DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

2023 Scheme and Syllabus

Scheme of Teaching and Evaluation for B. Tech., V, VI, VII & VIII semester Electrical and Electronics Engg. (2023 scheme)

VISION AND MISSION OF THE UNIVERSITY

VISION:

To develop an ethical and a competent global workforce with an inquisitive mind.

MISSION:

M1. To equip the students with professional skills, ethical values and competency.
M2. To offer state of the art programs by collaborating with industry, academia and society.
M3. To undertake collaborative & inter disciplinary research for overall development.
M4. To develop leaders and entrepreneurs for the real and sustainable world

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION:

To develop electrical engineers with strong technical skills, practical experience, and adaptability, ready to meet industry demands and uphold ethical standards.

MISSION:

M1. **To deliver high-quality education** that enhances technical skills and practical knowledge, preparing students to excel in their chosen fields.
M2. **To provide hands-on learning opportunities** and real-world experiences that equip students with the adaptability and problem-solving skills needed to meet the evolving requirements of the industry.
M3. **To enhance practical skills and adaptability** through immersive learning experiences and problem-solving activities that address societal needs.
M4. **To instill a strong sense of ethical responsibility** to ensure that students uphold high moral standards in their professional and personal lives.

PROGRAM OUTCOMES (PO's)

PO1: **Engineering Knowledge:** Apply principles of mathematics, natural sciences, computing, engineering fundamentals, and specialized engineering knowledge to develop solutions for complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, and analyse complex engineering problems by reviewing research literature and drawing well-founded conclusions, while considering sustainable development.

PO3: **Design/Development of Solutions:** Design innovative solutions for complex engineering problems and develop systems, components, or processes that address identified needs, considering public health and safety, whole-life cost, net-zero carbon goals, culture, society, and environmental impact.

PO4: **Conduct Investigations of Complex Problems:** Utilize research-based knowledge to investigate complex engineering problems, incorporating experiment design, modelling, data analysis, and interpretation to derive valid conclusions.

PO5: **Engineering Tool Usage:** Develop, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, while recognizing their limitations in solving complex engineering problems.

PO6: **The Engineer and the World:** Assess and evaluate societal and environmental factors when addressing complex engineering problems, considering their impact on sustainability in relation to the economy, health, safety, legal frameworks, culture, and the environment.

PO7: **Ethics**: Uphold ethical principles, demonstrate commitment to professional integrity, respect human values, and promote diversity and inclusion while adhering to national and international laws.

PO8: **Individual and Team Collaboration:** Work effectively both independently and as a member or leader in diverse, multidisciplinary teams.

PO9: **Communication:** Communicate clearly and inclusively within the engineering community and society, demonstrating the ability to write effective reports, develop design documentation, and deliver impactful presentations while considering cultural, language, and learning differences.

PO10: **Project Management and Finance:** Apply engineering management principles and economic decision-making to one's work, effectively managing projects and contributing as both a team member and leader in multidisciplinary environments.

PO11: **Life-Long Learning:** Acknowledge the importance of continuous learning and cultivate the skills necessary for:

i) Independent and sustained self-improvement,
ii) Adaptability to evolving and emerging technologies, and
iii) Critical thinking in the broader landscape of technological advancements.

PROGRAMME SPECIFIC OUTCOME (PSO'S):

PSO-1. Demonstrate strong fundamentals in network analysis, field theory, transmission and distribution, and programming.
PSO-2. Apply critical thinking to solve challenges in modern power systems.
PSO-3. Troubleshoot circuits involving microcontrollers, SCADA, and related technologies.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO'S):

PEO-1. Graduates will demonstrate a high level of technical proficiency and problem-solving skills in electrical and electronics engineering.

PEO-2. Graduates will be prepared to meet industry demands by applying their hands-on experience and practical knowledge effectively.

PEO-3. Graduates will uphold ethical standards and exhibit professionalism in their engineering practice, positively impacting their organizations and society.

PEO-4. Graduates will engage in continuous learning and professional development to adapt to emerging technologies and maintain their relevance in the field.

Scheme of Syllabus

B.Tech–V,VI,VII and VIII Semester

Electrical and Electronics Engineering(2023Scheme)

