)**

Total L: 30 periods

TEXT BOOKS:

1. Subash C Kashyap, '*Our Political System*'. National Book Trust, 2011.
2. Praveenkumar Mellalli E, '*Constitution of India, Professional Ethics and Human Rights*'. Sage Publications India Pvt. Ltd., 2015.

REFERENCES:

1. Briji Kishore Sharma, '*Introduction to the Constitution of India*'. Prentice Hall of India, 2010.
2. Basu D D, '*Introduction to the Constitution of India*'. Prentice Hall of India, 2016.
3. Jain. M C, '*The Constitution of India*'. Law House, New Delhi, 2001.
4. Shukla V N, '*Constitution of India*'. Eastern Book Company Ltd., New Delhi, 2011.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the evolution, significance, and philosophy of the Indian Constitution, including its Preamble, composition, and core principles.	**K2**
CO2	Analyze the structure, powers, and functions of the Union and State Governments, including the roles of the President, Parliament, Governor, and Council of Ministers, as well as the legislative process, types of bills, and constitutional amendments.	**K4**
CO3	Conduct a case study on the Indian Constitution, demonstrating understanding of its evolution, fundamental rights and duties, structure of Union and State governments, federal system, and the role of the judiciary in governance.	**-**

COs-POs & PSOs MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2												
CO3								2	2		2		
	2							**2**	**2**		**2**		

1-low, 2-medium, 3-high

25MC003 INDUSTRIAL SAFETY
(Common to B.E./B.Tech. Programmes)

2 0 0 0

SAFETY TERMINOLOGIES: Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators-Flammability- Toxicity Time-weighted Average (TWA) - Threshold Limit Value (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. **(6)**

STANDARDS AND REGULATIONS: 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. **(6)**

SAFETY ACTIVITIES: 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. **(6)**

WORKPLACE HEALTH AND SAFETY: 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. **(6)**

HAZARD IDENTIFICATION TECHNIQUES: 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. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Jain R. K. and Sunil S. Rao, '*Industrial Safety, Health and Environment Management Systems*'. Khanna Publisher, 4th Edition, 2000.
2. Deshmukh L. M., *'Industrial Safety Management: Hazard Identification and Risk Control'.* McGraw-Hill Education, 2007.

REFERENCES

1. John Ridley, John Channing, '*Safety at Work*'. Routledge, 7th Edition, 2008.
2. Dan Petersen, '*Techniques of Safety Management*: *A System Approach*'. Amer Society of Safety Engineers, 4th Edition, 2003.

COURSE OUTCOMES

At the end of the course, students will be able to		Bloom's Level
CO1	Describe the safety protocols and standard operating procedures in industrial settings to ensure compliance with safety regulations and minimize hazards in the workplace.	**K2**
CO2	Implement and test emergency response plans tailored to the industrial environments, ensuring effective action during emergencies such as fires, chemical spills or equipment malfunctions.	**K3**
CO3	Review and present on risk assessments and hazards using industry-specific tools to identify potential safety risks and choose appropriate corrective actions to prevent accidents and injuries.	-

CO - PO & PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1													
CO2	2					2	2						
CO3						1	1	1	1		1		1
	2					**2**	**2**	**1**	**1**		**1**		**1**

1 - low, 2- medium, 3 – high

25MC004 DISASTER RISK REDUCTION AND MANAGEMENT
(Common to B.E./B.Tech. Programmes)

2 0 0 0

HAZARDS, VULNERABILITY AND DISASTER RISKS: 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. **(6)**

DISASTER RISK REDUCTION (DRR): Sendai Framework for Disaster Risk Reduction, Disaster cycle - Community Based DRR, Structural – Non-structural measures, Roles and responsibilities of - community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders - Early Warning System – Relevance of indigenous Knowledge, appropriate technology and Local resources. **(6)**

DISASTER MANAGEMENT: 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 - Institutional Processes and Framework at State and Central Level - (NDMA – SDMA – DDMA – NRDF - Civic Volunteers). **(6)**

TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT: 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 in Disaster Management – Disaster Damage Assessment - Elements of Climate Resilient Development – Standard operation Procedure for disaster response – Financial planning for disaster Management. **(6)**

DISASTER MANAGEMENT: CASE STUDIES: Case studies in the context of disasters - Landslide Hazard Zonation, Earthquake Vulnerability Assessment of Buildings and Infrastructure, Drought Assessment, Coastal Flooding, Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding, Forest Fire, Man Made disasters. **(6)**

Total L: 30 periods

TEXTBOOKS

1. Thomas D. Schneid, and Larry Collins, '*Disaster Management and Preparedness*'. CRC Publications, 2016.
2. R. Singh, '*Disaster Management Guidelines: Earthquakes, Landslides, Avalanches and Tsunami'*. Horizon Press Publications, 2017.
3. J. P. Singhal, '*Disaster Management'*. Laxmi Publications, 2024.
4. T. Bhattacharya, '*Disaster Science and Management'*. McGraw Hill India Education Pvt. Ltd., 2012.

REFERENCES

1. Government of India, '*Disaster Management Act'*. New Delhi, 2005.
2. Government of India, '*National Disaster Management Policy'*. New Delhi, 2009.
3. R. Shaw, '*Community based Disaster risk reduction*'. Natural Hazard Science, Oxford Research Encyclopedias, 2016.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Summarize the concepts, tools, technologies and strategies for disaster risk reduction and management.	**K2**

COs-POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1					1	1	1	1	1		1		
					1	**1**	**1**	**1**	**1**		**1**		

1-low, 2-medium, 3-high

25MC005 INDIAN KNOWLEDGE SYSTEMS FOR SUSTAINABLE HUMAN DEVELOPMENT

2 0 0 0

INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS & HUMAN DEVELOPMENT (6)

- Meaning, scope, and significance of Indian Knowledge Systems
- Indian view of life: Purusharthas (Dharma, Artha, Kama, Moksha)
- Relationship between individual, society, and nature
- Relevance of IKS in modern education and engineering

INDIAN PERSPECTIVES ON SUSTAINABILITY & ECOLOGY (6)

- Indian worldview on nature: Pancha Mahabhutas
- Traditional water management, agriculture, and resource conservation
- Sustainable lifestyles in Indian traditions
- Comparison with modern sustainable development goals (SDGs

HEALTH, WELL-BEING & HUMAN POTENTIAL IN IKS (6)

- Indian concept of health: Body–Mind–Spirit integration
- Introduction to Ayurveda & Yoga for sustainable health
- Mental health and emotional balance in Indian wisdom
- Food, nutrition, and lifestyle from IKS perspective
- Preventive healthcare through traditional knowledge

ETHICS, VALUES & SOCIAL SUSTAINABILITY (5)

- Work ethics and leadership in Indian tradition
- Gender dignity and social justice in Indian thought
- Professional ethics through IKS

IKS, TECHNOLOGY & SUSTAINABLE DEVELOPMENT (7)

- Science and technology in ancient India
- Sustainable engineering in traditional architecture and town planning
- Metallurgy, textiles, and indigenous manufacturing systems
- IKS and modern innovation ecosystems and ethical responsibility
- Role of engineers in sustainable human development **Total L: 30 periods**

TEXTBOOKS:

1. Dharampal, Indian Science and Technology in the Eighteenth Century
2. Kapil Kapoor, Indian Knowledge Systems
3. S Radhakrishnan, Indian Philosophy
4. B K Matilal, The Character of Logic in India
5. UGC–IKS Documents and AICTE IKS Modules
6. David Frawley, *Ayurvedic Healing*
7. *IIT-IKS Foundation Course Materials*
8. Ministry of Education – IKS Portal Resources

