MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programme

Bachelor of Engineering

Department of

Electrical and Electronics Engineering

SCHEME AND SYLLABUS

(2024 Admitted Batch)

Dr. RAJANNA S. M.Tech., Ph.D., (IITR)
Professor & Head
Dept of E&E Engineering
Malnad College of Engineering
HASSAN 573202

Academic Year 2026-27

VISION OF THE INSTITUTE

To be an institute of excellence in engineering education and research, producing socially responsible professionals.

MISSION OF THE INSTITUTE

1. Create conducive environment for learning and research
2. Establish industry and academia collaborations
3. Ensure professional and ethical values in all institutional endeavors

VISION OF THE DEPARTMENT

To become a department of excellence in the domain of Electrical and Electronics Engineering producing competent engineers with research acumen having moral and social values.

MISSION OF THE DEPARTMENT

1. Enhance industry and alumni interaction.
2. Promote continuous quality up gradation of faculty and technical staff.
3. Time to time modernization of departmental infrastructure to provide state of the art laboratories.
4. Create research-oriented culture to invoke the desire and ability of lifelong learning among the students for pursuing successful career.
5. Create and sustain environment of learning in which students acquire knowledge and learn to apply it professionally with due consideration of social and ethical values.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Graduates of the program will be able to

PEO 1: Pursue a diverse range of career as engineers and researchers.

PEO 2: Design and develop innovative systems to provide best solutions to electrical engineering problems.

PEO 3: Learn and adapt in a world of constantly evolving technology.

PROGRAM OUTCOMES (POS)

PO 1: **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.

PO 2: **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO 3: **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)

PO 4: **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).

PO 5: **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)

PO 6: **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).

PO 7: **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO 8: **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO 9: **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

PO 10: **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.

PO 11: **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)

KNOWLEDGE AND ATTITUDE PROFILE (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Acquire core competency in analyzing, designing and controlling electrical and electronic systems to meet industrial and societal needs.

PSO 2: Adopt technology by leveraging state-of-the-art and AI tools to develop innovative solutions in emerging areas like renewable energy, electric vehicles and embedded systems.

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Scheme of Evaluation (Theory Courses)

Assessment	Marks
CIE 1	**10**
CIE 2	**10**
CIE 3	**10**
Activities as decided by course faculty	**20**
SEE	**50**
Total	**100**

Scheme of Evaluation (Laboratory Courses)

Assessment	Marks
Continuous Evaluation in every lab session by the Course Coordinator	**10**
Record Writing	**20**
Laboratory CIE conducted by the Course Coordinator	**20**
SEE	**50**
Total	**100**

Examination	Maximum Marks	Minimum marks to qualify
CIE	50	20
SEE	50	20

COURSE TYPES

Basic Science Course	BSC
Engineering Science Course	ESC
Emerging Technology Course	ETC
Programming Language Course	PLC
Professional Core Course	PCC
Integrated Professional Core Course	IPCC
Professional Core Course Laboratory	PCCL
Professional Elective Course	PEC
Open Elective Course	OEC
Project/Mini Project/Internship	PI
Humanities and Social Sciences, Management Course	HSMC
Ability Enhancement Course	AEC
Skill Enhancement Course	SEC
Universal Human Value Course	UHV
Non-credit Mandatory Course	MC

Semester-wise Credit Distribution

Curricular Component / Semester	I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course (BSC)	8	8	3	1	-	-	-	-	**20**
Engineering Science Course (ESC)/ Emerging Technology Course (ETC)/Programming Language Course	9	9	3	3	-	-	-	-	**24**
Professional Core Course (PCC)	-	-	12	15	14	14	8	-	**63**
Professional Elective Course (PEC)	-	-	-	-	3	3	3	3	**12**
Open Elective Course (OEC)	-	-	-	-		3	3	3	**09**
Project/Mini Project/Internship (PI)	-	-	-	-	-	2	4	10	**16**
Humanities and Social Sciences, Management Course (HSMC)	1	2	1	-	2	-	-	-	**06**
Ability Enhancement Course (AEC)/ Skill Enhancement Course (SEC)	2	1	1	1	3	1	-	-	**09**
Universal Human Value Course (UHV)	-	-	-	1	-	-	-	-	**01**
Total Credits	**20**	**20**	**20**	**21**	**22**	**23**	**18**	**16**	**160**

THIRD SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	BSC	24MA301	Mathematics -III for Electrical and Electronics Engineering	42	-	-	48	90	50	50	100	3
2	PCC	24EE302	Electrical Network Analysis	42	28	-	50	120	50	50	100	4
3	PCC	24EE303	Analog Electronic Circuits	42	-	-	48	90	50	50	100	3
4	PCC	24EE304	Transformers and Induction Machines	42	-	-	48	90	50	50	100	3
5	PCCL	24EE305	Analog Electronics Laboratory	-	-	28	02	30	50	50	100	1
6	PCCL	24EE306	Transformers and Induction MachinesLaboratory	-	-	28	02	30	50	50	100	1
7	ESC	24ESEE3X	Engineering Science Course – II	42	-	-	48	90	50	50	100	3
8	HSMC	24SCR	Social Connect and Responsibility	-	-	28	02	30	100	-	100	1
9	AEC	24AEEE3X	Ability Enhancement Course - III	-	-	28	02	30	50	50	100	1
10	MC	24NYP1	NSS,YOGA,PE	-	-	28	02	30	100	-	-	Audit
11	BSC	24BCM301	Bridge Mathematics-I (Mandate Audit Course for Diploma entry students)	42	-	-	48	90	100	-	100	Audit
Total								**720**				**20**

Note:

This scheme is as per the new National Credit Framework, which accounts for 30 hours of learning as equivalent to 1 credit

L: Lecture; T: Tutorial; P: Practical/Drawing; TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.);

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

ENGINEERING SCIENCE COURSES – II			
24ESEE31	Electrical and Electronics Measurements	24ESEE33	Sensors and IoT
24ESEE32	Introduction to PLC	24ESEE34	Programming in C++
ABILITY ENHANCEMENT COURSE – III			
24AEEE31	Electric Circuits and Measurements Laboratory	24AEEE33	Effective Communication and Report Writing Skills
24AEEE32	Scilab/ MATLAB for Electrical Engineering	24AEEE34	Web Technology Laboratory

FOURTH SEMESTER											
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	PCC	24EE401	Digital Electronic Circuits	42	-	-	48	90	50	50	100	3
2	PCC	24EE402	Electric Power Generation and Transmission	56	-	-	64	120	50	50	100	4
3	PCC	24EE403	Synchronous and Special Electrical Machines	42	-	-	48	90	50	50	100	3
4	PCC	24EE404	Microcontrollers	42	-	-	48	90	50	50	100	3
5	PCCL	24EE405	Digital Electronic Circuits Laboratory	-	-	28	02	30	50	50	100	1
6	PCCL	24EE406	Microcontrollers Laboratory	-	-	28	02	30	50	50	100	1
7	ETC	24ETC42X	Emerging Technology Course - II	42	-	-	48	90	50	50	100	3
8	UHV	24UHV	Universal Human Values	-	28	-	02	30	50	50	100	1
9	AEC	24AEEE4X	Ability Enhancement Course - IV	-	-	28	02	30	50	50	100	1
10	MC	24NYP2	NSS,YOGA,PE	-	-	28	02	30	100	-	100	Audit
11	BSC	24BE41	Biology for Engineers	-	28	-	02	30	50	50	100	1
Total								**660**				**21**

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L: Lecture; T: Tutorial; P: Practical/Drawing; TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.);

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

EMERGING TECHNOLOGY COURSES – II			
24ETEE41	Signals and Systems	24ETEE43	Renewable Energy Systems
24ETEE42	Fundamentals of Electric Vehicles	24ETEE44	Python Programming for Electrical Engineering
ABILITY ENHANCEMENT COURSE – IV			
24AEEE41	AutoCAD for Electrical Engineering	24AEEE43	Renewable Energy Laboratory
24AEEE42	PCB Design Laboratory	24AEEE44	IoT Laboratory

FIFTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	PCC	24EE501	Linear Control Systems	42	-	-	48	90	50	50	100	3
2	PCC	24EE502	Power Electronics	42	-	-	48	90	50	50	100	3
3	PCC	24EE503	Switchgear and Protection	42	-	-	48	90	50	50	100	3
4	PCC	24EE504	Electromagnetic Fields	42	-	-	48	90	50	50	100	3
5	PCCL	24EE505	Power Electronics Laboratory	-	-	28	02	30	50	50	100	1
6	PCCL	24EE506	DC and Synchronous Machines Laboratory	-	-	28	02	30	50	50	100	1
7	HSMC	24EE507	Industrial Management	-	28	-	02	30	50	50	100	1
8	HSMC	24EVS	Environmental Studies	-	28	-	02	30	50	50	100	1
9	PEC	24EE51X	Professional Elective Course - I	42	-	-	48	90	50	50	100	3
10	MC	24NYP3	NSS,YOGA,PE	-	-	28	02	30	100	-	100	Audit
11	AEC	24RIP	Research Methodology and IPR	42	-	-	48	90	50	50	100	3
Total								**690**				**22**

Note:

This scheme is as per the new National Credit Framework, which accounts for 30 hours of learning as equivalent to 1 credit

L: Lecture; T: Tutorial; P: Practical/Drawing; TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.);

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

PROFESSIONAL ELECTIVE COURSE - I			
24EE511	Digital Signal Processing	24EE513	AI in Electrical Engineering
24EE512	Operational Amplifiers and Linear ICs	24EE514	Automation in Industry 4.0

SIXTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	PCC	24EE601	Electrical Machine Design	42	-	-	48	90	50	50	100	3
2	PCC	24EE602	Modern Control Theory	42	-	-	48	90	50	50	100	3
3	PCC	24EE603	Power System Analysis and Stability	42	-	-	48	90	50	50	100	3
4	PCC	24EE604	High Voltage Engineering	42	-	-	48	90	50	50	100	3
5	PCCL	24EE605	Linear Control Systems Laboratory	-	-	24	06	30	50	50	100	1
6	PCCL	24EE606	Relay and High Voltage Laboratory	-	-	24	06	30	50	50	100	1
7	PI	24PROJ1	Project Phase - I	-	-	42	18	60	50	50	100	2
8	PEC	24EE62X	Professional Elective Course - II	42	-	-	48	90	50	50	100	3
9	OEC	24OEX6X	Open Elective Course - I	42	-	-	48	90	50	50	100	3
10	MC	24NYP4	NSS,YOGA,PE	-	-	24	06	30	100	-	100	Audit
11	AEC	24ASK	Analytical Ability and Soft Skills	-	-	28	02	30	50	50	100	1
Total								**720**				**23**

Note:

This scheme is as per the new National Credit Framework, which accounts for 30 hours of learning as equivalent to 1 credit

L: Lecture; T: Tutorial; P: Practical/Drawing; TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.);

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

PROFESSIONAL ELECTIVE COURSE - II			
24EE621	Flexible AC Transmission Systems	24EE623	Testing and Commissioning of Electrical Equipment
24EE622	Embedded Systems	24EE624	Electrical Power Quality
OPEN ELECTIVE COURSE - I			
24OEEE61	Electric Vehicle Technology	24OEEE62	Alternate Energy Sources

SEVENTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	PCC	24EE701	Computer Methods in Power Systems	56	-	-	64	120	50	50	100	4
2	PCC	24EE702	Industrial Drives and Applications	42	-	-	48	90	50	50	100	3
3	PCCL	24EE703	Power System Simulation Laboratory			28	02	30	50	50	100	1
4	PI	24PROJ1	Project Phase - II			84	36	120	50	50	100	4
5	PEC	24EE73X	Professional Elective Course - III	42	-	-	48	90	50	50	100	3
6	OEC	24OEX7X	Open Elective Course – II	42	-	-	48	90	50	50	100	3
Total								**540**				**18**