V - Semester

SN	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	23EEE510	Generation Transmission and distribution	EEE	3	0	2	0	03	50	50	100	4
2	IPCC	23EEE520	Control systems	EEE	3	0	2	0	03	50	50	100	4
3	IPCC	23EEE530	Operational amplifiers and Linear Integrated Circuits	EEE	3	0	2	0	03	50	50	100	4
4	AEC	23MEE540	Management and Entrepreneurship	Any Dept.	3	0	0	0	03	50	50	100	3
5	PEC	23EEE551/ 23EEE552/ 23EEE553/	1. Object Oriented Programming using C++ 2. Fundamentals of VLSI design 3. Internet of things	EEE	3	0	0	0	03	50	50	100	3
6	SEC	23EEE561/ 23EEE562/ 23EEE563	1. Electrical and electronics measurements. 2. PLC & SCADA 3. Energy conservation and audit	EEE	If course is theory: 1	0	0	0	01	50	50	100	1
					If course is lab: 0	0	2	0	02				
7	AEC	23AAE570	Advance Aptitude	EEE	1	0	0	0	02	50	50	100	1
8	MC	23NSE580	National Service Scheme (NSS)	NSS Coordinator	0	0	2	0		100	-	100	0
		23PEE580	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		23YOE580	Yoga	Yoga Teacher									
										450	**350**	**800**	**20**

VI - Semester

SN	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	23EEE610	Power system -1	EEE	3	0	2	0	03	50	50	100	4
2	IPCC	23EEE620	Signals and Digital Signal Processing	EEE	3	0	2	0	03	50	50	100	4
3	IPCC	23EEE630	Embedded System Design	EEE	3	0	2	0	03	50	50	100	4
4	AEC	23RMI640	Research methodologies and Intellectual property rights	Any Dept.	3	0	0	0	03	50	50	100	3
5	PEC	23EEE651/ 23EEE652/ 23EEE653	1. Electrical machine design 2. Sensors and transducers 3. Artificial neural network for power systems	EEE	3	0	0	0	03	50	50	100	3
6	OE	23EEE661/ 23EEE662/ 23EEE663/	1. Computer aided electrical drawing 2. Electric Vehicles 3. Technologies of Renewable energy sources	EEE	If course is theory 1 If course is lab 0	0 0	0 2	0 0	01 02	50	50	100	1
7	PROJ	23EEE670	Mini Project	EEE	0	0	2	1	03	100	-	100	1
8	MC	23IKS680	Indian Knowledge System	EEE	1	0	0	0	--	100	-	100	0
										500	**300**	**800**	**20**

VII - Semester

SN	Course	Course Code	Course Title	Teaching Department (TD)and Question Paper Setting Board (PSB)	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	23EEE710	Power system -2	EEE	3	0	2	0	03	50	50	100	4
2	IPCC	23EEE720	Switchgear protection and High voltage engineering	EEE	3	0	2	0	03	50	50	100	4
3	IPCC	23EEE730	Industrial drives and applications	EEE	3	0	2	0	03	50	50	100	4
4	PEC	23EEE741 23EEE742 23EEE743	1. Solar and wind energy 2. Smart grid 3. FACTS and HVDC transmission	Any Dept.	3	0	0	0	03	50	50	100	3
5	PROJ	23EEE750	Major Project	EEE	0	0	6	0	03	50	50	100	6
6	OE(CERT)	23EEE760**	Credit transfer Certification course		2	0	0	3	03	30	70	100	2
										280	**320**	**600**	**23**

VIII - Semester

SN	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC	23EEE810	Power system operation and control	EEE	3	0	0	0	03	50	50	100	3
2	PEC	23EEE821/ 23EEE822/ 23EEE823/	1. Testing & Commissioning of electrical equipment 2. Electric Vehicle technologies 3. Electrical Power Quality	EEE	3	0	0	0	03	50	50	100	3
3	INT	23EEE830	Internship (8 Weeks)	EEE	--	--	--	--	03	100	100	200	8
4	OE(CERT)	23EEE840**	Credit Transfer Certification Courses	EEE	3	0	0	3	03	30	70	100	3
										230	**270**	**500**	**17**

PCC: Professional Core Course, **OE:** open elective, **PEC**: Professional Elective Course, **PROJ**: Project Work, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.**TD**-Teaching Department, **PSB**: Paper Setting, department, **PEC**: Professional Elective Course, SEC: Skill Enhancement Course. CERT: Credit Transfer Certification Courses. INT: Internship

**** Credit Transfer Certification Courses:** The Credit Transfer Certification Course is a UGC initiative offered through the SWAYAM platform/credible MOOCS, providing online credit-eligible courses across various engineering domains. Students must enroll in an equivalent credit course, as decided by the department which is to in nature, and ensure it is a subject not studied in previous semesters and it may be inter-disciplinary also.

Universities must register with SWAYAM or establish a local chapter to enable participation. SWAYAM provides all learning materials and evaluates assignments, which carry 30 marks as part of the Continuous Internal Evaluation (CIE). The Semester End Examination (SEE) is conducted by the university under the Controller of Examinations for 70 marks.

The combined CIE and SEE marks must be uploaded to the SWAYAM portal for certification.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multi-disciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective (OE)

Students may choose open electives offered by other departments. They are also allowed to take open electives offered

by their own department, subject to eligibility. If a student opts to take an equivalent credit course from another department, they must forgo a corresponding course from their parent department. Any course selected as an open elective must not duplicate a course the student has already completed or is currently enrolled in.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/sand recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to agrouphavingnotmorethan4 students.