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Explain the core concepts and evolution of Indian Knowledge Systems.	**K2**
CO2	Interpret Indian views on human development, ethics, and sustainability.	**K3**
CO3	Apply IKS principles to sustainable living and professional practices.	**K3**
CO4	Demonstrate social, ecological, and ethical responsibility in real-life situations.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						3	2				3
CO2						3	3				2
CO3			2			3	3		2	2	
CO4				2		3	3	2			
			2	**2**		**3**	**3**	**2**	**2**	**2**	**3**

1 - low, 2- medium, 3 - high

25MC006 STRATEGIC DATA MANAGEMENT AND GOVERNANCE
(Common to all B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION TO STRATEGIC DATA MANAGEMENT Data and Its strategic Value; Types of Data, Data as a Source of Competitive Advantage; The Data Lifecycle; Aligning Data Management with Business Goals; Data Management challenges in Contemporary Organizations; Overview of Data driven Decision making. **(6)**

DATA GOVERNANCE AND FRAMEWORK Introduction to Data Governance; Data Management Frameworks (DAMA-DMBOK, COBIT, ISO Data management Standards); Structuring Data Leadership Roles; Implementation of Data Policies and Standards. Master Data Management (MDM) and API Integration. **(6)**

DATA PRIVACY, ETHICS AND QUALITY MANAGEMENT Data Privacy and Protection Regulations (DPDP Act, GDPR); Principles and Importance of Ethical data management; Ethical decision-making models; Key data Quality Dimensions; Role of Data Quality in Effective Decision-Making; Tools and techniques for ensuring data quality. **(6)**

DATA LITERACY AND ORGANIZATIONAL TRANSFORMATION Role of Data Literacy in Modern Organisations; Strategies for implementing data-driven transformation; Communication and training for Overcoming Resistance to Change; Cross-Functional Collaboration across Organisational Departments; Fostering a Data-Driven Culture. **(6)**

DATA ARCHITECTURE AND RECENT TRENDS Business Intelligence (BI) Architecture; Big Data Ecosystem; AI/ML data pipelines in Business enterprises, Strategic Planning for Data Infrastructure; Build vs. Buy Decisions for Data Platforms; Generative AI in Data Management. **(6)**

Total L: 30 periods

TEXT BOOKS

1. Ladley, J. & Ladley, A. '*Data Governance: How to Design, Deploy, and Sustain an Effective Data Governance Program* (3rd ed.)'. Morgan Kaufmann (Elsevier).
2. Eryurek, E., Gilad, U., Kaye, B., Sicular, S., & Schur, E. (2021). '*Data Governance: The Definitive Guide: People, Processes, and Tools to Operationalize Data Trustworthiness'*. O'Reilly Media.

REFERENCE BOOKS

1. Plotkin, D. (2020). '*Data Stewardship: An Actionable Guide to Effective Data Management and Data Governance* (2nd ed.)'. Academic Press (Elsevier).2020.
2. DAMA International. (2024). '*DAMA-DMBOK: Data Management Body of Knowledge* (2nd ed. Revised)'. Technics Publications.2024.
3. Loukides, M., Mason, H., & Patil, D. J. (2018). '*Ethics and Data Science'*. O'Reilly Media.2018.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understanding the Management role in leveraging data for competitive advantage and strategic decision-making.	**K2**
CO2	Applying governance frameworks to design policies, roles, and standards.	**K3**
CO3	Analyzing ethical challenges in data management to improve data-literacy across organization departments.	**K4**
CO4	Evaluating enterprise data architecture and modern platforms for making strategic decisions on Data Management.	**K5**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	2				3				3	3
CO2			2			2	3	2		3	
CO3						3	3		3		2
CO4	2		2	2	3	2				3	2
	2	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**

1 - low, 2- medium, 3 - high

25MC007 PROFESSIONAL ETHICS
(Common to all B.E./B.Tech. Programmes)

2 0 0 0

INTRODUCTION TO THE CONCEPTS OF ETHICS: Introduction to ethics – meaning, definition, dimensions of ethics, determinants and consequences of ethics; ethical dilemmas – types of ethical dilemmas. Morality – definition, types of moral values, levels of moral development. Ethics Versus morality. Professional Ethics – definition, components, types and significance. **(6)**

