MALNAD COLLEGE OF ENGINEERING, HASSAN

(An Autonomous Institution Affiliated to VTU, Belagavi)

Autonomous Programmes

Bachelor of Engineering

SCHEME AND SYLLABUS

(2023 Admitted Batch)

DEPARTMENT OF
ELECTRICAL AND ELECTRONICS ENGINEERING
Academic Year: 2025 – 2026

VISION of the Department

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

MISSION of the Department

- Enhance industry and alumni interaction.
- Promote continuous quality up gradation of faculty and technical staff.
- Time to time modernization of departmental infrastructure to provide state of the art laboratories.
- Create research-oriented culture to invoke the desire and ability of lifelong learning among the students for pursuing successful career.
- 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

PEO1: Pursue a diverse range of career as engineers and researchers.
PEO2: Design and develop innovative systems to provide best solutions to electrical engineering problems.
PEO3: Learn and adapt in a world of constantly evolving technology.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Acquire core competency in analyzing, designing and controlling electrical and electronic systems to meet industrial and societal needs.

PSO2: 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.

Scheme of Evaluation (Theory Courses)

Assessment	Marks
CIE 1	**10**
CIE 2	**10**
CIE 3	**10**
Activities (Minimum 2)	**20**
SEE	**50**
Total	**100**

Scheme of Evaluation (Laboratory Courses)

Assessment	Marks
Continuous internal Evaluation in every lab session by the Course coordinator	**30**
Laboratory CIE conducted by the Course coordinator	**20**
SEE	**50**
Total	**100**

MALNAD COLLEGE OF ENGINEERING, HASSAN

Regulations governing the award of B.E. (2023) Scheme

Credit Breakup for a Programme			
Sl. No	Category	Credits(AICTE Breakup)	MCE – Department of EEE
1.	Humanities and Social Sciences including Management courses, including AE	16	18
2.	Basic Science Courses	22	20
3.	Engineering Science course including workshop, drawing,basics of electrical / mechanical / computer / PL / ET etc.	24	17
4.	Professional Core courses relevant to chosen specialization/branch	59	62
5.	Professional Elective courses relevant to chosen specialization/branch	12	13
6.	Open subjects - Electives from other technical and/or emerging subjects	12	12
7.	Project work and internship in industry or elsewhere	15	18
8.	Mandatory Courses	(non-Credit)	-
Total		**160**	**160**

Semester-wise Allocation of Credits

Year	Semester	Credits	Total Credits
I Year	1	20	40
	2	20	
II Year	3	23	45
	4	22	
III Year	5	22	43
	6	21	
IV Year	7	19	32
	8	13	
Total		160	**160**

- Lecture (L): one hour/week : 1 credit
- Tutorial (T): Two hours/week : 1 credit
- Practical/Lab/Drawing(P): Twohours/week : 1 credit

The duration for courses: Integrated courses and courses with tutorial can have more teaching hours:

- 4-credits – 50 Hrs
- 3-credits – 40 Hrs
- 2-credits – 25 Hrs
- 1-credit – 15 Hrs

Scheme of Teaching for the 2023-24 Admitted Batch

THIRD SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
BSC	23MA301	Linear Algebra and Integral Transforms	3-1-0	3	4
PCC	23EE302	Electrical Network Analysis	4-1-0	4	5
IPCC	23EE303	Analog Electronic Circuits (Integrated Laboratory)	3-0-2	4	5
PCC	23EE304	Electric Power Generation &Transmission	4-0-0	4	4
PCC	23EE305	Transformers & Induction Machines	3-0-0	3	3
ESC	23ESEE3X	Engineering Science Course - II	3-0-0	3	3
HSMC	23SCR3X	Social Connect and Responsibility	0-0-2	1	2
AEC	23AEEE3X	Ability Enhancement Course - III	0-0-2	1	2
BSC	23BCM3XX	Bridge Mathematics-1 (Mandate Audit course for Diploma entry students)	3(A)-0-0	Audit	3
MC	23NYP3X	NSS/Yoga/PE	0-0-2(A)	Audit	2
Total				**23**	**33**

Engineering Science Courses – II			
23ESEE31	Electrical and Electronics Measurements	23ESEE33	Sensors and Transducers
23ESEE32	Introduction to PLC	23ESEE34	IoT and its Applications
Ability Enhancement Courses – III			
23AEEE31	Electric Circuits Laboratory	23AEEE33	Electrical Measurements Laboratory
23AEEE32	Electrical Engineering Practices Laboratory	23AEEE34	Renewable Energy Laboratory

FOURTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
IPCC	23EE401	Digital Electronic Circuits (Integrated Laboratory)	3-0-2	4	5
PCC	23EE402	Power Electronics	3-0-0	3	3
IPCC	23EE403	Synchronous and Special Electrical Machines (Integrated Laboratory)	3-0-2	4	5
IPCC	23EE404	Microcontrollers (Integrated Laboratory)	3-0-2	4	5
PCC	23EE405	Transformers & Induction Machines Laboratory	0-0-2	1	2
ETC	23ETC42X	Emerging Technology Course - II	3-0-0	3	3
HSMC	23UHV4X	Universal Human Values	0-0-2	1	1
BSC	23BE4X	Biology for Engineers	1-0-0	1	2
AEC	23AEEE4X	Ability Enhancement Course - IV	0-0-2	1	2
MC	23NYP4X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**22**	**30**

Emerging Technology Courses - II			
23ETEE41	Fuzzy Logic Control	23ETEE43	Python for Electrical Engineers
23ETEE42	Battery Energy Storage Systems	23ETEE44	Object Oriented Programming with C++
Ability Enhancement Course - IV			
23AEEE41	Statistics with R	23AEEE43	Integrated Circuit Laboratory
23AEEE42	Simulation of Digital Electronic Circuits	23AEEE44	IoT Laboratory

FIFTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
HSMC	23EE501	Industrial Management and Professional Engineering Practice	4-0-0	4	4
IPCC	23EE502	Linear Control Systems (Integrated Laboratory)	3-0-2	4	5
PCC	23EE503	Power System Analysis and Stability	3-0-0	3	3
PCC	23EE504	Electromagnetic Fields	3-0-0	3	3
PCC	23EE505	Power Electronics Laboratory	0-0-2	1	2
AEC	23RIP5X	Research Methodology & Intellectual Property Rights	3-0-0	3	3
PEC	23EE51X	Professional Elective Course - I	3-0-0	3	3
HSMC	23EVS5X	Environmental Studies	0-2-0	1	2
MC	23NYP5X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**22**	**27**
The course analytical ability and soft skills 23ASK will be conducted by the TAP coordinator during the vacation period of fifth semester for one credit. The marks for the same will be entered in sixth semester grade card.					

Professional Elective Course – I			
23EE511	Renewable Energy Systems	23EE513	AI in Electrical Engineering
23EE512	Testing and commissioning of Electrical equipment	23EE514	Operational Amplifiers and Linear ICs

SIXTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
PCC	23EE601	Electrical Machine Design	3-0-0	3	3
PCC	23EE602	Modern Control Theory	3-0-0	3	3
PCC	23EE603	Switchgear and Protection	3-0-0	3	3
PEC	23EE62X	Professional Elective Course - II	3-0-0	3	3
OEC	23OEX6X	Open Elective – I	3-0-0	3	3
PI	23PROJ6X	Project Work Phase - I	0-0-4	2	4
PEC	23SW01	SWAYAM - I	0-1(A)-0	Audit	--
AEC	23ASK6X	Analytical Ability and Soft Skills	0-0-2	1	2
MC	23NYP6X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**18**	**23**

Professional Elective Course – II			
23EE621	Flexible AC Transmission Systems	23EE623	Smart Grid Technologies
23EE622	Power System Operation and Control	23EE624	Signals and Digital Signal Processing
Open Elective – I			
23OEEE61	Basic Power Electronics	23OEEE62	Alternate Energy Sources

SEVENTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
IPCC	23EE701	Computer Methods in Power Systems (Integrated Laboratory)	3-0-2	4	5
PCC	23EE702	High Voltage Engineering	3-0-0	3	3
PCC	23EE703	Relay and High Voltage Laboratory	0-0-2	1	2
PEC	23EE73X	Professional Elective Course - III	3-0-0	3	3
PEC	23EE74X	Elective -IV (Industry Elective)	1-0-0	1	1
OEC	23OEX7X	Open Elective -II	3-0-0	3	3
PI	23PROJ7X	Project Work Phase - II	0-0-8	4	8
MC	23NYP7X	NSS/Yoga/PE	0-0-2	Audit	2
Total				**19**	**27**

Professional Elective Course – III			
23EE731	Energy Auditing & Demand-Side Management	23EE733	Solar Power Conversion Systems
23EE732	Automation in Industry 4.0	23EE734	Electrical Power Quality
Open Elective – II			
23OEEE71	Smart Grid Technologies	23OEEE71	Utilization of Electric Power

EIGHTH SEMESTER					
Course Category and Course Code		Course Title	L-T-P	Credits	Contact Hours
PEC	23SW02	Professional Elective (Online Courses) Only through NPTEL - SWAYAM - II		3	12 (weeks)
OEC	23SW03	Professional Elective (Online Courses) Only through NPTEL - SWAYAM - III		3	12 (weeks)
PI	23INT3	Internship (Research / Industry)	0-0-20	10	20
Total				**16**	**20**

V SEMESTER

Course Title	INDUSTRIAL MANAGEMENT AND PROFESSIONAL ENGINEERING PRACTICE		
Course Code	23EE501	L-T-P	(4-0-0) 4
CIE	50	Hours/Week	4
SEE	50	Total Hours	52

Course Objective: To acquire managerial skills, ethical principles and their application in engineering practice.