CIE procedure for Mini-project:

Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

No SEE component for Mini-Project

Project Phase-I: Students have to discuss with the mentor/guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

Shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25.

PROJECT: The objective of the Project work is

i. To encourage independent learning and the innovative attitude of the students.
ii. To develop interactive attitude, communication skills, organization, time management, and presentation skills.
iii. To impart flexibility and adaptability.
iv. To inspire team working.
v. To expand intellectual capacity, credibility, judgment and intuition.
vi. To adhere to punctuality, setting and meeting deadlines.
vii. To install responsibilities to oneself and others.
viii. To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present and exchange ideas.

CIE procedure for Project Work:

1. Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work, shall be based on the evaluation of the project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batchmates.

2. Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level **with** the participation of all guides of the college. Participation of external guide/s, if any, is desirable. The CIE marks awarded for the project work, shall be based on the evaluation of project work Report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE procedure for Project Work: SEE for project work will be conducted by the two examiners appointed by the University. The SEE marks awarded for the project work.

****

Scheme of Teaching and Evaluation for B. Tech., V Semester Electrical and Electronics Engg. (2023 scheme)

GENERATION TRANSMISSION AND DISTRIBUTION			
Subject Code	23EEE510	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course Objectives:

- To understand the structure of electric power system: Generation, Transmission & Distribution of power.
- To understand the importance of higher voltage transmission and comparison of HVAC and HVDC transmission systems.
- To design insulators for a given voltage level.
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
- To study underground cables for power transmission and evaluate different types of distribution systems.

Module-1 **08 Hrs**

Generation of Electrical Energy: Importance of electrical energy, energy sources and their availability, generation of electrical energy, Principle types of power plants- conventional plants. Site selection, schematic arrangement and working of Hydro, Thermal, and Nuclear generating stations including advantages and disadvantages. Comparison of the various power plants based on initial cost, running cost, efficiency, maintenance, losses, space required etc.

Introduction to Power System: Structure of electric power system, Single line diagram of power system with voltage levels, Advantages of higher voltage transmission, Comparison of HVAC and HVDC transmission system.

Module-2 **08 Hrs**

Mechanical Design of Overhead Transmission Lines: Main components of overhead lines: conductors, supports, insulators. Properties and types of conductors: AAC, AAAC, ACSR, Bundled conductors. Properties and types of supporting structures. Importance of Sag in overhead lines, Sag calculation – supports at same and different levels, effect of wind and ice.

Overhead Line Insulators: A brief introduction to types of insulators, material used- porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency and Methods of increasing string efficiency.

Module-3 **08 Hrs**

Line Parameters: Introduction to line parameters- resistance, inductance and capacitance. Skin effect.

Calculation of inductance: single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines. Inductance of composite – conductors, Concept of Self-GMD and Mutual-GMD, Inductance formulas in terms of GMD.

Calculation of capacitance: single phase and three phase lines with equilateral spacing, unsymmetrical spacing, double circuit and transposed lines.

Module-4 **08 Hrs**

Performance of Transmission Lines: Classification of overhead lines – short, medium and long. Important terms- voltage regulation, transmission efficiency. Performance analysis of short transmission lines, Medium transmission line considering Nominal T and Nominal π lines, and long transmission lines by Rigorous method. Generalized circuit constants (ABCD), Determination of ABCD constants for transmission lines.

Corona: Theory of corona formation, factors affecting corona, Important terms- disruptive and visual critical voltages, corona loss, Advantages and disadvantages of corona, Methods of reducing corona.

Module-5 **08 Hrs**

Distribution Systems: Feeders, distributors and service mains, classification according to scheme of connection – Radial, Ring main and interconnected system.

DC distribution: Types of DC distributors, DC distributor calculations, Distributor fed at one end, fed at both ends, fed at the center, ring distributor.

Underground Cables: Constructional features, Types of cables, insulation resistance, capacitance and Dielectric Stress in a Single-Core Cable, most economical conductor size in a cable, grading of cables – capacitance and inter-sheath.

PRACTICAL COMPONENT OF IPCC

Sl No	List of Experiments
1	Modeling of Power System Network (Generation to Distribution)
2	Sag-Tension Calculation of Overhead Transmission Line
3	Inductance Calculation of Transmission Lines
4	Capacitance Calculation of Transmission Lines
5	ABCD Constants of Short, Medium, and Long Transmission Lines
6	Simulation of Long Transmission Line Using Hyperbolic Equations
7	Corona Loss Estimation
8	Insulation Resistance and Capacitance of Underground Cables
9	Distribution System Analysis (Radial vs Loop Feeders)
10	Effect of Neutral Disconnection in 3-Phase 4-Wire System

Course Outcomes:

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

CO-1. Describe the working of various types of conventional power plants.
CO-2. Compute the parameters related to mechanical design of overhead transmission line.
CO-3. Analyze and compute the parameters of the transmission line for different configurations.
CO-4. Analyze the performance of transmission lines and corona phenomenon.
CO-5. Evaluate the different types of distribution systems and underground cables.