Note:

This scheme is as per the new National Credit Framework, which accounts for 30 hours of learning as equivalent to 1 credit

L: Lecture; T: Tutorial; P: Practical/Drawing; TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.);

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

PROFESSIONAL ELECTIVE COURSE - III			
24EE731	Energy Auditing and Demand-Side Management	24EE733	Solar Power Conversion Systems
24EE732	Smart Grid Technologies	24EE734	VLSI Design
OPEN ELECTIVE COURSE - II			
24OEEE71	Battery Energy Storage Systems	24OEEE72	Utilization of Electric Power

EIGHTH SEMESTER												
Sl. No	Course Category	Course Code	Course Title	Teaching Hours per Semester					Exam Marks			Credits
				L	T	P	TW + SL	Total	CIE	SEE	Total	
1	PEC	24SW01	Professional Elective (Online Course)	-	-	-	-	-	50	50	100	3
2	OEC	24SW02	Open Elective (Online course)	-	-	-	-	-	50	50	100	3
3	PI	24INT	Internship (Research/Industry) (15-20 weeks)	-	-	210	90	300	100	100	200	10
Total								**300**				**16**

V SEMESTER

Course Title	LINEAR CONTROL SYSTEMS		
Course Code	24EE501	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To model and analyze Linear control systems.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Model of electrical, mechanical and electro-mechanical systems based on fundamental laws.	1, 2, 5	1
2	Analyse time response specifications of second order systems.	1, 2, 3 ,5	1
3	Evaluate the stability of a system using R-H criteria, root locus and frequency domain analysis.	1, 2, 3, 5	1
4	Discuss the basic parameters of P, PI, PD and PID Controllers and compensating networks.	1, 5	1

MODULE - 1 **10 Hrs.**

Modelling of Systems: Definition of control systems, open loop and closed loop systems, types of feedback, Differential equations of physical systems, analogous systems. Transfer function, transfer function for electrical, mechanical and electro-mechanical system – DC servo motor.

SLC: Modelling of mechanical system with coupling elements lever and gear train.

MODULE - 2 **10 Hrs**

Block Diagrams and Signal Flow Graphs: Block diagram representation and reduction, Signal flow graph representation and reduction using Mason's gain formula.

Time Domain Analysis: Standard test signals, Unit step response of first and second order systems. Time domain specifications and transient response of a second order system, steady state error and error constants.

SLC: Response of first and second order systems with impulse and ramp inputs.

MODULE - 3 **10 Hrs.**

Stability Analysis: Bounded input and bounded output stability, zero input and asymptotic stability, Methods of determining stability, Routh-Hurwitz criterion.

Root Locus Techniques: Root locus concepts, Rules for construction of root loci, Stability analysis.

SLC: Graphical determination of gain K for angle of closed loop pole.

MODULE - 4 **12 Hrs**

Frequency Domain Analysis: Frequency domain specifications- Resonant peak, resonant frequency and bandwidth. Bode plots, Gain and phase cross over points, gain margin and phase margin, stability analysis using Bode plots.

Methods to Improve Time Response: P, PI, PD and PID Controllers. Introduction to compensating networks, Phase-Lead and Phase-Lag Compensator.

SLC: Polar plots and stability analysis for minimum phase systems.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Control System Engineering	Nagrath and Gopal	7th	New Age Internal	2021

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Modern Control Engineering	K. Ogata	5th	PHI/Pearson Education	2009
2	Automatic Control Systems	B. C. Kuo	7th	PHI	2002
3	Control System Engineering	Nagoor Jani	4th	CBS Publishers	2020

E Books and online course materials:

1. https://ggnindia.dronacharya.info/Downloads/Sub-info/RelatedBook/8thSem/Advanced-Control-Systems-text-book-3.pdf

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc19_de04/preview

Teaching -Learning– Evaluation Scheme:

Sl.No	Teaching and Learning Method	No.of Hours/ Week	No.of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Activity Based Learning (ABL1 & ABL2)	-	-	27
4	Evaluation of Learning Process	-	-	07
Total Learning Hours/Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1:	10
	Activity 2:	10
Total		**50**

Activity Based Learning (27 Hours)

ABL1 (14Hours) : Activity1details		**Hours**
Writing Assignment with Problems on concerned to real world applications.	Submission of the final assignment report and evaluation.(Questions of Blooms level L3 and Higher)	14
ABL1: Total		**14**
ABL2(13Hours): Activity 2 details		
Problem Solving Assignment	Understand the input data requirements	1
	Formulate the methodology	4
	Design the solution	4
	Solving the problem and submission	4
ABL2: Total		**13**
ABL1 + ABL2: Total		**27**

Course Articulation Matrix

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

Course Title	POWER ELECTRONICS		
Course Code	24EE502	(L-T-P) C	(3-0-0)3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L+48ABL=90

Course Objective: To design suitable power electronic converter for various engineering applications.

Course outcomes : At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the fundamental concepts of power electronic converters.	1	1
2	Explain the basic principles of various power electronic converters and their characteristics.	1	1
3	Apply power electronics principles for obtaining the performance parameters of various types of converters.	1, 2	1
4	Analyze the performance parameters of various power electronic converters.	1,2,3,5,8	2

MODULE-1 **11Hrs**

Introduction to power electronics, classification of power electronic devices & converters, ideal/practical switches, peripheral effects. **Power Transistors:** Power MOSFETs (n channel enhancement type MOSFET) – structure, switching characteristics, IGBT- structure, necessity of isolation in power transistor circuits, Isolation techniques, gate drive requirements, di/dt and dv/dt protection. **Thyristors:** Structure of SCR, v-i characteristics, two transistor model of SCR, turn-onandturn-off,di/dtanddv/dtprotection,Thyristorcommutationtechniques,Thyristorfiringcircuits –RC half wave and full-wave triggering, UJT triggering, digital triggering.

SLC:V-I characteristics of DIAC,TRIAC&GTO.

MODULE-2 **10Hrs**

Controlled Rectifiers: Introduction, Principle of Phase control, single-phase semi converter (RL load), single phase full converter (RL load), single-phase dual converter (RL load), three-phase half wave converters (R load, No problems). **AC Voltage Controllers:** Introduction, Principle of on-off control, single phase bi-directional controller with R & RL loads.

SLC: Applications of controlled rectifiers and AC voltage controllers.

MODULE-3 **10 Hrs**

DC-DC Converters: Introduction, step-down(buck) converter, Analysis of step-down converter for R,RL& RLE loads, step-up (boost) converter, Control strategies. Full-bridge chopper (Class E) and multi-quadrant operation. Comparison of DC-DC converters.

SLC: Applications of DC-DC converters.

MODULE-4 **11 Hrs**

Inverters: Introduction, **Single-phase inverters:** Single-phase half bridge inverters, performance parameters, single-phase bridge inverters, Voltage control of single-phase inverters: single-pulse-width modulation(PWM), Multiple PWM, Sinusoidal PWM, **Three phase Inverters:** 180-degree conduction, Voltage control of three phase inverters: Sinusoidal pulse width modulation and space vector modulation.

SLC: Applications of Inverters

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Power Electronics	M.H. Rashid	4th	Pearson	2014
2	Power Electronics	NedMohan	-	Wiley	2007

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Power Electronics Principlesand Applications	JosephVithyathil	-	TataMcgrawHill	2010
2	Power Electronics	P.S. Bimbhra	-	Khanna Publishers	2018

E Books and online course materials:

1. https://www.geeksforgeeks.org/electrical-engineering/power-electronics/

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/

Teaching -Learning–Evaluation Scheme:

Sl.No	Teaching and Learning Method	No.of Hours/Week	No.of Weeks	Hours/Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours–Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	13+14=27
Total Learning Hours/ Semester				**90**

Proposed Assessment Plan(50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and downgraded to 10 marks	30
Activity Details	Details of activities to be conducted Activity1: Rig-up / simulation of a power electronic converter	10
	Activity2: IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power Electronics	10
Total		**50**

Activity Based Learning (27 Hours)

ABL1: Rig-up / simulation of a power electronic converter		
Rig-up/Simulation-Based Learning	AC-DC, DC-AC, DC-DC, AC - AC converters, Study of Switching Characteristics of SCR, MOSFET, and IGBT	**13**
	The question will be given to the students (a batch of 4 to 5 students) by the course faculty	
ABL1:Total		**13**
ABL2: IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power Electronics		
Presentation	"IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power Electronics". This topic will be selected by the course faculty.	**14**
ABL2:Total		**14**
ABL1+ABL2:Total		**27**

Evaluation of Learning Process (7Hours)

Type of Evaluation	Hours
CIE(1, 2 and 3)	03
Activity 1and 2	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	SWITCHGEAR AND PROTECTION		
Course Code	24EE503	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To analyse switchgears and protection of power system from various abnormal conditions.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the basic concepts and operating principles of switchgear used in electrical power systems.	1	1
2	Compare various switchgear and their roles in power system protection	1,6	1
3	Analyze the function of protective relays in fault detection and isolation in power systems.	1,2	1
4	Evaluate the performance of power distribution systems through numerical analysis.	1,2	1

MODULE-1	10 Hrs

Switches and Fuses: Isolator, Earthing switches, Load breaking switch, fuse, types of fuse, HRC fuse, fuse material, cut off characteristics of fuse, Discrimination, selection of fuse links for different types of load. Principles of Circuit Breakers: Functions of Circuit breakers, Current interruption in AC circuit breaker, Initiation, maintenance and interruption of Arc, Arc Extinction modes, transient Recovery voltage (TRV), factors affecting TRV, Restriking Voltage, RRRV and Recovery Voltage.

SLC:

MODULE-2	10 Hrs

Principles of Circuit Breakers: Arc interruption theories – Slepain's theory and Energy balance theory, Current chopping, Resistance Switching, Making and breaking capacity of circuit breakers. Circuit Breakers: Rating of circuit breakers, classification of circuit breakers, Air- break circuit breakers, Air blast circuit breakers, Properties of SF6, SF6 circuit breakers and Vacuum circuit breakers.

SLC:

MODULE-3	11 Hrs

Protective Relaying: Relay – Definition, faults causes and effects, Zones of protection, Primary and backup protection, Qualities of protective relaying, Specific terminologies of relevance, Classification of Relays, Plug setting (PS), Plug setting multiplier (PSM), Time multiplier setting (TMS) and relay Characteristics - DMT and IDMT characteristics. Induction types relays: Non-directional and directional Induction type over current relay, Impendence relay. Transformer Protection: Buchholz Relay, Differential Protection.

SLC:

MODULE-4	11 Hrs

Power Distribution Systems: Introduction, Radial and Ring main systems, DC Three-wire Systems, Different types of Distributors, Method of calculations, AC Distributors with concentrated loads- Numerical problems.