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

#	Course outcomes	Mapping to PO's	Mapping to PSO's
1	Interpret various functions of management and emerge as a productive member of society.	1,6,12	1
2	Assess familiarity on structure of the organization in present day scenario.	1, 6,12	1
3	Discuss characteristics of Engineering Profession, Professional responsibility and Rules of Practice	1, 8, 11, 12	1
4	Describe the concepts of Project management and apply project management tools and techniques.	1, 11, 12	1

MODULE-1 — **13 Hrs**

Introduction to Management: Managers and their work, Management Functions, Mintzberg's Managerial Roles and a Contemporary Model of Managing, Management Skills, Management history- Early, classical, behavioural, quantitative and contemporary approaches. Managers as decision makers: decision making process, types of decision making, decision making styles and effective decision makingin today's world.

MODULE-2 — **13 Hrs**

Functional areas of management: Planning-goals and plans, types of goals and plans, setting goals and developing plans. Organizing- Designing organizing structure, work specialization, departmentalization, span of control, centralization and decentralization. Controlling-the control process. Motivation-Early and contemporary theories of motivation. Leadership-Early and contingency theories of leadership.

MODULE-3 — **13 Hrs**

Professional Engineering Practice: Introduction, characteristics of a profession, The Engineering Profession, licence, professional responsibility, The Engineer's duty to report, Rules of Professional Engineering Practice, certificate of authorisation, advertising, Professional Standards.

MODULE-4 — **13 Hrs**

Project management: Introduction, Understanding Project Management, Defining Project Success, The Project Manager–Line Manager Interface, Defining the Project Manager's Role, Defining the functional Manager's Role, Defining the Functional Employee's Role, Defining the Executive's Role, The Downside of Project Management. Time management and stress: Introduction, Understanding Time Management, Time Robbers, Time Management Forms, Effective Time Management, Stress and Burnout.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Management	Stephen P Robinns	11th	Prentice Hall	2012
2	Professional Engineering Practice: Professional engineers Ontario	PEO		Sheppard Avenue	2010

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Project Management: A Systems Approach to Planning, Scheduling, and Controlling	Harold K	10th	John Wiley & Sons, Inc	2009

E Books and online course materials:

1. https://elearn.daffodilvarsity.edu.bd/pluginfile.php/925812/mod_resource/content/3/Management-Stephen.P%20Robbins.pdf
2. https://www.peo.on.ca/sites/default/files/2019-10/GuideHandbook_0.pdf
3. https://ftp.idu.ac.id/wp-content/uploads/ebook/ip/BUKU%20MANAJEMEN%20PROYEK/project-management-harold-kerzner1.pdf

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc22_me04/preview

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) Details of activity 1 2) Details of activity 2	20
Total		**50**

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	1	
CO2	3					2						2	1	
CO3	3							2			2	2	1	
CO4	3										1	1	1	

Course Title	LINEAR CONTROL SYSTEMS		
Course Code	23EE502	L-T-P	(3-0-2) 4
CIE	50	Hours/Week	5
SEE	50	Total Hours	40L + 24P

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.

MODULE-2 **12 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.

MODULE-3 **08 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.

MODULE-4 **10 Hrs**

Frequency Domain Analysis: Frequency domain specifications- Resonant peak, resonant frequency and bandwidth. Bode plots, Gain and phase cross over points.
Methods to Improve Time Response: P, PI, PD and PID Controllers. Introduction to compensating networks, Phase-Lead and Phase-Lag Compensator.

Laboratory Component

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.

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 Systems: Theory and Application	Smarajit Ghosh	2nd	Pearson Education	2012

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

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 3) Details of activity 1 4) Details of activity 2	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**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 SYSTEM ANALYSIS AND STABILITY		
Course Code	23EE503	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To introduce fault analysis and stability concepts in power systems using per-unit models, symmetrical components, and sequence networks.

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 reactance diagram for a given Electrical Power System.	1, 2	1
3	Solve various numerical examples for symmetrical faults of the given power system network.	1, 2	-
4	Evaluate system behavior under different unsymmetrical fault conditions with and without fault impedance.	1, 2	-

MODULE - 1 — 10Hrs.

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 and demerits, per unit impedance diagram of power system, illustrative examples. **Symmetrical 3-Phase Faults:** Transients on transmission lines, Short circuit currents and the time varying reactances of synchronous machines by considering the subtransient, transient and steady state periods of short circuit, , illustrative examples.