Text/Reference Books:

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Course in Electrical Power	Soni Gupta and Bhatnagar	DhanpatRai	-
2	Power System Analysis and Design	J. Duncan Gloverat el	Cengage Learning	4th Edition 2008
3	Principles of Power System	V.K. Mehta, Rohit Mehta	S. Chand	1st Edition 2013
4	Electrical power Generation, Transmission and Distribution	S.N. Singh	PHI	2nd Edition,2009
5	Electrical Power	S.L.Uppal	Khanna Publication	
6	Electrical power systems	C. L. Wadhwa	New Age	5th Edition, 2009
7	Electrical power systems	Ashfaq Hussain	CBS Publication	
8	Electric Power Distribution	A.S. Pabla	McGraw-Hill	6th Edition,2012
9	*For* High temperature conductors refer www.jpowers.co.jp/english/product/pdf/gap_c1.pdfand Power System Analysis and Design, J. Duncan Glover.			

CONTROL SYSTEMS			
Subject Code	23EEE520	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course objectives:

- To understand the fundamentals of control systems:
- To develop mathematical models of control systems:
- To analyze time-domain behavior of systems:
- To perform frequency-domain analysis:
- To design control systems to meet performance criteria:

Module-1 **08 Hrs**

Introduction to control systems: Introduction, classification of control systems.
Mathematical models of physical systems: Modelling of mechanical system elements, electrical systems, Analogous systems, Transfer function, Single input single output systems, Procedure for deriving transfer functions, servomotors, synchros, gear trains.

Module-2 **08 Hrs**

Block diagram: Block diagram of a closed loop system, procedure for drawing block diagram and block diagram reduction to find transfer function.
Signal flow graphs: Construction of signal flow graphs, basic properties of signal flow graph, signal flow graph algebra, construction of signal flow graph for control systems.

Module-3 **08 Hrs**

Time Domain Analysis: Standard test signals, time response of first order systems, time response of second order systems, steady state errors and error constants, types of control systems.
Routh Stability criterion: BIBO stability, Necessary conditions for stability, Routh stability criterion, difficulties in formulation of Routh table, application of Routh stability criterion to linear feedback systems, relative stability analysis.

Module-4 **08 Hrs**

Root locus technique: Introduction, root locus concepts, construction of root loci, rules for the construction of root locus.
Frequency Response analysis: Co-relation between time and frequency response – 2nd order systems only.
Bode plots: Basic factors G(iw)/H(jw), General procedure for constructing bode plots, computation of gain margin and phase margin.

Module-5 **08 Hrs**

Nyquist plot: Principle of argument, Nyquist stability criterion, assessment of relative stability using Nyquist criterion.
Design of Control Systems: Introduction, Design with the PD Controller, Design with the PI Controller, Design with the PID Controller, Design with Phase-Lead Controller, Design with Phase- Lag Controller, Design with Lead-Lag Controller.

PRACTICAL COMPONENT OF IPCC

Sl No	List of Experiments
1	Experiment to draw the speed torque characteristics of (i) AC servo motor (ii) DC servo motor.
2	Experiment to draw synchro pair characteristics.
3	Experiment to determine frequency response of a second order system.
4	To design a passive RC lead compensating network for the given specifications, viz, the maximum phase lead and the frequency at which it occurs and to obtain the frequency response.
5	(a) To design a passive RC lag compensating network for the given specifications, viz the maximum phase lag and the frequency at which it occurs and to obtain the frequency response.

	To determine experimentally the transfer function of the lag compensating network.
6	Experiment to draw the frequency response characteristics of the lag – lead compensator network and determination of its transfer function.
7	To study a second order system and verify the effect of (a) P, (b) PI, (c) PD and (d) PID controller on the step response.
8	(a) To simulate a typical second order system and determine step response and evaluate time response specifications. (b) To evaluate the effect of adding poles and zeros on time response of second order system. To evaluate the effect of pole location on stability.
9	(a) To simulate a D.C. Position control system and obtain its step response. (b) To verify the effect of input waveform, loop gain and system type on steady state errors. (c) To perform trade-off study for lead compensator. To design PI controller and study its effect on steady state error.
10	(a) To examine the relationship between open-loop frequency response and stability, open-loop frequency and closed loop transient response. To study the effect of open loop gain on transient response of closed loop system using root locus.
11	(a) To study the effect of open loop poles and zeros on root locus contour. Comparative study of Bode, Nyquist and root locus with respect to stability.