SLC:

Prescribed Text Books

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Switchgear Protection and Power Systems	SunilS. Rao	14th	Khanna	1977
2	Power System Engineering	A. Chakrabarti, M.L. Soni, P.V. Gupta, U.S. Bhatnagar	2nd	Dhanpat Rai	2016

Reference Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Power System Protection and Switchgear	Badriram and D.N. Vishwakarma	3rd	Mc GrawHill	2022
2	Power System Protection and Switchgear	B. Ravindranath and M. Chande	2nd	New Age International	2018

E Books and online course materials:

1. https://gnindia.dronacharya.info/EEE/6thSem/Downloads/POWER-SYSTEMS-II/Books/POWER%20SYSTEMS-II-reference-book-4.pdf

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/105/108105167/
2. https://archive.nptel.ac.in/courses/108/107/108107167/

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity1: Substation visit and build a mini smart substation model.	10
	Activity 2: Students analyze and select suitable breakers for different real world systems.	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Drafting survey paper (14 Hrs.)		
Substation visit and build a miniature smart substation model	Substation visit	07
	Building miniature substation model	07
ABL 1: Total		**14**
ABL 2: Students analyse real world case studies (13 Hrs.)		
Students analyze and select suitable breakers for different real world systems.	Analysing	03
	Selection of suitable protective device for the systems	05
	Presentation, demonstration, viva-voce	05
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	ELECTROMAGNETIC FIELDS		
Course Code	24EE504	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To apply the knowledge of electromagnetic fields in diverse areas of electrical engineering.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the fundamental laws of Electromagnetic Fields.	1,2	1
2	Analyze Electromagnetic laws to find solutions to different charge bodies.	1,2,5	1
3	Solve problems involving steady current flow using magneto static principles.	1,2,5	1
4	Utilize Maxwell's equation in time varying field for different applications.	1,2,5	1

MODULE - 1 **11 Hrs.**

Electrostatics: Introduction to co-ordinates, representation of vectors in different co-ordinates, Coulomb's Law, Electric field intensity, Electric field intensity calculations due to point charge, line charge, surface charge. Electric flux density, Gauss's law, Examples on Gauss's law applications, Vector operator and Divergence - Statement, Equations of divergence in cartesian, cylindrical and spherical co-ordinates, Divergence theorem.

MODULE - 2 **10 Hrs.**

Work done in moving a point charge in an electric field and its line integral, Definition of potential difference and potential, Electric field as a negative gradient of potential. Current and current density, Equation of continuity, Metallic conductors and dielectrics under the influence of electric fields.

MODULE - 3 **10 Hrs.**

Capacitance and examples, Poisson's and Laplace's equations, examples on Laplace's equation.

Magnetostatics: Steady magnetic field, Biot-Savart's law, Ampere's circuit law, Curl, Stoke's theorem - Statement, Magnetic flux and flux density, Maxwell's equations for static fields.

MODULE - 4 **11 Hrs.**

Force on a moving charge – Lorentz force equation, Force on a differential current element, force on a straight current carrying conductor, force on differential current carrying loops. Classification and properties of magnetic materials, Self-inductance.

Time-varying fields: Faraday's Law, Transformer and Motional e.m.f., Displacement current, Maxwell's equations in point and integral forms.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Elements of Electromagnetics	Matthew N.O. Sadiku	7th Edition	Oxford University Press	2000

Reference Books:

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Engineering Electromagnetics	William H. Hayt, Jr. John A. Buck	7th Edition	Tata McGraw hill	2005
2	Engineering Electromagnetics – A simplified approach	D. Ganesh Rao and C. K. Narayanappa	2nd Edition	Sanguine Technical publishers	2004

E Books and online course materials:

1. https://www.ssgmce.ac.in/student_resource/Electronics%20&%20Telecommunication%20Engg./EMF/EMF%20%206th%20Edition%20%5BWilliam%20H.%20Hayt%5D.pdf
2. https://ashokainstitute.com/assets/pdf/new_has/ECE_E_Book/emft_sadiku.pdf

Online Courses and Video Lectures:

1. https://www.coursera.org/learn/electrodynamics-electric-magnetic-fields
2. https://nptel.ac.in/courses/108102119

Teaching - Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Model/Simulation using FEMM software 2) Presentation of related IEEE paper	20
Total		**50**

Activity Based Learning (27 Hours)

ABL 1 : (14 Hrs)		
Simulation using FEMM software	Introduction to FEMM	02
	Geometry Creation and Material Assignment	02
	Field Distribution Visualization and Analysis	04
	Parametric Variation and Comparative Study	04
	Submission of the report	02
ABL 1: Total		**14**
ABL 2 : Seminar (13 Hrs)		
Presentation of related IEEE paper	IEEE Paper Selection and Literature Review	02
	Understanding Problem Statement and Objectives	03
	Analysis of Results and Technical Discussion	03
	Final Presentation, report submission, Viva and Assessment	05
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Quiz (1 and 2) (optional)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	POWER ELECTRONICS LABORATORY		
Course Code	24EE505	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	28P + 02 = 30

Course Objective: To develop practical skills in the characterization, triggering, control, and application of power electronic devices and converters.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Perform experiments to determine the characteristics and triggering requirements of power semiconductor devices.	1,2,4,9,11	1,2
2	Analyze the operation and performance of controlled rectifiers, AC voltage controllers, and inverters under different load conditions.	1,2,3,4,9,11	1,2
3	Evaluate the control techniques of power electronic converters and electrical drives for industrial applications.	1,2,3,4,6,9,11	1,2

LIST OF EXPERIMENTS

1. Static V-I characteristics of SCR.
2. Static V-I characteristics of TRIAC.
3. Static V-I characteristics of MOSFET.
4. Generation of firing signals using UJT relaxation oscillator.
5. Controlled HWR using RC Triggering circuit for resistive Load.
6. Controlled FWR using RC Triggering circuit for resistive Load.
7. AC voltage controller using TRIAC-DIAC combination for R loads.
8. AC voltage controller using TRIAC-DIAC combination for RL loads.
9. Control of stepper motor in half step and full step mode.
10. Output voltage control of single phase inverter for resistive load.

Course Articulation Matrix

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

Course Title	DC AND SYNCHRONOUS MACHINES LABORATORY		
Course Code	24EE506	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	28P + 02 = 30

Course Objective: To develop practical knowledge of testing, performance analysis, and control of synchronous machines, special electrical machines and DC machines.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Perform tests on alternators and determine their voltage regulation using standard methods.	1,2,4,5,9,11	1,2
2	Analyze the operating characteristics, performance of synchronous and DC machines under different operating conditions.	1,2,3,4,5,9,11	1,2
3	Evaluate the control and performance of special electrical machines for speed regulation applications.	1,2,3,4,5,9,11	1,2

LIST OF EXPERIMENTS

1. OC and SC Test and predetermination of Voltage Regulation of Alternator by EMF and MMF methods.
2. Voltage regulation of an alternator by zero power factor method.
3. Determination of Xd, Xq &regulation of a salient pole alternator by Slip rest
4. Performance of synchronous generator connected to infinite bus, constant power-variable excitation & vice versa
5. V and inverted V curve of synchronous motor.
6. Speed control of DC shunt motors.
7. OC characteristics of DC shunt generator.
8. Load test on DC shunt generator.
9. Load test on DC shunt motor.
10. Speed control of Stepper motor and Permanent magnet motors

Course Articulation Matrix

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

Course Title	INDUSTRIAL MANAGEMENT		
Course Code	24EE507	(L-T-P)C	(0-1-0) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	30

Course Objective: Students will be able to acquire knowledge of management, professional ethics, and project management skills for engineering practice.

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

	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Interpret various functions of management and emerge as a productive member of society.	8, 11	-
2.	Assess familiarity on structure of the organization	8, 9	-
3.	Discuss characteristics of Engineering Profession, Professional responsibility and Rules of Practice	7,11	-
4.	Describe concepts of Project management and apply project management tools and techniques.	7, 10	-

MODULE-1	8 Hrs

Introduction: Introduction to Management, Functions of Management: Planning, Organizing, Leading, Controlling. Roles of Managers, Decision Making Process, Types of Decision Making, Planning-goals and plans, types of goals and plans. Controlling-the control process.

MODULE-2	8 Hrs

Organizational Structure and Leadership: Organizational Structure: Work Specialization, Departmentalization, Centralization and Decentralization, span of control, Leadership Styles: Leadership trait theories, Hershay blanchard situational theory. Motivation Techniques: Maslow's hierarchy of needs, Herzberg's two-factor theory.

MODULE-3	7 Hrs

Professional Engineering Practice and Ethics: Engineering Profession and Professionalism, characteristics of a profession, licence, Engineering Ethics, Rules of Professional Practice.

MODULE-4	7 Hrs

Project Management and Time Management: Introduction to Project Management**,** Roles of Project Manager**,** Basics of Project Planning**,** Time Management Techniques**,** Stress and Burnout Management

Prescribed Textbooks:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	**Management**	Stephen P Robinns	3rd	Prentice Hall	2003.
2.	**Professional Engineering Practice**	Professional engineers Ontario		101-40 Sheppard Avenue West Toronto ON M2N 6K9.	

Reference Books:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	A Systems Approach to Planning, Scheduling, and Controlling	**Harold Kerzner**	2nd	Prentice Hall	

Proposed Assessment Plan (for 50 marks of CIE)

CIE	Schedule	Assessment Method	Marks	Duration (Min.)
CIE I	At the end of 8 weeks	Objective Questions	20	60
CIE II	At the end of 11weeks	Objective Questions	20	60
Activity	After CIE 2	Presentation/Case Study/Role Play.	10	-

Course Articulation Matrix

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

Course Title	ENVIRONMENTAL STUDIES		
Course Code	24EVS	(L-T-P) C	(0-2-0) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	28P + 02 = 30

Course Objective: The student will acquire basic knowledge of renewable energy systems.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Acquire an awareness of sensitivity to the total environment and its allied problems.	7,9,11	--
2	Develop strong feelings of concern, sense of ethical 2 responsibility for the environment and the motivation to act in protecting and improving it.	6,8	--
3	Analyze and evaluate environmental measures in real 3 world situations in terms of ecological, political, economical, societal and aesthetic factors.	6, 7,8, 9	--

MODULE - 1	5 Hrs.
Environment: Definition, Ecosystem, Balanced ecosystem, Effects of human activities on environment Agriculture Housing Industry Mining and Transportation	
MODULE - 2	**5 Hrs.**
Natural Resources: Water resources, Availability and Quality, Water borne diseases, Water induced diseases, Fluoride problem in drinking water. Mineral Resources - Forest Resources - Material Cycles - Carbon, Nitrogen and Sulphur Cycles.	
MODULE - 3	**5 Hrs.**
Pollution: Effects of pollution - Water pollution - Air pollution Land pollution - Noise pollution.	
MODULE - 4	**5 Hrs**
Current Environmental issues of importance: Acid Rain, Ozone layer depletion - Population Growth, Climate change and Global warming. Environmental Impact Assessment and Sustainable Development Environmental Protection - Legal aspects. Water Act and Air Act.	

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Environmental Studies	Dr. D.L Manjunath	1st Edition	Pearson Education	2006
2	Environmental Studies	Dr. S. M. Prakash	1st	Elite Publishers	2006

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Environmental Studies	Benny Joseph	1st	TMH	2010
2	Principles of Environmental Science and Engineering	P. Venugopala Rao	1st	Prentice hall of India.	2006
3	Elements of Environmental Science and Engineering	P. Meenakshi	1st	Prentice hall of India Private Limited	2006

E Books and online course materials:

1. https://encr.pw/QPYlh

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2. https://archive.nptel.ac.in/courses/127/105/127105018/

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
Activity Details	Details of activities to be conducted 1) Details of activity 1 2) Details of activity 2	50
Total		**50**

Course Articulation Matrix

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

PROFESSIONAL ELECTIVE COURSE – I

Course Title	DIGITAL SIGNAL PROCESSING		
Course Code	24EE511	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To design and implement digital filter for signal processing applications.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Transform signals using discrete Fourier and Fast Fourier transforms.	1, 2	2
2	Realize IIR and FIR digital systems in various forms.	1, 2	2
3	Design IIR filters as per required specifications.	1, 2, 3	2
4	Design FIR filters as per required specifications.	1, 2, 3	2

Course Articulation Matrix

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1											2
CO2	1	2	1											2
CO3	1	2	3											2
CO4	1	2	3											2

MODULE-1 — 10 Hrs

Discrete Fourier Transforms: Definitions, Circular shift, Properties of DFTs, Circular convolution, Stockham's method, Linear convolution of two finite duration sequences, Filtering of long sequences.