MODULE - 2 — 10 Hrs.

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 invariancy 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 — 10 Hrs.

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., calculation of fault 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	McGraw Hill Higher Education	1982

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	ModernPowerSystemAnalysis	J. Nagrath and D. P. Kothari	ThirdEdition	TataMcGrawHill	2003

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) Single line diagram of a substation 2) Presentation of a power system related IEEE paper	20
Total		**50**

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	
CO2	2	3											2	
CO3	2	3												
CO4	2	3												

Course Title	ELECTROMAGNETIC FIELDS		
Course Code	23EE504	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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	Analyse 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	10 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	10 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

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**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO 10**	**PO 11**	**PO1 2**	**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	23EE505	(L-T-P) C	(0-0-2) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	24

Course Objective: To provide hands-on experience in the operation, triggering, and control of power electronic devices and circuits

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

#	Course Outcomes	Mapping to PO's	Mapping to PSO's
1	Analyze the static V-I characteristics of SCR, TRIAC, and MOSFET.	1,8,9,10	1
2	Design firing circuits for SCR using a UJT relaxation oscillator.	1,8,9,10	1
3	Construct controlled rectifiers and AC voltage controllers for resistive and RL loads using RC and TRIAC-DIAC triggering methods.	1,8,9,10	1
4	Demonstrate the operation of a stepper motor in full-step and half-step modes and voltage control of a single-phase inverter for a resistive load	1,8,9,10	1

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

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

Course Title	RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS		
Course Code	23RIP5X	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To give an overview of technical research activities and patenting methodology.

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 — 10 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 — 10 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

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO 8**	**PO9**	**PO 10**	**PO 11**	**PO1 2**	**PS O1**	**PS O2**
CO1	-	3	2	3	-		-	2	-	-	-	3	-	-
CO2	-	-	-	-	-	3	-	2	-	3	-	3	-	-
CO3	-	-	-	-	-	3	-	2	-	3	-	3	-	-
CO4	-	3	2	3	-		-	2	-	-	-	3	-	-

PROFESSIONAL ELECTIVE COURSE – I

Course Title	RENEWABLE ENERGY SYSTEMS		
Course Code	23EE511	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objectives: To analyze the renewable energy technologies for real time application.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Understand the various technologies of solar photovoltaic & thermal systems.	1, 6, 7	1
2	Solve various problems on solar photovoltaic & thermal systems.	2,6,7,12	1
3	Design different components of solar thermal & photovoltaic systems	3,6,7,12	1
4	Apply modern tools for prediction & modeling of renewable energy systems.	5,12	1

MODULE-1	10 Hrs

Solar Photovoltaic Technologies: Basic of solar photovoltaic technology – Amount of power generated, generating more power using solar PV. Solar PV system& their components. Solar PV lantern- Design & costing of Solar PV lantern. Solar Standalone PV system-Home lighting & other usage-case study. Solar PV water pumping systems- design of solar PV Pumping system- Case study.

MODULE-2	10 Hrs

Solar Thermal systems & Applications: Review of Flat Plate Collectors- Efficiency of flat plate collectors, numerical problems.

Applications: Solar Water Heater- Components & specification of Solar water heater, Design & Costing solar heating, Installation & Maintenance.

Solar Energy storage: Introduction, Solar energy storage systems-Solar Pond Electric power generation.

MODULE-3	10 Hrs

Applications: Solar cooking systems: Principle of cooking, cooking by boiling, speed of cooking, energy required for cooking (numerical problems). Types of solar cooker- Box, Dish Heat transfer type solar cooker.

Solar Distillation: Water categories, distillation process for water purification, operation of solar distillation. Design of solar still & costing. Parameters affecting solar still performance, Economics of solar still. Maintenance and troubleshooting.

MODULE-4	10 Hrs

Mathematical Modelling of Renewable energy systems: Solar, wind, Biomass/ biogas & battery systems. Integrated renewable energy system for on/off grid Applications. Introductions to Software Tools (HOMER & MATLAB software). Case study for a typical residential/ commercial application- Load assessment & resources assessment.