Note:

1. Perform experiments 1 and 2 using suitable components/equipment.

Perform experiments 3,4,5,6 and 7 using suitable components/equipment and verify the results using standard simulation package. Perform simulation only of experiments 8,9,10 and 11using standard package.

Course outcomes:

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

CO1: Analyze the effects of feedback and identify the types of feedback control systems.
CO2: Evaluate the transfer function and stability of linear time-invariant systems.
CO3: Apply block diagram reduction and signal flow graph methods to determine system transfer functions.
CO4: Perform stability analysis using Root Locus, Bode, and Nyquist plots.
CO5: Design controllers and compensators to meet system performance specifications.

Textbook

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Control Systems	Anand Kumar	PHI	2nd Edition, 2014
Reference Books				
1	Automatic Control Systems	Farid Golnaraghi, Benjamin C. Kuo	Wiley	9th Edition, 2010
2	Control Systems Engineering	Norman S. Nise	Wiley	4th Edition, 2004
3	Modern Control Systems	Richard C Dorf et al	Pearson	11th Edition, 2008
4	Control Systems, Principles and Design	M. Gopal	McGaw Hill	4th Edition, 2012
5	Control Systems Engineering	S. Salivahanan et al	Pearson	1st Edition, 2015
6	Modern Control Engineering	Katsuhiko Katsuhiko Ogata	Pearson	5th Edition, 2009

OPERATIONAL AMPLIFIERS AND LINEAR INTEGRATED CIRCUITS			
Course Code	23EEE530	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course Learning Objectives:

- To understand the basics of Linear ICs such as Op-amp, Regulator, Timer & PLL.
- To learn the designing of various circuits using linear ICs.
- To use these linear ICs for specific applications.
- To understand the concept and various types of converters.
- To use these ICs, in Hardware projects.

Module-1

Operational Amplifiers: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback (excluding derivations).
General Linear Applications: A.C. amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, Instrumentation amplifier.

Module-2

Active Filters: First & Second order high pass & low pass Butterworth filters. Band pass filters, all pass filters.
DC Voltage Regulators: voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators.

Module-3

Signal Generators: Triangular / rectangular wave generator, phase shift oscillator, saw tooth oscillator.
Comparators & Converters: Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters.

Module-4

Signal processing circuits: Precision half wave & full wave rectifiers
A/D & D/A Converters: Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC

Module-5

Phase Locked Loop (PLL): Basic PLL, components, performance factors.
Timer: Internal architecture of 555 timer, Mono stable multivibrators and applications.

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

- Describe the characteristics of ideal and practical operational amplifier.
- Design filters and signal generators using linear ICs.
- Demonstrate the application of Linear ICs as comparators and rectifiers.
- Analyze voltage regulators for given specification using op-amp and IC voltage regulators.
- Summarize the basics of PLL and Timer.

PRACTICAL COMPONENT OF IPCC

Sl. No	Experiments
1	Design and verify a precision full wave rectifier. Determine the performance parameters.
2	Design and realize to analyse the frequency response of an op – amp amplifier under inverting and non - inverting configuration for a given gain.
3	Design and verify the output waveform of an op – amp RC phase shift oscillator for a desired frequency.
4	Design and realize Schmitt trigger circuit using an op – amp for desired upper trip point (UTP) and lower trip point (LTP).
5	Verify the operation of an op – amp as (a) voltage comparator circuit and (b) zero crossing detector.
6	Design and verify the operation of op – amp as an (a) adder (b) subtractor (c) integrator and (d) differentiator.

7	Design and realize an op – amp based first order Butterworth (a) low pass (b) high pass and (c) band pass filters for a given cut off frequency/frequencies to verify the frequency response characteristic.
8	Design and realize an op – amp based function generator to generate sine, square and triangular waves of desired frequency.
9	Design and realization of R-2R ladder DAC.
10	Realization of Two bit Flash ADC
11	Design and verify an IC 555 timer based pulse generator for the specified pulse.
12	Designing of Fixed voltage power supply (voltage regulator) using IC regulators 78 series and 79 series.