SLC: Proofs of different Properties of DFTs.

MODULE-2 — 10 Hrs

Fast Fourier transforms algorithms: Introduction, decimation in time algorithm, decimation in frequency algorithm, decomposition for 'N' a composite number, computation of DFTs and IDFTs. **Realization of digital systems:** Introduction, block diagrams, Realization of IIR systems-direct form and Parallel form.

SLC: Realization of IIR system in Cascade form.

MODULE-3 — 10 Hrs

Realization of FIR systems: Introduction, Direct form, cascade form, linear phase realizations. **Design of IIR Digital filters:** Introduction, Types of filters, Analog Butterworth and Chebyshev filters, frequency transformations.

SLC: Lattice structure realization of FIR Filter.

MODULE-4 — 10 Hrs

Methods of Designing Digital Filters, Impulse Invariant and Bilinear Transformations, Design of digital Butterworth and Chebyshev filters, Frequency transformations. **Design of FIR Digital filters:** Introduction, Windowing, Design of Linear phase FIR filter using rectangular and Hamming windows. Design of Linear phase FIR filter using Frequency sampling technique.

SLC: Design of Linear phase FIR filter using Kaiser Window.

Text books:

1. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing: Principle, Algorithms and Applications, Fourth Edition, PHI, 2007.

Reference Books:

1. Johnny R. Johnson, Introduction to Digital Signal Processing, PHI, 2003.
2. B. Somanathan Nair, Digital Signal Processing, PHI, 2003.
3. P. Ramesh Babu, Digital Signal Processing, Fourth Edition, SciTech Publications, 2011.
4. A. Nagoor Kani, Digital Signal Processing, Second Edition, McGraw Hill Education (India) Private Ltd., 2012.

Course Title	OPERATIONAL AMPLIFIERS AND LINEAR ICs		
Course Code	24EE512	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To design op-amp based electronic circuits for different applications.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Analyze Op-Amp based AC amplifiers.	1	2
2	Realize signal conditioning electronic circuits using Op-Amp.	1	2
3	Develop Op-Amp based non-linear electronic circuits.	1,2	2
4	Design electronic circuits to generate waveforms and filter noises using Op-Amp.	1,2,3	2

MODULE-1	11 Hrs
Op-amps as AC Amplifiers: Capacitor coupled voltage follower, High Zin capacitor coupled voltage follower, Capacitor coupled non-inverting amplifier, High Zin capacitor coupled non–inverting amplifier, Capacitor coupled inverting amplifier, setting upper cutoff frequency, Use of single polarity supply.	
MODULE-2	**10 Hrs**
Signal Processing circuits: Design of Precision half-wave and full-wave rectifiers, Limiting circuits, Clamping circuits, Peak detectors, Sample-and-Hold (S/H) circuit.	
MODULE-3	**10 Hrs**
Op-amps and Non-linear circuits: Op-amps in switching circuits, Crossing detectors, Inverting Schmitt trigger circuits. Non-inverting Schmitt circuits, Astable multivibrator, Monostable multivibrator.	
MODULE-4	**11 Hrs**
Signal generator: Triangular/Rectangular wave generator without frequency and duty cycle adjustment, Phase shift oscillator, Wein bridge oscillator. Active filters: First and Second order Low-pass and High-pass filters; First order Band pass filter and First order Band stop filter.	
Note: Students are permitted to use op-amp data sheets and standard Resistor and capacitor values list, for solving the design connected numerical problems in the examination. The said information is available in the Appendix of Text authored by David A. Bell.	

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Operation Amplifiers and Linear ICs	David A. Bell	2nd	Prentice Hall of India	2008

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Op-Amps and Linear Integrated Circuits	Ramakanth A. Gayakwad	4th	Pearson Education	2007
2	Operational amplifiers and Linear Integrated Circuits	R. Coughlin & F. Driscoll	6th	Prentice Hall of India	2004

E Books and online course materials:

1. http://gnindia.dronacharya.info/ECE/5thSem/Downloads/IntegratedCircuits/Books/Integrated-Circuit-Text-Book-5.pdf

Online Courses and Video Lectures:

https://onlinecourses.nptel.ac.in/noc24_ee73/preview

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 3) Details of activity 1 4) Details of activity 2	20
Total		**50**

Activity Based Learning (27 Hours)

ABL 1 (14 Hours) : Simulation Based Activity		**Hours**
Simulation based Assignment	Precision Half Wave Rectifier Precision Full Wave Rectifier Summing And Differential Amplifiers RC Phase Shift Oscillator And Determination Of Frequency Of Oscillation	**08**
	Report writing	04
	Submission	02
ABL1: Total		**14**
ABL 2 (13 Hours): Laboratory Activity		
Hands on laboratory experiments	1. Realization of Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP). 2. Test low-pass and high-pass active filter circuits using IC 741. 3. Realization of Digital to Analog Converter (DAC) circuit using an op – amp. 4. Realization of Analog to Digital Converter (ADC) circuit using an op – amp.	05
	Experimental set up and demonstration	05
	Submission of report	03
ABL2: Total		**13**
Total (ABL1+ABL2)		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	AI IN ELECTRICAL ENGINEERING		
Course Code	24EE513	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To develop various intelligent techniques for power system applications.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Apply evolutionary algorithms like GA and PSO for problem-solving.	1, 2, 5	2
2	Analyze the various artificial neural network architectures and algorithms.	1, 2, 5	2
3	Examine usage of deep learning techniques in various applications.	1, 2, 5	2
4	Assess AI techniques for solving real world power system problems.	1, 2, 3, 4, 5, 6	1, 2

MODULE - 1 **10 Hrs.**

Introduction: The AI problems, the underlying assumption, what is an AI Techniques? Difference between soft computing techniques and hard computing systems. Expert systems brief history of Artificial Neural Network.

Genetic Algorithm and Particle Swarm Optimization: Genetic Algorithms-Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators – Particle Swarm Optimization- Topologies – Control parameters.

SLC: Emerging Optimization Techniques

MODULE - 2 **10 Hrs.**

Artificial Neural Network: Artificial neuron, activation function, supervised, unsupervised learning, Single layer perceptron – Limitation – Multi layer perceptron – Back Propagation Algorithm (BPA) – Recurrent Neural Network (RNN) – Adaptive Resonance Theory (ART) based network – Radial basis function network –Reinforcement learning, Neural Network Architectures, Application of Neural Network in Power System.

SLC: Modern Neural Network Frameworks

MODULE - 3 **10 Hrs.**

Deep Neural Networks: Convolutional Neural networks- LeNet- AlexNet – GoogLeNet – ResNet - Long Short-Term Memory (LSTM), Recurrent Unit- Deep Belief Network - Ensemble methods: Bagging, boosting, Evaluating and debugging learning algorithms.

SLC: Transfer Learning and Generative AI

MODULE - 4 **10 Hrs**

Application of AI in Power Systems: Application of Neural Network and Expert Systems in Voltage Control, Application of ANN for security assessment, Schedule Maintenance of Electrical Power Transmission Networks using Genetic Algorithm, Intelligent Systems for Demand Forecasting, Load forecasting - Fault Identification in transmission lines.

SLC: Smart Grid and AI Applications

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Introduction to Machine Learning	Ethem Alpaydin	4th	MIT Press	2020
2	Deep Learning: From Basics to Practice	Andrew Glassner	1st	The Imaginary Institute, Seattle	2018

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Artificial Intelligence Techniques in Power Systems	Kevin Warwick, Arthur Ekwue and Raj Aggarwal	-	IEE Power Engineering Series	1997
2	Artificial Intelligence and Intelligent Systems	N. P. Padhy	-	OXFORD University Press	2005

E Books and online course materials:

1. https://kkpatel7.wordpress.com/wp-content/uploads/2015/04/alppaydin_machinelearning_2010.pdf
2. https://dlbasics.com/resources/Backpropagation/Chapter18PDF.pdf
3. https://ieeexplore.ieee.org/document/9130896/
4. https://www.tandfonline.com/doi/abs/10.1080/15325008.2022.2049659
5. https://www.sciencedirect.com/science/article/abs/pii/S0196890422007166
6. https://digital-library.theiet.org/doi/book/10.1049/pbpo022e

Online Courses and Video Lectures:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/cec26_cs04
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs129
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs182

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: AI Concepts and Tool Exploration	10
	Activity 2: Case Study on AI Applications in Power Systems	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: AI Concepts and Tool Exploration (14 Hrs.)		
AI Concepts and Tool Exploration	Introduction to AI tools and applications in engineering	02
	Study of Genetic Algorithm and Particle Swarm Optimization through demonstrations	03
	Exploration of Artificial Neural Network models and architectures	03
	Familiarization with Deep Learning models (CNN and LSTM)	04
	Report preparation and presentation	02
ABL 1: Total		**14**
ABL 2: Case Study on AI Applications in Power Systems (13 Hrs.)		
Case Study on AI Applications in Power Systems	Identify an AI application in power systems (load forecasting, fault detection, voltage control, etc.)	02
	Literature survey and information collection	03
	Analyze the selected AI technique and its implementation methodology	03
	Study the results and benefits of the selected application	02
	Prepare technical report	01
	Presentation and viva-voce	02
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	AUTOMATION IN INDUSTRY 4.0		
Course Code	24EE514	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To explore Industry 4.0 technologies and their impact on intelligent manufacturing and automation.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain Industry 4.0 technologies and Cyber-Physical Systems.	1, 2, 11	1,2
2	Analyze smart industrial and healthcare applications.	1, 2, 3, 4,11	1,2
3	Evaluate smart energy systems and energy storage technologies.	1, 2, 4, 11	1,2
4	Apply Industry 4.0 concepts in smart automation and intelligent applications.	1, 3, 11	1,2

MODULE – 1	10 Hrs.

INTRODUCTION TO INDUSTRY 4.0: Introduction, Historical Context, General framework, Application areas, Dissemination of Industry 4.0 and the disciplines that contribute to its development, Artificial intelligence, The Internet of Things and Industrial Internet of Things, Additive manufacturing, Robotization and automation, Current situation of Industry 4.0. comparison of Industry 4.0 to Industry 5.0

MODULE - 2	11 Hrs.

INDUSTRY 4.0 AND CYBER PHYSICAL SYSTEM: Introduction to Cyber Physical Systems (CPS), Architecture of CPS- Components, Data science and technology for CPS, Emerging applications in CPS in different fields. Case study: Application of CPS in health care domain.

MODULE - 3	11 Hrs.

SMART ENERGY SOURCES: Energy Storage for Mitigating the Variability of Renewable Electricity Sources-Types of electric energy storage, Potential of Sodium-Sulfur Battery Energy Storage to Enable Integration of Wind-Case study. Electric Vehicles as Energy Storage: V2G Capacity Estimation.

MODULE - 4	10 Hrs.