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	Solar energy: fundamentals and applications	Garg, H. P.	-	Tata McGraw-Hill Education	2000
2	Solar energy: principles of thermal collection and storage	Sukhatme, S. P., & Sukhatme	-	Tata McGraw-Hill	1996

E Books and online course materials:

1. https://www.scribd.com/document/491553447/Non-conventional-Energy-Sources-by-G-D-Rai

Online Courses and Video Lectures:

1. https://ocw.tudelft.nl
2. https://open.umn.edu/opentextbooks
3. https://www.edx.org/learn/renewable-energy

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: presentation 2) Activity 2: Field visit	20
Total		**50**

Course Articulation Matrix:

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

Course Title	TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT		
Course Code	23EE512	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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	1
2	Demonstrate the knowledge of need and method for testing of each part of equipment's to prove the reliability.	1, 2	1
3	Apply the knowledge to perform the corrective, preventive and maintenance of electrical equipment's.	1, 2, 3	1
4	Describe the tests conducted on switch gear and protection equipment's of electrical power system.	2,3	1

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 — 10 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 — 10 Hrs

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 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 Commissioning & 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:

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

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 3) Activity 1: presentation 4) Activity 2: Field visit	20
Total		**50**

Course Articulation Matrix:

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

Course Title	AI IN ELECTRICAL ENGINEERING		
Course Code	23EE513	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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	Understand AI foundations and 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	Develop the various artificial intelligence techniques in electrical power systems applications.	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.

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.

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.

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.

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
3	Fuzzy set theory and its application	H J Zimmermann	4th	Allied Publishers	2014
4	Nature – Inspired Optimization Algorithms	Xin-She Yang	2nd	Elsevier	2020
5	A novel nonlinear deep reinforcement learning controller for DC–DC power buck converters	Gheisarnejad, Meysam, Hamed Farsizadeh, and Mohammad Hassan Khooban	-	IEEE Transactions on Industrial Electronics	2020
6	Fault identification on	Asbery, Chris, and Yuan Liao	-	Electric Power	2022

	electrical transmission lines using artificial neural networks.			Components and Systems	
7	Energy management model for a standalone hybrid microgrid through a particle Swarm optimization and artificial neural networks approach	Aguila-Leon, Jesus, Vargas-Salgado, C., Chiñas-Palacios, C., & Díaz-Bello, D	-	Energy Conversion and Management	2022

E Books and online course materials:

1. https://shorturl.at/VtGJD
2. https://shorturl.at/hW9cd
3. https://shorturl.at/vdcIB
4. https://shorturl.at/vt5Or
5. https://shorturl.at/5hnqb
6. https://ieeexplore.ieee.org/document/9130896/
7. https://www.tandfonline.com/doi/abs/10.1080/15325008.2022.2049659
8. https://www.sciencedirect.com/science/article/abs/pii/S0196890422007166
9. https://digital-library.theiet.org/doi/book/10.1049/pbpo022e

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/106/102/106102220/
2. https://archive.nptel.ac.in/courses/112/103/112103280/
3. https://archive.nptel.ac.in/courses/108/104/108104157/
4. https://archive.nptel.ac.in/courses/108/104/108104051/

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) Details of activity 1 2) Details of activity 2	20
Total		**50**

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									1
CO2	3	3			2									1
CO3	3	3			2									2
CO4	3	2	3	3	2	1							1	2

Course Title	OPERATIONAL AMPLIFIERS AND LINEAR ICS		
Course Code	23EE514	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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	10 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	10 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:

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

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 3) Details of activity 1 4) Details of activity 2	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1												2
CO2	3	1												2
CO3	3	2												2
CO4	3	2	1											2

Course Title	ENVIRONMENTAL STUDIES		
Course Code	23EVS5X	(L-T-P) C	(0-2-0) 1
CIE	50	Hours/Week	2
SEE	50	Total Hours	20

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.	7,9,12	--
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 5) Details of activity 1 6) 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**	**PO12**	**PSO1**	**PSO2**
CO1	3	2											3	
CO2	3	2											3	
CO3	3	3											3	
CO4	3	2											2	

SIXTH SEMESTER

Course Title	ELECTRICAL MACHINE DESIGN		
Course Code	23EE601	(L-T-P)C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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	1
2	Develop the knowledge required for electrical machine design.	1,2	1
3	Design Transformers and Induction motor from the given data.	1,2,3	1
4.	Design Synchronous machine from the given data	1,2,3	1

MODULE-1 **10 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 **10 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

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 7) Details of activity 1 8) Details of activity 2	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	1											1	
CO2	2	3											2	
CO3	2	2	3										3	
CO4	2	2	3										3	

Course Title	MODERN CONTROL THEORY		
Course Code	23EE602	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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 **10 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 **10 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/

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 5) Activity 1: Matlab Simulation for 10 Marks 6) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	SWITCHGEAR AND PROTECTION		
Course Code	23EE603	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

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

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

#	Course outcomes	Mapping to PO's	Mapping to PSO's
1	Explain the basic concepts of fuses and circuit breakers.	1	1
2	Select suitable switchgears necessary for protection in the power system.	1, 2	1
3	Apply different protective relays against various fault conditions.	1, 2	1
4	Apply the knowledge of various distribution system needed in LT side.	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.

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.

MODULE-3	10 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.

MODULE-4	10 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.