PSYCHOLOGY OF ETHICAL BEHAVIOR: Attitude – components of attitude in promoting ethical behavior; Motivation – human drives as a trigger for ethical behavior; Role of Cognitive biases (self-serving bias, incrementalism and overconfidence bias) in shaping ethical behavior. **(6)**

WORKPLACE ETHICAL BEHAVIORS: Integrity, honesty, accountability, responsibility, fairness, civic virtue, conscientiousness, empathy, self-confidence, character, respect for others, transparency, loyalty. **(6)**

APPLICATION AREAS OF ETHICS: Application of Ethics in different fields - Engineering ethics, medical ethics, financial ethics, technological ethics, scientific ethics, legal ethics, business ethics, environmental ethics. **(6)**

INDICATORS OF PROFESSIONAL ETHICS IN ORGANIZATIONS: Corporate Governance – Definition, importance, Theories of Corporate Governance: Agency Theory, Stewardship theory, Stakeholder Theory, Resource Dependency Theory. Corporate Social Responsibility – Definition, Models of CSR. **(6)**

Total L: 30 periods

TEXT BOOKS

1. Govindarajan M, Natarajan S and Senthil Kumar VS, *'Engineering Ethics'*. Prentice Hall of India, New Delhi, 2013.
2. Stephen P. Robbins, *'Essentials of Organizational Behavior'.* Pearson Education, 2023.
3. Subramanian. R. '*Professional Ethics'*. Oxford Publication, 2013.
4. Nagarasan. R.S. *Professional Ethics and Human Values'.* New Age International Publications, 2006.

COURSE OUTCOMES:

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Understand the fundamental concepts of ethics, morality and the psychological principles behind ethical behavior.	**K2**
CO2	Demonstrate the application of core ethical values in the different situations of the workplace.	**K3**
CO3	Analyze the ethical issues, challenges in different professional domains and the application of ethical principles to solve the issues	**K4**
CO4	Evaluate the relevance and effectiveness of corporate governance theories and CSR models in addressing ethical and managerial challenges in organizations.	**K5**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1						2	3				3
CO2						2	3	3	2		
CO3		2	2			3	3				
CO4						3	3	2		3	2
		2	**2**			**3**	**3**	**3**	**2**	**3**	**3**

1 - low, 2- medium, 3 - high

25HSO01 PHYSICAL EDUCATION
(Common to all B.E./B.Tech. Programmes)

0 0 2 0

INTRODUCTION TO PHYSICAL EDUCATION: Importance and scope of physical education, Physical fitness and exercise fundamentals, Conditioning and calisthenics exercises, Posture, flexibility, balance, and coordination, Warm-up, cool-down, and relaxation techniques, Basics of injury prevention and first aid practices, Importance of teamwork, discipline, and sportsmanship.

BASIC GYMNASTICS AND MOVEMENT EXERCISES: Warm-up exercises, conditioning drills, movement education, balance exercises, floor exercises, tumbling basics, swinging and grip exercises, simple apparatus activities, lead-up games, coordination drills, and safety practices.

SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING OUTDOOR GAMES: Basketball, Volleyball, Ball Badminton, and Football.

SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING INDOOR GAMES: Shuttle Badminton, Chess, Carrom, and Table Tennis.

Total P: 30 Periods

WEIGHTAGE
Continuous Assessment: 100%

ASSESSMENT
- Attendance and Participation – 70%
- Practical Assessment of Physical Fitness and Sports Skills – 30%

REFERENCES

1. Singh, A. '*Essentials of Physical Education'*. Kalyani Publishers.
2. Kamlesh, M.L. '*Psychology in Physical Education and Sport'*.
3. Mangal, S.K. '*Psychology of Sports Performance'*. Sports Publication.
4. Kandappan, K. '*Foundations of Physical Education'*. Friends Publications.