SMART APPLICATIONS: Understanding Smart Appliances -Smart Operation-Smart Monitoring-Smart Energy Savings-Smart Maintenance, Case study-Smart Cars, Self-Driving Cars, Introducing Google's Self-Driving Car, Intellectual Property Rights.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Industry 4.0l, Wiley- ISTE,	Jean-Claude André	2019	Wiley- ISTE	JULY 2019
2	Handbook of Industry 4.0 and SMART Systems	Diego Galar Pascual, Pasquale Daponte, Uday Kumar	2020	Taylor and Francis	2020
3	Industry 4.0: Managing the Digital Transformation	Alp Ustundag, Emre Cevikcan	-	Springer	2017

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Cybersecurity for Industry 4.0: Analysis for Design and Manufacturing	Lane Thames, Dirk Schaefe	-	Springer	201

E Books and online course materials:

1. https://nielibrary.com/stream_pdf/publication/701/663b3174f2408.pdf

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/106105195

2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_mg92

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: Study of Digital Transformation in Industries	10
	Activity 2: Smart Industrial Solutions Case Study	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Study of Digital Transformation in Industries (14 Hrs.)		
Study of Digital Transformation in Industries	Identification of automation practices in local industries	02
	Collection of information on digital technologies used in industries	03
	Analysis of benefits of industrial automation	03
	Preparation of a report on future trends in industrial systems	04
	Presentation and discussion	02
ABL 1: Total		**14**
ABL 2: Smart Industrial Solutions Case Study (13 Hrs.)		
Smart Industrial Solutions Case Study	Selection of an industrial problem	02
	Study of existing technological solutions	03
	Development of a conceptual smart solution	03
	Preparation of block diagram and workflow	02
	Presentation of the proposed solution	01
	Report submission	02
ABL 2: Total		13
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	RESEARCH METHODOLOGY AND IPR		
Course Code	24RIP	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To understand research methodology, technical writing, and IPR concepts in engineering research.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Carry out Literature Review and write technical paper	2,3,4,8,12	-
2	Describe the fundamentals of patent laws and the patent drafting procedure.	6,8,10,12	-
3	Elucidate the copyright laws and subject matters of copyright	6,8, 10,12	-

MODULE-1 — 10 Hrs

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research. **Ethics in Engineering Research:** Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Web of Science, Google and Google Scholar, Effective Search: The Way Forward, Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading.

MODULE-2 — 10 Hrs

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions.

Technical Writing and Publishing : Free Writing and Mining for Ideas, Attributes and Reasons of Technical Writing, Patent or Technical Paper?—The Choice, Writing, Journal Paper: Structure and Approach: Title, Abstract, and Introduction, Methods, Results, and Discussions, Table, Figures, Acknowledgments, and Closures

MODULE-3 — 11 Hrs

Introduction To Intellectual Property: Role of IP in the Economic and Cultural Development of the Society, IP Governance, IP as a Global Indicator of Innovation, Origin of IP, Major Amendments in IP Laws and Acts in India. **Patents:** Conditions for Obtaining a Patent Protection, To Patent or Not to Patent an Invention. Rights Associated with Patents. Enforcement of Patent Rights. Inventions Eligible for Patenting. Non- Patentable Matters. Patent Infringements.

Process of Patenting: Prior Art Search. Choice of Application to be Filed. Patent Application Forms. Jurisdiction of Filing Patent Application. Publication. Pre-grant Opposition. Examination. Grant of a Patent. Validity of Patent Protection. Post-grant Opposition. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications.

MODULE-4 — 11 Hrs

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements. Copyright Infringement is a Criminal Offence. Copyright Infringement is a Cognizable Offence. Copyrights and Internet. Non-Copyright Work. Copyright Registration. Judicial Powers of the Registrar of Copyrights. Fee Structure. Copyright Symbol. Validity of Copyright. Copyright Profile of India. Copyright and the word 'Publish'. Transfer of Copyrights to a Publisher. Copyrights and the Word 'Adaptation'. Copyrights and the Word 'Indian Work'. Joint Authorship. Copyright Society. Copyright Board. Copyright Enforcement Advisory Council (CEAC).

Trademarks: Eligibility Criteria. Who Can Apply for a Trademark. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration of a Trademark is Not Compulsory. Validity of Trademark. Types of Trademark Registered in India. Trademark Registry. Process for Trademarks Registration.

Self study: Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, IP Organizations In India.

Prescribed Text Books

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Engineering Research Methodology	Dipankar Deb, Rajeeb Dey, Valentina E, Balas	-	Springer	2019
2	Intellectual Property	Prof. Rupinder Tewari, Ms. Mamta Bhardwa	6th	Publication Bureau, Panjab University	2021

Reference Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Research Methods for Engineers	David V. Thiel	-	Cambridge University Press	2014
2	Intellectual Property Rights	N.K. Acharya	8th	Asia Law House	2021

E Books and online course materials:

1. https://sl1nk.com/y4ggnaa
2. https://dst.gov.in/sites/default/files/E-BOOK%20IPR.pdf

Online Courses and Video Lectures:

1. http://digimat.in/nptel/courses/video/127106227/L05.html
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/aic25_ge09

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: Students select any research topic and perform a literature review, identifying existing knowledge, synthesizing prior art, and compiling relevant citations leading to publishing a survey paper.	10
	Activity 2: Students analyze real world case studies for legal issues and propose solutions to infringement cases.	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Drafting survey paper (14 Hrs.)		
Drafting survey paper	Research Topic Selection	02
	Literature review & Identifying existing knowledge	05
	Synthesizing prior art & compiling relevant citations	02
	Presentation & Publication	05
ABL 1: Total		**14**
ABL 2: Students analyse real world case studies (13 Hrs.)		
Real world case studies analysis	Legal issues	04
	Propose solutions to infringement cases	04
	Presentation, demonstration, viva-voce	05
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

VI SEMESTER

Course Title	ELECTRICAL MACHINE DESIGN		
Course Code	24EE601	(L-T-P)C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: Students will be able to design electrical machines.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Describe the basic concepts of electric machines with respect to design considerations.	1,2,3,5	1
2	Develop the knowledge required for electrical machine design.	1,2,3,5	1
3	Design Transformers and Induction motor from the given data.	1,2,3,5	1
4.	Design Synchronous machine from the given data	1,2,3,5	1

MODULE-1 **11 Hrs**

Basic principles of electrical machine design: Introduction, Considerations for the design of electrical machines, limitations. Different types of materials and insulators used in electrical machines.

Design of transformers (Single phase and three phase): Brief discussion on construction; Output equation for single phase and three phase transformers, Choice of specific loadings, Expression for volts/turn, determination of main dimensions of the core.

MODULE-2 **11 Hrs**

Estimation of number of turns and cross sectional area of Primary and secondary coil, Estimation of losses and no load current, Design of the tank and cooling tubes.

Design of Induction motors: Brief discussion on construction, Output equation, choice of specific loadings, main dimensions of three phase induction motor, stator winding design, choice of length of the air gap, estimation of number of slots for the squirrel cage rotor.

MODULE-3 **10 Hrs**

Estimation of dimension of the slot Rotor design, Length of the air gap, Types of rotor, Design of squirrel cage rotor, design of Rotor bars and end ring.

Design of synchronous machines: Brief discussion on construction, Output equation, choice of specific loadings, short circuit ratio, number of slots for the stator, Design of main dimensions, armature winding, slot details for the stator of salient synchronous machine.

MODULE-4 **10 Hrs**

Design of rotor of salient pole synchronous machine, Dimensions of the pole body, Estimation of height, number of turns and arrangement of turns for the field winding.

Design of main dimensions, armature winding, slot details for the stator of non-salient pole synchronous machine

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	A Course in Electrical Machine Design	A. K. Sawhney	6th	Dhanpat Rai & Sons	2006

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Design of Electrical Machines	V.N.Mittle	4th	Standard Publishers	1996
2	Electrical Machine Design Data Hand Book	Sahnmugsundaran & Palani	-	New Age International	2004

Online Courses and Video Lectures:

1. https://nptel.ac.in/courses/108105155

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	-	-	-
3	Evaluation of Learning Process			07
4	Activity Based Learning **(ABL)**			26+15=41
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: Programs on design of main dimensions of power transformer and calculation of tank design using MATLAB.	10
	Activity 2: Programs on design of main dimensions of 3 phase induction motor and design of main dimensions of squirrel cage rotor	10
Total		**50**

Activity Based Learning (41 Hours)

ABL 1 :		
Programs on design of Transformer	Programs on design of main dimensions of power transformer	10
	Programs for calculation of tank design.	10
ABL1: Total		**20**
ABL 2 :		
Programs on design of Induction motor	Program for design of main dimensions of 3 phase induction motor	11
	Program for design of main dimensions of stator slots of 3 phase induction motor.	11
ABL2: Total		**22**
ABL1 + ABL2: Total		**42**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	MODERN CONTROL THEORY		
Course Code	24EE602	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To develop skills to obtain state space model of the systems and analyze systems using state space techniques.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Model the systems using state space techniques choosing appropriate state variables.	1, 2,5	1
2	Solve homogeneous and non-homogeneous state space models.	1, 2,5	1
3	Design system using pole placement techniques after checking controllability and observability of the system.	1, 2, 3,5	1
4	Analyze the stability of linear systems using Liapunov's criteria.	1, 2,5	1

MODULE-1 **11 Hrs**

Introduction to State variable analysis: Limitations of classical control theory, Concept of state, State variables, state space model for physical systems – Electrical, Mechanical and Electro- Mechanical systems.

State Space Model: State model of linear systems from differential equations and State space model from transfer functions, direct (CCF and OCF), series and parallel decomposition. Transfer function from state model.

MODULE-2 **11 Hrs**

Canonical Models from Similarity Transformation: Similarity transformation of state model, Invariance property, computation of diagonalizing matrix: Eigen values, Eigen vectors and generalized Eigen vectors, Linear transformation of state model into CCF and OCF, Diagonalcanonical model, Jordan canonical model.

Time Domain Analysis in State Space: Solution of state equations for homogeneous systems, State Transition matrix, Properties of State Transition matrix, Computation of State Transition matrix using Power series and Laplace Transformation methods.

MODULE-3 **10 Hrs**

STM using Similarity transformation and Caley-Hamilton methods, Solution of state equations for non-homogeneous systems.

Controllability and Observability: Concept of controllability and observability, Criterion for controllability and observability using Kalman's test and Gilbert's method, controllability and observability of state models.

MODULE-4 **10 Hrs**

Pole placement Techniques: Stability improvements by State feedback, necessary and sufficient conditions for arbitrary pole placement, Design of state feedback controllers, Ackerman's formula. Design of state observers- full order observer.

Stability Analysis: Concept of stability, Equilibrium points, Liapunov's stability definitions, Sign definiteness of scalar functions, Liapunov's function, Liapunov's method for Linear time invariant systems and Non-linear Systems.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Modern Control Engineering	K.P. Mohandas	2nd	Sanguine Technical Publishers	2016

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Digital Control & State Variable Methods	M. Gopal	4th	Mc Graw Hill	2017
2.	Modern Control Engineering	K. Ogata	5th	Pearson	2015
3.	Automatic Control Systems	B.C. Kuo	9th	Wiley	2014
4.	Modern Control Systems	Richard C. Dorf	14th	Pearson	2022

E Books and online course materials:

1. Chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://nitc.ac.in/imgserver/uploads/attachments/moderncontrol_2db5fc9d-ffe1-42cd-b695-946ca7e9d64b_0.pdf

2. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://gcebargur.ac.in/sites/gcebargur.ac.in/files/lectures_desk/Digital%20Control%20and%20State%20Variable%20Methods%20M%20Gopal.pdf
3. https://pdf.lib.vntu.edu.ua/books/2021/Dorf_Modern_control_systems_2017_1106.pdf
4. https://mrce.in/ebooks/Control-Modern%20Control%20Systems%2014th%20Ed.pdf

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/103/108103007/

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	-	-	-
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	26+15=41
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: Basic Programs	10
	Activity 2: OOPs Programming	10
Total		**50**

Activity Based Learning (41 Hours)

ABL 1 : Basic Programs		
Programming using branching , looping, functions	Programming using to class based on percentage	02
	Programming the simple calculator	02
	Programming using looping find total marks of all semester then declare CGPA	04
	Program to generate even/prime/odd series	04
	Program to find factorial of a number	04
	Submission of the report	06
	Quiz	04
ABL1: Total		**26**
ABL 2 : OOPs Programming		
Programming using OOPs	Create class called library	05
	Program to monitor the books drawn, date of return and calculate the fine to be paid	10
ABL2: Total		**15**
ABL1 + ABL2: Total		**41**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	POWER SYSTEM ANALYSIS AND STABILITY		
Course Code	24EE603	(L-T-P) C	(3-0-0)3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L+48ABL=90

Course Objective: To develop the ability to analyze the behavior and stability of power systems under fault conditions.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the concepts of symmetrical and unsymmetrical faults and stability studies.	1	1
2	Develop positive, negative, and zero sequence networks for a given power system.	1,2,3,4	1
3	Apply fault analysis methods for symmetrical faults in power systems.	1,2,3,4,5	2
4	Evaluate the behavior of power systems under various unsymmetrical fault conditions with and without fault impedance.	1,2,3,4,5	2

MODULE-1	11Hrs.