Text Books:

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Op-Amps and Linear Integrated Circuits	Ramakant A Gayakwad	Pearson	4th Edition 2015

Reference Books:

1	Operational Amplifiers and Linear ICs	David A. Bell	Oxford	3rd Edition 2011
2	Linear Integrated Circuits; Analysis, Design and	B. Somanthan Nair	Wiley India	2013
3	Linear Integrated Circuits	S. Salivahanan, et al	McGraw Hill	2nd Edition,2014
4	Operational Amplifiers and Linear Integrated Circuits	K. Lal Kishore	Pearson	1st Edition, 2012

MANAGEMENT AND ENTREPRENEURSHIP			
Subject Code	23MEE540	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- To introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- To discuss the ways in which work is allocation, structure of organizations, modes of communication and importance of managerial control in business.
- To explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- To explain various types of entrepreneurs and their functions, the myths of entrepreneurship and the factors required for capacity building for entrepreneurs
- To discuss the importance of Small-Scale Industries and the related terms and problems involved.
- To discuss methods for generating new business ideas and business opportunities in India and the importance of business plan.
- To introduce the concepts of project management and discuss capitol building process.
- To explain project feasibility study and project appraisal and discuss project financing
- To discuss about different institutions at state and central levels supporting business enterprises.

Module-1 **08 Hrs**

Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession**.**

Planning: Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.

Module-2 **08 Hrs**

Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Versus Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment.

Directing and Controlling: Meaning and Nature of Directing-Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.

Module-3 **08 Hrs**

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.

Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship

Module-4 **08 Hrs**

Modern Small Business Enterprises: Role of Small-Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only).

Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.

Module-5 **08 Hrs**

Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification- Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation.

New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM.

Course outcomes:

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

CO1: Explain the tasks of management, including planning, staffing, recruitment, and selection processes.

CO2: Discuss organizational structure, communication modes, and the importance of managerial control.

CO3: Analyze the social responsibility of business and the role of leadership in organizations.

CO4: Explain the concepts of entrepreneurship and the role of small-scale industries in economic development.

CO5: Discuss project management concepts, including feasibility, appraisal, financing, and support from government agencies.

Text Books:

1. Principles of Management – P. C. Tripathi, P.N. Reddy – Tata McGraw Hill.
2. Dynamics of Entrepreneurial Development & Management-Vasant Desai,Himalaya PublishingHouse.
3. Entrepreneurship Development – Poornima. M. Charantimath, Small Business Enterprises – PearsonEducation - 2006 (2 & 4).

Reference Books:

1. Management Fundamentals - Concepts, Application, Skill Development – RobersLusier, Thomson. 2. Entrepreneurship Development - S. S. Khanka, S. Chand & Co. New Delhi.
3. Management - Stephen Robbins, Pearson Education/PHI - 17thEdition, 2003

OBJECT ORIENTED PROGRAMMING USING C++			
Course Code	23EEE551	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course Learning Objectives:

- Define Encapsulation, Inheritance and Polymorphism.
- Solve the problem with object-oriented approach.
- Analyze the problem statement and build object-oriented system model.
- Describe the characters and behavior of the objects that comprise a system.
- Explain function overloading, operator overloading and virtual functions.
- Discuss the advantages of object-oriented programming over procedure-oriented programming.

Module-1 **08 Hrs**

Beginning with C++ and its Features:
What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, operator overloading and control structures in C++ . (Topics from Chapter 2 and 3 of textbook]

Module-2 **08 Hrs**

Functions, Classes and Objects:
Functions, Inline function, function overloading, friend and virtual functions, Specifying a class, C++ program with a class, arrays within a class, memory allocation to objects, array of objects, members, pointers to members and member functions. (Selected Topics from Chapter 4 and 5 of textbook).

Module-3 **08 Hrs**

Constructors, Destructors and Operator Overloading: Constructors, Multiple constructors in a class, Copy constructor, Dynamic constructor, Destructors, Defining operator overloading, Overloading Unary and binary operators, Manipulation of strings using operators. (Selected topics from Chapter 6 and 7 of textbook).

Module-4 **08 Hrs**

Inheritance, Pointers, Virtual Functions, Polymorphism:
Derived Classes, Single, multilevel, multiple inheritance, Pointers to objects and derived classes, this pointer, Virtual and pure virtual functions (Selected topics from Chapter 8 and 9 of textbook).

Module-5 **08 Hrs**

Streams and Working with Files:
C++ streams and stream classes, formatted and unformatted I/O operations, Output with manipulators, Classes for file stream operations, opening and closing a file, EOF (Selected topics from Chapters 10 and 11 of textbook).

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

- CO-1. Explain the fundamental concepts of Object-Oriented Programming (OOP) such as classes, objects, encapsulation, and abstraction.
- CO-2. Implement object initialization and destruction using constructors and destructors.
- CO-3. Apply polymorphism concepts through method and operator overloading (compile-time) and virtual functions, function overriding, and abstract classes (run-time).
- CO-4. Demonstrate the use of inheritance to promote code reusability and evaluate its effectiveness.
- CO-5. Perform input/output operations and manage data using file streams in programs.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Object Oriented Programming with C++	E.Balaguruswamy	TMH	6th Edition, 2013
Reference Books				
1	Object-oriented Programming with C++	Robert Lafore	Galgotia publication	2010
2	Object-oriented Programming with C++	Sourav Sahay	Oxford University	2006

FUNDAMENTALS OF VLSI DESIGN			
Subject Code	23EEE552	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- Impart knowledge of mass transistors theory and CMOS technology.
- Understand the basic electrical properties of mass and BICMOS circuits.
- Cultivate the concept of subsystem design and layout processes.
- Understand the concept of design process computational elements.