Prescribed Text Books:

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

Reference 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. Chander	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/

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 7) Activity 1: Matlab Simulation for 10 Marks 8) Activity 2: Substation visit for 10 Marks	20
Total		**50**

Course Articulation Matrix:

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

PROFESSIONAL ELECTIVE COURSE – II

Course Title	FLEXIBLE AC TRANSMISSION SYSTEM		
Course Code	23EE621	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To analyze role of different FACTS controller in transmission system.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain basic concepts of Flexible AC Transmission Systems	1	1
2	Apply shunt type FACTS controllers to improve the performance of transmission systems.	1,2	2
3	Choose series FACTS devices to enhance control capability of the system.	1,2	2
4	Develop the knowledge of voltage regulators, phase angle regulators, UPFC and IPFC to improve different features of system.	1,2	2

MODULE-1 — 10 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

Static Series Compensators- TCSC, GCSC, TSSC: Objectives of series compensation, Variable impedance 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, immunity to sub-synchronous resonance.

MODULE-4 — 10 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 Stability with phase Angle Regulators , Power Oscillation Damping with phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and phase Angle Regulators (TCVRs and TCPARs) , Continuously Controllable Thyristor Tap Changers, Continuously Controllable Thyristor Tap Changers, Thyistor Tap Changer with Discrete Level Control, switching converter based voltage and phase angle regulators, Hybrid Phase Angle Regulators.

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/

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 9) Activity 1: Matlab Simulation for 10 Marks 10) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Course Articulation Matrix:

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

Course Title	POWER SYSTEM OPERATION AND CONTROL		
Course Code	23EE622	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To analyze electrical networks using various techniques.

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 principles of power system and SCADA for the stable system operation.	1	1
2	Model the power system components for secure operation of power system.	1, 2	1
3	Analyse the economic and operational aspects of power systems with different methods.	1, 2	1
4	Apply modern techniques in power system network for economic system operation and control for various applications.	1, 2	1

MODULE - 1	10 Hrs.

Introduction to Power system operation and control: Introduction, operating states of Power system, objectives of Power system control, key concepts of reliable operation, major threats to system security- case study. Introduction to SCADA, components of SCADA system. Digital computer configuration. Introduction to voltage and reactive power control-production and absorption of reactive power, methods of voltage control by reactive power injection.

MODULE - 2	10 Hrs.

Automatic Generation control and interconnected Power systems:
Introduction, basic generator control loops, commonly used terms in AGC, functions of AGC, speed governors, mathematical model of ALFC, Automatic generation controller, proportional integral controller, Tie-line control with primary speed control, Tie-line bias control (frequency bias Tie-line control)

MODULE - 3	10 Hrs.

Economic Operation of Power Systems: Introduction to Economic and Operational aspects of Power Systems, Optimal system operation with thermal plants, constraints in economic operation, Spinning reserve, Performance Curves, Incremental production costs for steam power plants, Problems of Economic Load Scheduling - solution through Equal Incremental cost criterion for operation of power plants, Equal Incremental cost criterion for operation of power plants with generation capacity limits and transmission losses considered, transmission loss as a function of plant generation, the B-coefficients, expression for incremental transmission loss in terms of B-coefficients, Numerical Examples comprising of all the cases included above.

MODULE - 4	10 Hrs

Unit commitment: Introduction, Constraints in unit commitment, Priority list method, dynamic programming, Alternative approaches to unit commitment.

Prescribed Text Books:

Sl. No	Book Title	Authors	Edition	Publisher	Year
1	Power System Operation and Control.	Dr. K Uma Rao	1st	Wiley India	2012

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Power Generation Operation and Control	Allen J Wood et al,	2nd	Wiley	2003

E Books and online course materials:

1. https://surl.li/utbwxg
2. https://www.coursera.org/search?query=power%20system&sortBy=BEST_MATCH

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/104/108104052/

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) Details of activity 1 2) Details of activity 2	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2												1	
CO2		2											1	
CO3		2											1	
CO4		2											1	

Course Title	SMART GRID TECHNOLOGIES		
Course Code	23EE623	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs	Hours/Week	3
SEE	50 Marks	Total Hours	40

Course Objective: To apply control and automation to modern electrical Power systems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Interpret different components of smart grid	1	1
2	Apply intelligent techniques to sense, measure and automate Power system	1,2	1
3	Describe controlling and management of Transmission and Distribution system.	1	1
4	Develop energy storage systems required for Smart Grid.	1	1

MODULE-1	10 Hrs

Introduction to Smart Grid: Evolution of Electric Grid, Evolution of Indian National Grid, Regulatory authorities in Indian Power sector, Concept of Smart Grid, Why implement the Smart Grid now? Early Smart Grid initiatives, Overview of the technologies required for the Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid.