Representation of Power System Components: Circuit models of transmission lines, Synchronous machines, Transformers & loads, one-line diagrams, impedance and reactance diagrams, per-unit systems, Change of base rule, merits anddemerits, perunit impedancediagramofpowersystem, illustrative examples.**Symmetrical3-Phase Faults:** Transients on transmission lines, Short circuit currents and the time varying reactances of synchronous machines by considering the sub transient, transient and steady state periods of short circuit, illustrative examples.

MODULE-2	11Hrs.

Symmetrical Components: Analysis of unbalanced loads against balanced 3-phase supply, resolution of unbalanced phasors into their symmetrical components and vice versa, power in terms of symmetrical components, consideration of power in variancy conditions, analysis of balanced and unbalanced loads against unbalanced 3 φ supply, illustrative examples.

Sequence Impedances and Sequence Networks: Consideration of positive, negative and zero sequence diagrams with all kinds of power system elements involved such as,-Alternator, transformer,
Transmission line, etc., neutral line currents in zero sequence diagrams, obtaining the equivalent sequence diagrams at the point of fault, illustrative examples.

MODULE-3	10Hrs.

Unsymmetrical Faults: Line to Ground(LG) faults, Double Line(LL) faults, Double Line to ground(LLG) faults and 3 phase to ground (LLLG) faults on an unloaded alternator with-out and with the fault impedance Zf, consideration of c.u.f, d.c.u.f, connection of sequence networks, expression for various faulty parameters for all the above kinds of faults, illustrative examples. **Unsymmetrical Faults on Power System:** Consideration of all the types of unsymmetrical faults with reference to a general point of fault "F" of a power system with-out and with the fault impedance Zf., calculationoffault current at the point of fault with-out and with the fault impedance Zf. For the Power System faults. Illustrative examples.

MODULE-4	10 Hrs

Stability Studies: Steady state stability, Dynamic stability and Transient Stability, Definitions, stability margins, Bad effects of Instability, concept of Power Angle equation and Power Angle curves, Rotor dynamics and the Swing equation, derivation, Significance of Swing equation, Inertia constants M and H, Equation for kinetic energy and Inertia constants, illustrative examples.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Elements of Power System Analysis	W.D. Stevenson	4th	McGrawHill Higher Education	1982

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Modern Power System Analysis	J. Nagrath and D.P.Kothari	Third Edition	Tata Mc Graw Hill	2003

Online Courses and VideoLectures:

1. https://nptel.ac.in/courses/108102080
2. https://nptel.ac.in/courses/108101004
3. https://www.udemy.com/courses/search/?src=ukw&q=power%20system%20matlab%20simulation

Teaching-Learning–EvaluationScheme:

Sl.No	TeachingandLearning Method	No.of Hours/Week	No.of Weeks	Hours/Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours–Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning**(ABL)**	-	-	14+13=27
Total Learning Hours/ Semester				**90**

Proposed Assessment Plan(50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to10 marks	30
Activity Details	Details of activities to be conducted Activity1: Simulation of Power System Fault Analysis Using MATLAB/ETAP/MiPower Activity2: IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power Electronics	20
Total		**50**

Activity Based Learning(48Hours)

ABL 1: Simulation of Power System Fault Analysis Using MATLAB/ETAP/MiPower		
Simulation of Power System Fault Analysis using MATLAB /ETAP/MiPower	Simulation of fault analysis and stability studies in electrical power systems using suitable software tools. The topic will be given by the course faculty to a batch of students	14
ABL1:Total		**14**
ABL2: IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power systems		
IEEE/Elsevier or other Peer-Reviewed Reputed Journal Paper Presentation on Power systems	This topic will be selected by the course faculty.	13
ABL2:Total		**13**
ABL1+ABL2:Total		**48**

Evaluation of Learning Process(07 Hours)

Typeof Evaluation	Hours
CIE(1,2and 3)	03
Activity(1and2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-								2	-
CO2	3	3	2	-	2									2
CO3	3	3	-	2	2									2
CO4	3	3	-	3	2									2

Course Title	HIGH VOLTAGE ENGINEERING		
Course Code	24EE604	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To learn the technology associated in high voltage generation, measurement and testing.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the classification, need to generate high voltages and applications of high voltages.	1	1
2	Demonstrate fundamental knowledge of gaseous insulation and theoretically analyze criterion for electrical breakdown of gaseous insulating media.	1,2	1
3	Describe the techniques of generating HVAC, HVDC, Lightning & Switching impulse voltage and current.	1,2	1
4	Explain measurement of high voltages, high currents and high voltage surges.	1,2	1

MODULE-1	10 Hrs

Introduction: Introduction to HV technology, Advantages of electric power transmission at high voltages. Need for generating high voltages in a laboratory. Important applications of high voltages. Types of HV insulators, cables and bushings. Breakdown phenomena: Classification of HV insulating media. Gaseous dielectrics: Ionization: Primary and secondary ionization processes. Criterion for gaseous insulation breakdown based on Townsend's theory. Limitations of Townsend theory, Streamer theory, Corona discharges. Breakdown in electronegative gases. Paschen's law and its significance. Time lags of breakdown.

SLC: Solid insulating media.

MODULE-2	10 Hrs

Generation of High voltage AC and DC: HVAC - HV transformer; Need for cascade connection and working of transformers units connected in cascade. Series resonant circuit - Principle of operation and advantages. Tesla coil. HVDC - Voltage doubler circuit. Cockcroft-Walton type high voltage DC set. Calculation of Voltage regulation, Ripple and Optimum number of stages for minimum voltage drop.

SLC: Potential dividers - Resistance dividers, Capacitance divider.

MODULE-3	11 Hrs

Generation of Lightning Impulse voltages: Introduction to standard Lightning Impulse (LI) voltages and necessity of generating them in a laboratory. Analysis of single stage impulse generator – Deriving impulse voltage expression representing a double exponential wave. Multistage IG and Generation of LI & SI voltages: Multistage impulse generator working on Marx principle. Rating of a Multistage impulse generator. Components of Multistage impulse generator.

SLC: Air blast circuit breaker, Vacuum circuit breaker.

MODULE-4	11 Hrs

Measurement of high voltages, currents and surges: Electrostatic voltmeter - Principle, construction and limitations. Chubb and Fortes cue method for HVAC measurement. Generating voltmeter - Principle and construction. Standard sphere gap for measurement of various types of high voltages; Factors affecting the measurements. Potential dividers - Resistance dividers, Capacitance divider, Mixed RC potential divider. Surge measurement - Klydanograph and magnetic links, Introduction to Partial discharges (PD), PD measurement.

SLC: Solid state relay, microprocessor based relay, Bucholoz relay.

Prescribed Text Books

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	High Voltage Engineering	M. S. Naidu and V. Kamaraju	4th	Tata McGraw Hill	1995
2	High Voltage Engineering	C. L. Wadhwa	-	New Age International Private Limited	1995

Reference Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	High Voltage Engineering Fundamentals	E. Kufell and W.S. Zaengl	2nd	Pergamon Press	1984

E Books and online course materials:

1. https://psr.edu.in/wp-content/uploads/2023/06/High-Voltage-Engineering.pdf
2. https://www.udemy.com/course/high-voltage-and-insulators-for-electrical-power-engineering/?srsltid=AfmBOoplACr-6MRi1NrK1zoKTXF0ilsMiE9fzqyg81rCyLKRgpjeT4-a&coupo

Online Courses and Video Lectures:

1. https://www.udemy.com/course/high-voltage-and-insulators-for-electrical-power-engineering/?utm_campaign=Search_DSA_Beta_Prof_la.EN_cc.India_Subs&utm_source=google&
2. https://nescacademy.nasa.gov/playlist/c8a0c94a732a4385a383ae64e9a6aabc54.

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity1: Substation visit and build a mini smart substation model.	10
	Activity 2: Students analyze and select suitable breakers for different real world systems.	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Drafting survey paper (14 Hrs.)		
Substation visit and build a miniature smart substation model	Substation visit	07
	Building miniature substation model	07
ABL 1: Total		**14**
ABL 2: Students analyse real world case studies (13 Hrs.)		
Students analyze and select suitable breakers for different real world systems.	Analysing	03
	Selection of suitable protective device for the systems	05
	Presentation, demonstration, viva-voce	05
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	LINEAR CONTROL SYSTEMS LABORATORY		
Course Code	24EE605	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	28P + 02 = 30

Course Objective: To develop practical skills in modeling, simulation, stability analysis, and controller design of dynamic systems using MATLAB/SIMULINK.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Perform modeling and simulation of electrical, mechanical, and control systems using MATLAB/SIMULINK.	1,8,9,10	1
2	Analyze the dynamic response and stability characteristics of control systems using time-domain and frequency-domain techniques.	1,8,9,10	1
3	Evaluate the performance of controllers and compensators for improving system response and stability.	1,8,9,10	1

LIST OF EXPERIMENTS

1. Simulation of electrical and mechanical system using MATLAB/SIMULINK.
2. Simulation of a typical second order system and determination of step response and evaluation of time-domain specifications using MATLAB.
3. Analysis on the effect of variation of damping ratio in a typical second order system using MATLAB.
4. Analysis of stability of the system using MATLAB simulation of Root loci of a given transfer function.
5. Analysis of stability of the system using MATLAB simulation of Bode plot of a given transfer function.
6. Compare the effect of P, PI and PD controller on the step response of a feedback control system using MATLAB.
7. Analysis of Phase Lead, Phase Lag and Phase Lead-Lag networks using Bode plot.

Course Articulation Matrix

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

Course Title	RELAY AND HIGH VOLTAGE LABORATORY		
Course Code	24EE606	L-T-P	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	28P + 02 = 30

Course Objective: To demonstrate behaviour of switchgear devices subjected to high voltage application.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSO's
1	Perform experiments to determine the operating characteristics of protective relays, fuses, and insulation systems.	1, 2, 4, 9, 11	1,2
2	Analyze the breakdown and spark-over characteristics of insulating media under various high-voltage conditions.	1, 2, 3, 4, 9, 11	1,2
3	Evaluate protection schemes and high-voltage testing methods for reliable power system operation.	1, 2, 3, 4, 6,9, 11	1,2

LIST OF EXPERIMENTS

1. Operating characteristics and calculation of error in operating time for over-current electromechanical relay.
2. Operating characteristics of static over-voltage relay.
3. Operating characteristics of static under-voltage relay.
4. Breakdown strength of transformer oil, using oil testing unit.
5. Current-time characteristics of fuse.
6. Spark over characteristics of air insulation subjected to high voltage AC-with Spark over voltage corrected to STP.
7. Spark over characteristics of air insulation subjected to high voltage DC under uniform field condition.
8. Spark over characteristics of air insulation subjected to high voltage DC under non-uniform field condition.
9. Measurement of HVAC using standard spheres.
10. Field mapping using electrolytic tank for Co-axial cable model.