COURSE OUTCOMES

At the end of the course, students will be able to:		**Bloom's Level**
CO1	Demonstrate basic movement, balance, coordination, and fitness exercises with proper technique and safety awareness.	**K2**
CO2	Demonstrate physical fitness parameters such as endurance, agility, flexibility, speed, and strength through regular participation in physical activities.	**K2**
CO3	Develop teamwork, discipline, leadership qualities, and sportsmanship through participation in games and group activities.	**K3**
CO4	Adopt active lifestyle habits and participate regularly in physical and recreational activities for overall well-being.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3			2
CO2						2		3			3
CO3							3	3	2		2
CO4						2	2	3			3
						2	**2**	**3**	**2**		**3**

1 - low, 2- medium, 3 - high

25HSO02 YOGA AND HEALTH
(Common to all B.E./B.Tech. Programmes)

0 0 2 0

INTRODUCTION TO YOGA: Yoga as a tool for physical and mental wellness, Importance of posture, breathing, relaxation, and mindfulness, Role of yoga in stress management and lifestyle balance, Basic guidelines and safety precautions for yoga practice, Introduction to healthy habits including sleep hygiene, nutrition, and digital well-being

SURYA NAMASKAR – TYPES OF POSTURES: Pranamasana (Prayer Pose), Hastauttanasana (Raised Arms Pose), Padahastasana / Hastapadasana (Standing Forward Bend), Ashwa Sanchalanasana (Equestrian Pose), Dandasana (Plank Pose), Ashtanga Namaskara (Eight-Limbed Salutation), Bhujangasana (Cobra Pose), Adho Mukha Svanasana (Downward-Facing Dog), Ashwa Sanchalanasana (Equestrian Pose), Padahastasana (Standing Forward Bend), Hastauttanasana (Raised Arms Pose), and Pranamasana (Prayer Pose).

BASIC ASANAS:

1. Standing – Tadasana, Utkatasana, Trikonasana, Virabhadrasana, and Vrikshasana
2. Sitting – Sukhasana, Dandasana, Paschimottanasana, Vajrasana, and Gomukhasana
3. Prone Position – Bhujangasana, Salabhasana, Dhanurasana, Makarasana, and Urdhva Mukha Svanasana
4. Supine Position – Apanasana, Viparita Karani, Supta Baddha Konasana, Ardha Halasana, and Savasana

PRANAYAMA TECHNIQUES & MUDRAS: Ujjayi, Nadi Shodhana, Sheetali, Sitkari, Kapalabhati, Bhastrika, and Bhramari. Gyan Mudra (Chin Mudra), Prana Mudra, Apana Mudra, Vayu Mudra, Prithvi Mudra, Varun Mudra, Surya Mudra, Shunya Mudra, Linga Mudra, and Anjali Mudra.

Total P: 30 Periods

WEIGHTAGE: Continuous Assessment: 100%
ASSESSMENT METHODOLOGY: Attendance and Participation – 70%, Practical Demonstration (Surya Namaskar, Asanas, and Pranayama) – 30%

REFERENCES

1. *'The Heart of Yoga'.* – T.K.V. Desikachar
2. *'Yoga for Holistic Health'.* – Dr. H.R. Nagendra
3. *'Light on Yoga'.* – B.K.S. Iyengar
4. *'Asana Pranayama Mudra Bandha'.* – Swami Satyananda Saraswati

COURSE OUTCOMES

At the end of the course, students will be able to:		Bloom's Level
CO1	Demonstrate Surya Namaskar and basic asanas in standing, sitting, prone, and supine positions with correct alignment and breathing.	**K2**
CO2	Demonstrate pranayama techniques for stress management and respiratory health.	**K2**
CO3	Improve flexibility, balance, posture, breathing efficiency, and relaxation through regular yoga practice.	**K3**
CO4	Apply principles of healthy living such as nutrition, sleep hygiene, and digital well-being in daily life.	**K3**

COs - POs & PSOs MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3			2
CO2						2	2				2
CO3						2	2	3			3
CO4						3	2	2			3
						3	**2**	**3**			**3**

1 - low, 2- medium, 3 – high