Module-1 **08 Hrs**

Moore's law, speed power performance, nMOS fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS.

Basic Electrical Properties of MOS And BiCMOS Circuits: Drain to source current versus voltage characteristics, threshold voltage, transconductance.

Module-2 **08 Hrs**

Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull down ratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter, BiCMOS inverters, latch up.

Basic Circuit Concepts: Sheet resistance, area capacitance calculation, Delay unit, inverter delay, estimation of CMOS inverter delay, driving of large capacitance loads, super buffers, BiCMOS drivers.

Module-3 **08 Hrs**

MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style, design rules and layout, λ - based design.

Scaling of MOS Circuits: scaling factors for device parameters, limitations of scaling.

Module-4 **08 Hrs**

Subsystem Design and Layout-1: Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logic function block, code converter.

Subsystem Design and Layout-2: Clocked sequential circuits, dynamic shift registers, bus lines, subsystem design processes, General considerations, 4-bit arithmetic processes, 4-bit shifter.

Module-5 **08 Hrs**

Design Process-Computational Elements: Regularity, design of ALU subsystem, ALU using adders, carry lookahead adders, Multipliers, serial parallel multipliers, Braun array, Bough – Wooley multiplier.

Memory, Register and Aspects of Timing: Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flip flop, D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimization and CAD tools for design and simulation

Course outcome (Course Skill Set)

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

CO-1. Identify the CMOS layout levels, and the design layers used in the process sequence.
CO-2. Describe the general steps required for processing of CMOS integrated circuits.
CO-3. Design static CMOS combinational and sequential logic at the transistor level.
CO-4. Demonstrate different logic styles such as complementary CMOS logic, pass-transistor Logic and dynamic logic.
CO-5. Interpret the need for testability and testing methods in VLSI

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Text Books				

1	Basic VLSI Design	Douglas A Pucknell, Kamaran Eshraghian	Prentice Hall of India publication,	3rd Edition, 2005.
2	CMOS Digital Integrated Circuits Analysis And Design	Sung–Mo (Steve) Kang, Yusuf Leblbici	Tata McGraw Hill	3rd Edition, 2002.
3	VLSI Technology	S. M. Sze	Tata McGraw Hill	2nd edition, 2003.

INTERNET OF THINGS			
Course Code	23EEE553	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course Learning Objectives: This course will enable students to:

- Assess the genesis and impact of IoT applications, architectures in real world.
- Illustrate diverse methods of deploying smart objects and connect them to network.
- Compare different Application protocols for IoT.
- Infer the role of Data Analytics and Security in IoT.
- Identify sensor technologies for sensing real world entities and understand the role of IoT in various domains of Industry.

Module- 1 **08 Hrs**

What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Module- 2 **08 Hrs**

Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies.

Module- 3 **08 Hrs**

IP as the IoT Network Layer, The Business Case for IP, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

Module- 4 **08 Hrs**

Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment

Module- 5 **08 Hrs**

IoT Physical Devices and Endpoints - Arduino UNO: Introduction to Arduino, Arduino UNO, Installing the Software, Fundamentals of Arduino Programming. IoT Physical Devices and Endpoints – Raspberry-Pi: Introduction to Raspberry-Pi, About the Raspberry-Pi Board: Hardware Layout, Operating Systems on Raspberry-Pi, Configuring Raspberry-Pi, Programming Raspberry-Pi with Python, Wireless Temperature Monitoring System Using Pi, DS18B20 Temperature Sensor, Connecting Raspberry Pi via SSH, Accessing Temperature from DS18B20 sensors, Remote access to Raspberry-Pi, Smart and Connected Cities, An IoT Strategy for Smarter Cities, Smart City IoT Architecture, Smart City Security Architecture, Smart City Use-Case Examples.

Course Outcomes: The student will be able to:

CO1: Analyze the impact of IoT on network architectures and identify related challenges.
CO2: Compare smart object deployment methods and connectivity technologies.
CO3: Evaluate IoT communication protocols for efficient data exchange.
CO4: Explain the importance of data analytics and security in IoT systems.
CO5: Identify sensor technologies and their industrial IoT applications.