Course Articulation Matrix

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

PROFESSIONAL ELECTIVE COURSE – II

Course Title	**FLEXIBLE AC TRANSMISSION SYSTEM**		
Course Code	**24EE621**	**(L-T-P)C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**42L+48ABL=90**

Course Objective: To analyze the fundamentals of FACTS controllers and their role in improving power system performance.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Analyze the operating principles and characteristics of FACTS controllers used in power systems.	1,2,3,5	2
2	Explain the operation of voltage source converters and compensation techniques in transmission systems.	1,6	1
3	Analyze shunt and series compensation methods for power flow control and stability enhancement.	1,6	2
4	Evaluate the role of FACTS devices in power system performance enhancement.	1,6	1

MODULE-1	**11 Hrs**

FACTS Concepts & General System Considerations: Flow of power in an AC system, limits of the loading capability, Power flow and dynamic stability considerations of a transmission interconnection, relative importance of controllable parameters, Basic types of FACTS controllers, Brief description and definitions of FACTS controllers, Benefits from FACTS.

Voltage Sourced Converters: Basic concept, Single-phase full-wave bridge converter operation, Single phase-leg operation, square wave voltage harmonics for a single-phase bridge, three phase full wave bridge converter, sequence of valve conduction process in each phase-leg.

MODULE-2	**10 Hrs**

Static Shunt Compensator - SVC: Objective of shunt compensation, Methods of controllable VAR generation (Variable Impedance type, Switching converter type, Hybrid Var generators), Types and V-I Characteristics of - TCR, TSR, FC-TCR.

STATCOM: Comparison between SVC and STATCOM, The Principle of STATCOM Operation, The V-I Characteristic, The regulation slope, Transfer function and dynamic performance, transient stability enhancement and power oscillation damping, Var reserve control.

MODULE-3	**10 Hrs**

StaticSeriesCompensators-TCSC,GCSC,TSSC: Objectivesofseriescompensation,Variableimpedance type of series compensators: Fixed-Series Compensation, Thyristor-Controlled Series Capacitor (TCSC), Advantages of the TCSC, Operation of the TCSC,Modes of TCSC Operation- Bypassed-Thyristor Mode, Blocked-Thyristor Mode, Partially Conducting Thyristor and Vernier Mode, V-I characteristics of TCSC. Operation and V-I characteristics of GCSC and TSSC.

Switching converter type series compensators- SSSC: The Principle of Operation, V-I characteristics, capability to provide real power compensation.

MODULE-4	**11 Hrs**

Static Voltage and phase angle regulators: Objectives of Voltage and Phase Angle Regulation, Power Flow Control by Phase Angle Regulators, Real and Reactive Loop Power Flow Control, Improvement of Transient StabilitywithphaseAngleRegulators,PowerOscillationDampingwithphaseAngleRegulators,Approaches to Thyristor-Controlled Voltage and phase Angle Regulators (TCVRs and TCPARs) , Continuously ControllableThyristorTapChangers,ContinuouslyControllableThyristorTapChangers,ThyristorTapChanger with Discrete Level Control.

Unified Power Flow Controller –UPFC: Introduction, The Unified Power Flow Controller, Basic Operating Principles, Conventional Transmission Control Capabilities, Interline **Power Flow Controller -IPFC**: Basic Operating Principles and Characteristics.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G. Hingorani and Laszlo Gyugyi	1st	IEEE Press, Standard Publishers Distributors	2001
2.	Thyristor-based facts controllers for electrical transmission systems	R. R. Mohan Mathur and Rajiv K. Varma	1st	IEEE Press, John Wiley and Sons	2002

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	FACTS, Controllers in Power Transmission and Distribution	K. R. Padiyar	1st	New Age International Publishers	2007

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/107/108107114/

Teaching -Learning–Evaluation Scheme:

Sl.No	Teaching and Learning Method	No.of Hours/Week	No.of Weeks	Hours/Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours–Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours/ Semester				**90**

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Activity 1: MATLAB Simulation for 10 Marks 2) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Activity Based Learning (27 Hours)

ABL1: MATLAB Simulation		
MATLAB Simulation	MATLAB/Simulink based simulation and performance analysis of FACTS controllers in power systems.	**14**
	The question will be given to the students (a batch of 4 to 5 students) by the course faculty	
ABL1:Total		**14**
ABL2: Assignment and Quiz		
Assignment and Quiz	Assignment and Quiz on FACTS Controllers and Power System Compensation Techniques.	**13**
ABL2:Total		**13**
ABL1+ABL2:Total		**27**

Evaluation of Learning Process (7Hours)

Type of Evaluation	Hours
CIE(1, 2 and 3)	03
Activity 1and 2	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix:

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

Course Title	EMBEDDED SYSTEMS		
Course Code	24EE622	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To understand embedded systems and develop efficient programs for embedded applications.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the architecture of embedded system	1,2,5	2
2	Analyze the RTOS concepts in embedded system design	1,2,3,5	2
3	Apply the communication ports in real time system design	1,2,3,5	2
4	Asses the various supporting devices used to design an embedded system	1,2,3,5	2

MODULE-1	12 Hrs

INTRODUCTION: Introduction to embedded system- embedded system architecture - classification of embedded systems CISC Vs RISC - IC technology - processor technology.

PROCESSOR AND MEMORY ORGANIZATION: Structural units in a processor; selection of processor, selection of memory devices; allocation of memory to program segments and blocks, memory map of a system; DMA; interfacing processor, memory and I/O units, memory management, watch dog timers

MODULE-2	10 Hrs

REAL TIME OPERATING SYSTEM: Introduction of RTOS, Hard and soft real time systems- examples, RTOS -Interrupt handling, Embedded system design issues in system development process.

MODULE-3	10 Hrs

INPUT / OUTPUT DEVICES: Serial communication using I2C, CAN, USB buses- automobile, computer; parallel communication using ISA, PCI, PCI/X buses, arm bus; device drivers in a system -Serial port & parallel port, Testing of Embedded Systems, System Design Example.

MODULE-4	10 Hrs

REAL TIME EMBEDDED SYSTEM: Digital camera- washing machine- automated teller machine - open source embedded system software Free RTOS.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Embedded System-Architecture	Rajkamal	-	Programming, Design, Mc Graw Hill	2013
2.	Embedded system Design	Peckol	-	John Wiley & Sons	2010

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Embedded Systems-An Integrated Approach	Lyla B Das	-	Pearson	2013
2.	Introduction To Embedded Systems	Shibu. K.V	-	Tata Mcgraw Hill	2009
3.	Making Embedded Systems	Elicia White	-	O Reilly Series, SPD	2011

E-book

1. https://shorturl.at/exnA3

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs22
2. https://nptel.ac.in/courses/108102045
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_cs14

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 2) Activity 1: Lab based learning 3) Activity 2: Project Based Learning	20
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Lab based learning (14 Hrs.)		
IDE software	Introduction to ESP32 development environment and programming tools	02
	Interfacing sensors and input/output devices with ESP32 board	04
	UART, SPI, and I2C communication interfacing	02
	Real-time embedded application development using ESP32	04
	Testing and debugging embedded hardware modules	01
	Demonstration of IoT-based embedded applications	01
ABL 1: Total		**14**
ABL 2: Development of Models using ESP32 Board (13 Hrs.)		
Project Based Learning	Project-based learning: Embedded system problem identification	02
	Design and implementation of embedded models using ESP32	04
	Testing, validation, and project demonstration	07
ABL 2: Total		
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT		
Course Code	24EE623	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To develop the knowledge of testing, correcting, preventing and maintenance of electrical equipment's.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Assess the plan, control, implement and commissioning of electrical equipment.	1, 2	-
2	Demonstrate the knowledge of need and method for testing of each part of equipment's to prove the reliability.	1, 2	-
3	Apply the knowledge to perform the corrective, preventive and maintenance of electrical equipment's.	1, 2, 3	-
4	Describe the tests conducted on switch gear and protection equipment's of electrical power system.	2,3	

MODULE-1	10 Hrs

Transformers: Specifications: Power and distribution transformers as per BIS Standards. Installation: Location, Site, Selection, foundation details (like bolts size, Their number, etc), Code of practice for terminal plates, Polarity and phase sequence, Oil tanks, drying of windings and general Inspection.

Transformers: Commissioning Tests: Tests as per national & International Standards, volt ratio test, earth resistance oil strength, Buchalz & other relays, tap changing gear, fans & pumps, insulation test, impulse test, polarizing index, load & temperature raise test. Specific Tests: Determination of performance curves like efficiency, regulation

MODULE-2	10 Hrs

Synchronous Machines: Specifications: As per BIS Standards, Installation: Physical inspection, foundation details, alignments, excitation systems, and cooling & control gear, drying out. Commissioning Test: Insulation, Resistance measurement of armature and field winding, wave form and telephone interference test, line charging Capacitance.

Factory Test: Gap length, magnetic eccentricity, balancing Vibrations, bearing Performance.

Synchronous Machines Conditions: Performance test: Various test to estimate the performance of generator operations, slip test, maximum lagging Current, maximum reluctance power tests, Sudden short Circuit tests, transient & Sub-Transient Parameters, measurements of sequence impedances, temperature rise tests.

MODULE-3	11 Hrs

Induction Motors: Specifications: Different types of motors duty, protection. Insulation Location of the motors including the foundation details and its control apparatus, shaft and alignment for various coupling, fitting of pulleys & coupling. Drying of windings.

Induction Motor Conditions: Commissioning Tests: Mechanical test for alignment, air gap Symmetry, tests for bearings, Vibrations and balancing. Specific test: Performance and temperature raise test, stray load losses, shaft alignment.

MODULE-4	11 Hrs

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright.

Induction Motor Conditions: Electrical test: Insulation test, Earth resistance, High voltage test, Starting up, failure to speed up to take the load, Type of test- routine test, factory test, and site test, (In accordance with ISI Code.)

Switchgear and protective devices: Standards, types, specification, installation, commissioning tests, maintenance schedule, type and routine tests.

Prescribed Text Books

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Testing, Commissioning, Operation and Maintenance of Electrical Equipment's	prof. Sunil S Roa	-	Khanna publishers	2024

Reference Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Testing & Commission of Electrical Equipment	B.V.S. Rao	1st	Relevant Bureau of Indian Standards	-
2	Practical Guide to Inspection, Testing and Certification of Electrical Installations Christofer Kitcher. - - - 3 Installation Commission	N.K. Acharya	8th	Asia Law House	-
3	Maintenances of Electrical Equipment's	Tarlok Singh			-

E Books and online course materials:

1. https://www.scribd.com/document/373512192/s-rao-testing-commissioning-operations-maintenance-electrical-eq-pdf

Online Courses and Video Lectures:

3. Commissioning & Testing of Electrical Systems – GLOMACS
4. Testing & Commissioning of Switchgear (Part 1 & 2) – Udemy

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: Visit substations and observe: ➢ Protection systems and testing procedures ➢ Observe transformer maintenance and oil testing	10
	Activity 2: Commissioning procedure development of electrical systems.	10
Total		**50**

Activity Based Learning (27 Hours)

ABL 1: Drafting survey paper (14 Hrs.)		
Substation visit	**Visit substation and observe:** Protection systems and testing procedures	05
	Observe transformer maintenance and oil testing	05
	Report preparation and Presentation	04
ABL 1: Total		**14**
ABL 2: Students analyse real world case studies (13 Hrs.)		
Commissioning procedure/checklist development of motors and transformers in electrical machines laboratory.	Pre commissioning checklist	03
	Functional checklist	03
	Safety checklist	03
	Presentation	04
ABL 2: Total		**13**
ABL1 + ABL2: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	ELECTRICAL POWER QUALITY		
Course Code	24EE624	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To understand various power quality problems, their causes, effects, and evaluation procedures in electrical power systems.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	Identify various power quality issues including voltage variations, transients and waveform distortions.	1, 6	1
2.	Analyze voltage sags, interruptions, transients, and overvoltage phenomena in electrical networks.	1, 6	1
3.	Discuss the sources and effects of harmonic distortion in commercial and industrial systems.	1,6	1
4.	Evaluate power quality standards, benchmarking practices, and utility–consumer interface requirements.	1,7	1

MODULE-1	11 Hrs

Introduction: Power Quality-voltage quality, power quality evaluation procedures, general classes of power quality problems, transients-long duration voltage variation, short duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power quality terms.