Information and communication technologies: Data communication- Introduction, switching techniques and communication channels. Layered architecture and protocols-ISO/OSI model and TCP/IP

MODULE-2	10 Hrs

Information security for the Smart Grid: Introduction, Encryption and decryption - Symmetric key encryption and Public key encryption , Authentication - Authentication based on shared secret key and Authentication based on key distribution centre, Digital signatures - Secret key signature , Public key signature and Message digest, Cyber security standards and cyber security capabilities.

MODULE-3	10 Hrs

Sensing, Measurement, Control and Automation Technologies: Smart metering: Key components of smart metering, overview of the hardware used, Signal acquisition, Signal conditioning, Analogue to digital conversion, Computation, Input/output, Communication. Demand-side integration, Services provided by DSI, Implementations of DSI, Hardware support to DSI implementations.

MODULE-4	10 Hrs

Distribution automation equipment: Introduction, Substation automation equipment, Current transformers, Voltage transformers, Intelligent electronic devices, Bay controller, Remote terminal units. Faults in the distribution system: Components for fault isolation and restoration, Fault location, isolation and restoration, Voltage regulation.

Distribution Management System: Data sources and associated external systems-structure and main components, modelling and analysis tools, Applications.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Smart Grid: Technology and Applications	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama	1st	Wiley India	2012

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Fundamentals of Smart Grid Technology	Bharat Modi, Anu prakash and Yogesh Kumar	1st	S.K. Kataria & Sons	2015

E Books and online course materials:

1. https://content.e-bookshelf.de/media/reading/L-596321-3608238b29.pdf
2. https://unglueit-files.s3.amazonaws.com/ebf/d4fa5732b34f4a23a0630d366eaf2f28.pdf

Online Courses and Video Lectures:

1. https://onlinecourses.nptel.ac.in/noc23_ee60/preview

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 3) Details of activity 1 4) Details of activity 2	20
Total		**50**

Course Articulation Matrix

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

Course Title	SIGNALS AND DIGITAL SIGNAL PROCESSING		
Course Code	23EE624	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To classify signals and transform them to frequency domain. They will analyse basic properties of systems in time domain.

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

#	Course outcomes	Mapping to PO's	Mapping to PSO's
1	Analyze signals mathematically and gain knowledge to perform mathematical operations on CT/DT signals and classify the systems based on their properties.	1,2,5	2
2	Represent signals in time domain and analyze the characteristics of LTI systems.	1,2,5	2
3	Transform signals using discrete Fourier and Fast Fourier transforms.	1,2,5	2
4	Realize IIR and FIR digital systems in various forms.	1,2,5	2

MODULE-1	10 Hrs.

Introduction: Definition of a signal and a system, Classification of signals, Basic operations on signals, Elementary signals and Properties of systems.

MODULE-2	10 Hrs.

Impulse Response representations for LTI Systems: Properties of Impulse Response Representation of LTI Systems - Memoryless Systems, Causality and Stability. Concepts of Convolution, Computation of Convolution Sum and Convolution integral, Solution of Differential equations.

MODULE-3	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.

MODULE-4	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, Cascade form, Parallel form. **Realization of FIR systems**: Introduction, Direct form, cascade form, linear phase realizations.

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Signals and Systems	Simon Haykin Barry Van Veen	2nd	Wiley	2007
2.	Digital Signal Processing	John G. Proakis and Dimitris G. Manolakis	4th	Pearson	2017

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1.	Signals and Systems	D. Ganesh Rao & Satish Tunga	4th	Pearson	2010
2.	Digital Signal Processing	A. Nagoor Kani	2nd	Mc GrawHill	2017

E Books and online course materials:

1. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://studentshubblog.wordpress.com/wp-content/uploads/2014/12/signals-and-systems-simon-haykin.pdf
2. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://uvceee.wordpress.com/wp-content/uploads/2016/09/digital_signal_processing_principles_algorithms_and_applications_third_edition.pdf

Online Courses and Video Lectures:

1. https://archive.nptel.ac.in/courses/108/104/108104100/
2. https://nptel.ac.in/courses/117102060

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 11) Activity 1: Matlab Simulation for 10 Marks 12) Activity 2: Assignment and Quiz for 10 Marks	20
Total		**50**

Course Articulation Matrix:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1		2									**2**
CO2	2	3	1		2									**2**
CO3	2	3	1		2									**2**
CO4	2	3	1		2									**2**

OPEN ELECTIVE – I

Course Title	BASIC POWER ELECTRONICS		
Course Code	23OEEE61	(L-T-P) C	(3-0-0) 3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To utilize knowledge of power electronic devices in various electrical applications.