MODULE-2	10 Hrs

Voltage sags and Interruptions: Sources of sags and interruptions, estimating voltage sag performance, fundamental principles of protection, Motor sags.

Transients over voltages: Sources of transients over voltages, principles of over voltages protection, utility capacitor switching transients.

MODULE-3	11 Hrs

Fundamentals of harmonics: Harmonic distortion, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, effects of harmonics distortion.

Applied Harmonics: Harmonic distortion evaluations, principles for controlling harmonics, harmonic studies, devices for controlling harmonic distortion, harmonic filters.

MODULE-4	10 Hrs

Power quality benchmark: Introduction, benchmark in process, power quality contract, power quality state estimation, including power quality in distribution planning, interface to utility system, power quality issues, interconnection standards.

Prescribed Textbooks:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Electric power quality	Dugan, Roger C, Santoso, Surya, McGranaghan, Mark F/Beaty and H.Wayne	3rd	McGraw-Hill Professional Publication	2003.

Reference Books:

Sl.No	Book title	Authors	Edition	Publisher	Year
1.	Electric Power Quality	G.T. Heydt	3rd	Stars in a circle publications	1991
2.	Modern Power Electronics	M.H. Rashid	5th	Tata McGraw Hill	2002
3.	Understanding Power quality problems voltages sags and interruptions	Math H.J. Bollen	3rd	IEEE Press	2000

E-books and online course materials:

1. https://ebooks.iospress.nl/book electric -power-quality people
2. https://link.springer.com/book/10.1007/978-981-99-7333-0
3. https://nptel.ac.in/courses/115103123

Teaching -Learning– Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning **(ABL)**	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (50 marks):

Tool	Remarks	Marks
CIE	Three CIE's conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1. Case study on power quality issues in different commercial / industrial sectors 2. Quiz	 10 10
Total		50

Activity Based Learning (27 Hours)

ABL1 : Activity Based Learning (14 Hrs)		**Hours**
Case study	1. **Problem Identification:**Clear definition of power quality issues, Relevance of chosen sectors, Justification for sector selection. 2. **Technical Analysis:** Explanation of how each power quality issue affects sensitive equipment, Use of diagrams, waveforms, or simulation results to illustrate impacts, Sector-specific examples, Integration of quantitative data. 3. **Comparative Evaluation Across Sectors:**Identification of common vulnerabilities and sector-specific challenges, Tabular or graphical representation of findings. 4. **Mitigation Strategies:**Discussion of corrective technologies, Preventive measures, Cost-benefit analysis of solutions in different	**2** **3** **3** **3**

	sectors. 5. **Presentation & Originality:**Clarity, organization, and logical flow of the case study, Use of original phrasing, structured diagrams, and formal academic style, Proper citations and references to standards (IEEE, IEC) or industry reports.	**3**
ABL1: Total		**14**
ABL2 : Activity Based Learning (13 Hrs)		
Quiz	**1.** Basic Power Quality Concepts **2.** Voltage Sag, Interruptions and Transients **3.** Harmonics and Waveform Distortion 4. Standards and Mitigation Techniques	**4** **3** **3** **3**
ABL2: Total		**13**
ABL Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity (1 and 2)	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

OPEN ELECTIVE COURSE – I

Course Title	INTRODUCTION TO ELECTRIC VEHICLE		
Course Code	24OEEE61	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	42L + 48ABL = 90

Course Objective: To analyze various aspects of Electric Vehicles and Hybrid Electric Vehicles and various options of energy storage systems.

Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the basic concepts of various types of electric vehicles.	1	1
2	Analyze EV and EHV configurations and their electric propulsion systems.	1, 2	1
3	Discuss various type of batteries in EV and EHV.	1, 2	1
4	Outline the electric power supply, Operating principles of fuel cells.	1, 2	1

MODULE - 1 — 11 Hrs.

Introduction to Electric Vehicles: History of Electric Vehicles (EV), Hybrid Electric Vehicles (EHV) and Fuel Cell Vehicles. Social and environmental importance of electric and hybrid electric vehicles – air pollution, global warming, impact of modern drive trains on energy supplies.

Types of Electric Vehicles: Battery Electric Vehicles, IC Engine/Electric Hybrid Vehicle, Fuelled EVs, EVs using Supply Lines, EVs which use Flywheels or Super capacitors, Solar-Powered Vehicles, Vehicles using Linear Motors, EVs for the Future.

SLC: AC and DC motor drives.

MODULE - 2 — 11 Hrs.

Configuration of EV's and EHV's: Configurations of EVs, Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains - Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains and series-parallel Hybrid Electric Drive Trains.

SLC: BLDC motor drives.

MODULE - 3 — 10 Hrs.

Sources: Batteries, Battery Parameters, Lead Acid Batteries, Nickel-Based Batteries, Sodium-Based Batteries, Lithium Batteries, Battery Charging, Battery Management System.

SLC: Recent Trends in Battery technology.

MODULE - 4 — 10 Hrs

Fuel Cells: Operating principles of fuel cells, Fuel cell technologies, fuel supply, and non-Hydrogen Fuel cells.

Electric Supply: Normal Existing Domestic and Industrial Electricity Supply, Infrastructure needed for charging Electric Vehicles, Electricity supply Rails, Battery swapping, Battery Management System.

SLC: Hybrid Energy sources.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Electric Vehicle Technology	James Larminie, John Lowry	2nd	John Wiley & Sons Ltd	2012
2	Modern Electric, Hybrid Electric andFuel Cell Vehicles: Fundamentals, Theory and Design,	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi	3rd	CRC Press Taylor & Francis Group	2004

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid	John G. Hayes, G. Abas Goodarzi	3rd	Wiley	2005
2	Handbook of Automotive Power Electronics and Motor Drives	Ali Emadi	3rd	Taylor & Francis Group	2008

E Books and online course materials:

1. https://www.nielit.gov.in/content/online-course-ev-technology-public-charging-station
2. https://www.classcentral.com/subject/electric-vehicles
3. https://course.cutm.ac.in/wp-content/uploads/2020/06/Notes-on-Electric-Vehicles.pdf

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc22_ee53/preview
2. https://www.dqindia.com/iit-madras-offers-free-online-course-electric-vehicles-can-completed-12-weeks/

Teaching - Learning – Evaluation Scheme:

Sl. No	Teaching and Learning Method	No. of Hours/Week	No. of Weeks	Hours/ Semester
1	Class Room Teaching & Learning	3	14	42
2	Student Study Hours – Self Learning	1	14	14
3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning (ABL)	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted Activity 1: EV manufacturing plant visit	10
	Activity 2: Seminar on recent trends in Electric vehicle technologies (IEEE JOURNAL PAPER)	10
Total		**50**

Activity based learning (27 Hours)

ABL 1: EV manufacturing plant visit **(14 Hrs.)**	
ABL1: Total	**14**
ABL 2: Seminar on recent trends in Electric vehicle technologies (IEEE JOURNAL PAPER) **(13 Hrs.)**	
ABL2: Total	**13**
ABL1 + ABL2: Total	**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity 1 and 2	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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

Course Title	ALTERNATE ENERGY SOURCES		
Course Code	**24OEEE62**	**(L-T-P) C**	**(3-0-0) 3**
CIE	**50**	**Hours/Week**	**3**
SEE	**50**	**Total Hours**	**42L + 48ABL = 90**

Course Objective: To understand the operating principles, performance characteristics, and applications of renewable energy systems.

Course outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the classification, characteristics, advantages, and limitations of conventional and renewable energy resources.	1	1
2	Apply resource assessment and energy estimation methods for renewable energy applications.	1,2,6	1
3	Analyze the operating principles and performance of renewable energy conversion systems.	1,3,6,7	1
4	Evaluate the role of renewable energy technologies in sustainable energy generation.	1,6	1

MODULE-1	11 Hrs

Energy Sources: Classification of energy resources, limitations of non-renewable energy resources, renewable energy resources-classifications, advantages, limitations; comparison of conventional and non-conventional energy resources.

Solar Energy Basics: Solar constant, Basic sun-Earth angles-definitions and their representation, solar radiation geometry (numerical problems), Estimation of solar radiation of Horizontal and tilted surfaces (Numerical Problems)

SLC: Measurements of solar radiation data-Pyranometer and Pyrheliometer.

MODULE-2	10 Hrs

Solar Thermal Systems: Flat plate collectors-mathematical models for energy gain & efficiency; solar cookers (box type, concentrating type); solar dryers, furnaces, greenhouses.

Solar Electric Systems: Solar thermal electric generation—solar pond & concentrating collectors (parabolic trough, dish, central tower); advantages & disadvantages. Solar PV—cell fundamentals & characteristics.

SLC: Solar water heater.

MODULE-3	10 Hrs

Wind Energy: Introduction, properties of wind, history, global & Indian scenario. Principles of wind energy conversion systems (WECS), classification, components. Derivation for power in wind, electrical output & capacity factor, site selection, advantages & disadvantages.

SLC: Power coefficient, tip speed ratio, solidity.

MODULE-4	11 Hrs

Biomass Energy: Photosynthesis, biomass fuels, conversion technologies, gasification, ethanol production, biogas generation, factors affecting biogas, types of biogas plants (KVIC & Janata).

Energy from Ocean: Tidal energy—principle, components, classification, energy estimation, advantages & limitations. Ocean Thermal Energy Conversion (OTEC)—principle, open cycle (Claude), closed cycle (Anderson).

SLC: Double basin system (simple numerical problems).

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Non-conventional sources of energy	Rai, G D	4th	Khanna publishers	2007

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Non-conventional energy resources	Khan B H	2nd	New Delhi	2006
2	Fundamentals of Renewable Energy Systems	Mukherjee, D & Chakraborti S	2nd	New Age International Publishers	2005

E Books and online course materials:

1. https://www.vedantu.com/evs/sources-of-energy
2. https://en.wikipedia.org/wiki/Renewable_energy

Online Courses and Video Lectures:

1. https://www.youtube.com/watch?v=Giek094C_l4&pp=0gcJCdgAo7VqN5tD
2. https://www.youtube.com/watch?v=7wN4fI9iJH4

Teaching - Learning – Evaluation Scheme:

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3	Evaluation of Learning Process	-	-	07
4	Activity Based Learning (ABL)	-	-	14+13=27
Total Learning Hours / Semester				**90**

Proposed Assessment Plan (for 50 marks of CIE):

Tool	Remarks	Marks
CIE	Three CIEs conducted for 20 marks each and reduced to 10 marks	30
Activity Details	Details of activities to be conducted 1) Quiz 2) Report on real time applications of a renewable energy system.	20
Total		**50**

Activity based learning (27 Hours)

ABL: Activity Based Learning (27Hrs)		**Hours**
Quiz	Duration: 30 minutes Format: Multiple-choice and short-answer questions Evaluation: Accuracy of answers	**13**
Real time application	Length of the report: 8–10 pages Presentation time: 20Mins **Evaluation Criteria:** • Clarity of explanation (10 marks) • Technical depth and analysis (10 marks) • Practical relevance and case study (5 marks) • Presentation and formatting (5 marks)	**14**
ABL: Total		**27**

Evaluation of Learning Process (07 Hours)

Type of Evaluation	Hours
CIE (1, 2 and 3)	03
Activity 1 and 2	01
Semester End Exam	03
Total	**07**

Course Articulation Matrix

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