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 principle of power devices	1	2
2	Apply the concept of power devices to know their characteristics	1,2	2
3	Analyze the working of various power electronic converters	1,2	2
4	Implement the power electronic based circuits.	1,2,9	2

MODULE-1	10 Hrs

Introduction to Power Electronics, Power conditioning systems, Classification, power electronic device as an ideal switch, ideal switch characteristics, power semiconductor devices, Applications of power electronics.

Power Diode: Introduction, V-I characteristics, types.

MODULE-2	10 Hrs

Power Transistors: Power MOSFETs (n channel enhancement type MOSFET) – Structure, Specifications of MOSFETs, Control characteristics.

Thyristors: Types, Characteristics, Turn-on and turn-off methods.

MODULE-3	10 Hrs

AC Voltage Controllers: Introduction, Principle of ON-OFF control, Single phase Bi-directional phase controller with resistive loads, Single phase controllers with inductive loads (Block diagram approach only).

DC-DC Converters: Buck converter, Boost Converter, Buck-Boost converter (Block diagram approach only).

MODULE-4	10 Hrs

Controlled Rectifiers: Introduction, principle & operation of half wave-controlled rectifier, single-phase full wave rectifier for Resistive load, single-phase dual converter for Resistive load (Block diagram approach only).

Inverters: Introduction, Single-phase bridge inverters (Block diagram approach only).

Prescribed Text Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Power Electronics	M.H. Rashid	2nd edition	Prentice Hall of India Pvt. Ltd	2002

Reference Books:

Sl.No	Book Title	Authors	Edition	Publisher	Year
1	Power Electronics	M D Singh & Kanchandani,	2nd	MH publishing company limited	2001
2	Power Electronics	Dr. P.S. Bimbhra	-	Khanna Publishers	1996

E Books and online course materials:

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

Online Courses and Video Lectures:

1. https://www.youtube.com/watch?v=f7oXhDatwtY
2. https://www.youtube.com/watch?v=jgh0TNfx0gQ

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) Presentation on IEEE Conference/Journal papers-With report 2) Simulation of power electronic converter	20
Total		**50**

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
CO2	2	2												2
CO3	2	2												2
CO4	3	2							1					2

Course Title	ALTERNATE ENERGY SOURCES		
Course Code	23OEEE62	(L-T-P) C	(3-0-0)3
CIE	50	Hours/Week	3
SEE	50	Total Hours	40

Course Objective: To apply the concepts 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 basic concepts of Renewable energy sources	1,12	1
2	Develop the principles to learn solar system for various application	1,2,12	1
3	Describe the operation of system based on wind energy	1	1
4	Discuss the working of systems based on biomass & ocean thermal energy	1	1

MODULE-1	10 Hrs

Energy Sources: Renewable energy resources-classifications, advantages, limitations; comparison of conventional & non-conventional energy resources.

Environmental and Ecological Effects of Energy Production and Consumption: The Greenhouse Effect, Major Consequences of the Greenhouse Effect, Remedial Actions for Global Warming

Solar Energy Basics: Solar constant, Solar radiation at the earth surface, Basic sun-Earth angles- definitions & their representation, solar radiation geometry (Numerical problems).

MODULE-2	10 Hrs

Solar Thermal Systems: Concepts and comparison between concentrating and non-concentrating solar collectors, Solar Flat plat collectors, solar cookers-box type, concentrating dish type, solar driers, still furnaces, green houses.

Solar Electric Systems: solar thermal electric power generation-solar pond & concentrating solar collector (Parabolic trough, Parabolic dish central tower collector) advantages & disadvantages; solar photovoltaic-solar cell fundamentals and its characteristics.

MODULE-3	10 Hrs

Wind Energy: Introduction, wind & its properties, wind energy scenario-world & India. Basic principles of wind energy conversion systems (WECS), classification of WECS, Part of a WECS. Derivation for power in the wind, electrical power output & capacity factor of WECS, wind site selection consideration, advantages & disadvantages of WECS.

MODULE-4	10 Hrs

Biomass Energy: Introduction photosynthesis process, biomass fuels, biomass conversion technologies, Biomass gasification, Biomass to Ethanol production, Bio gas production from waste Biomass, factors Affecting Biogas generation, types of Biogas plants – KVIC & Janata Model.

Energy From Ocean: Tidal energy – principle of tidal power, components of tidal power plant (TPP), classification of tidal power plants, Advantages & Limitation of TPP. **Ocean thermal energy conversion (OTEC)** -Principle of OTEC system, methods of OTEC power generation – open cycle (Claude cycle), Closed cycle (Anderson cycle), Advantages and disadvantages of OTEC.

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

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 3) Presentation on IEEE Conference/Journal papers-With report 4) Quiz	20
Total		**50**

Course Articulation Matrix

Course Outcomes	Program Outcomes													
Cos	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3											2	1	
CO2	3	3										2	1	
CO3	3												1	
CO4	3												1	