Text books:

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry	Pearson Education (Cisco Press Indian Reprint).	1st Edition, (**ISBN:** 978-9386873743)
2	Internet of Things	Srinivasa K G,	CENGAGE Leaning India	2017
Reference books:				
1	Internet of Things (A Hands-on-Approach)",	Vijay Madisetti and Arshdeep Bahga	Orient Blackswan Private Limited - New Delhi	1stEdition, VPT, 2014(ISBN: 978-8173719547)
2	Internet of Things: Architecture and Design Principles	Raj Kamal	McGraw Hill Education	1st Edition, 2017. (ISBN: 978-9352605224)

ELECTRICAL AND ELECTRONIC MEASUREMENTS			
Subject Code	23EEE561	CIE Marks	50
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Credits	01	Exam Marks	50

Course Learning Objectives:

- To measure resistance, inductance and capacitance using different bridges and determine earth resistance.
- To study the construction and working of various meters used for measurement.
- To study the adjustments, calibration & errors in energy meters and methods of extending the range of instruments.

Module-1 **03 Hrs**

Measurement of Resistance: Wheatstone's bridge, sensitivity, limitations. Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Megger.
Measurement of Inductance and Capacitance: Sources and detectors, Maxwell's inductance and capacitance bridge, Hay's bridge, Anderson's bridge, Desauty's bridge, Schering bridge. Shielding of bridges. Problems.

Module-2 **03 Hrs**

Measurement of Power, Energy, Power Factor and Frequency: Torque expression, Errors and minimization, UPF and LPF wattmeters. Measurement of real and reactive power in 3 phase circuits. Errors, adjustments and calibration of single and three phase energy meters, Problems. Construction and operation of single-phase and three phase dynamometer type power factor meter. Weston frequency meter and phase sequence indicator.

Module-3 **03 Hrs**

Extension of Instrument Ranges: Desirable features of ammeters and voltmeters. Shunts and multipliers. Construction and theory of instrument transformers, Desirable characterises, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee's method of testing CT.
Magnetic measurements: Introduction, measurement of flux/ flux density, magnetising force and leakage factor.

Module-4 **03 Hrs**

Electronic and Digital Instruments: Introduction. Essentials of electronic instruments, Advantages of electronic instruments. True rms reading voltmeter. Electronic multimeters. Digital voltmeters (DVM) - Ramp type DVM, Integrating type DVM and Successive - approximation DVM. Q meter. Principle of working of electronic energy meter (with block diagram), extra features offered by present day meters and their significance in billing.

Module-5 **03 Hrs**

Display Devices: Introduction, character formats, segment displays, Dot matrix displays, Bar graph displays. Cathode ray tubes, Light emitting diodes, Liquid crystal displays, Nixes, Incandescent, Fluorescent, Liquid vapour and Visual displays.
Recording Devices: Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and xy recorders. Digital tape recording, Ultraviolet recorders. Electro Cardio Graph (ECG).

Course Outcomes: At the end of the course the student will be able to:
CO1: Measure resistance, inductance, and capacitance using bridge techniques.
CO2: Analyze power, energy, power factor, and frequency in AC circuits.
CO3: Extend instrument ranges and evaluate current and potential transformers.
CO4: Operate electronic and digital instruments for precise measurements.
CO5: Identify and compare display and recording devices used in instrumentation.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electrical and electronic Measurements and	A.K. Sawhney	Dhanpat Rai and Co	10th Edition
2	A Course in Electronics and Electrical Measurements and Instrumentation	J. B. Gupta	Katson Books	2013 Edition
Reference book				
1	Electrical and electronic Measurements and	R.K. Rajput	S Chand	5th Edition, 2012
2	Electrical Measuring Instruments and Measurements	S.C. Bhargava	BS Publications	2013
3	Modern Electronic Instrumentation and Measuring Techniques	Cooper D and A.D. Heifrick	Pearson	First Edition, 2015
4	Electronic Instrumentation and Measurements	David A Bell	Oxford University	3rd Edition, 2013
5	Electronic Instrumentation	H.S.Kalsi	Mc Graw Hill	3rd Edition,2010

PLC AND SCADA			
Subject Code	23EEE562	CIE Marks	50
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Credits	01	Exam Marks	50

Course objectives:

1. To explain the basic structure, advantages, and operation sequence of PLCs.
2. To describe PLC hardware components and memory organization.
3. To develop ladder logic programming skills using relay logic and narrative-based programming.
4. To apply timers, counters, and control instructions in industrial automation.
5. To understand communication methods and integration of PLCs in industrial control systems.

Module-1 **03 Hrs**

Programmable Logic Controllers: Introduction, Parts of a PLC, Principles of Operation, Modifying the Operation, PLCs versus Computers, PLC Size and Application.
PLC Hardware Components: The I/O Section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O Specifications, The Central Processing Unit (CPU), Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces (HMIs).
Basics of PLC Programming: Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation.

Module-2 **03 Hrs**

Developing Fundamental PLC Wiring Diagrams and Ladder Logic Programs: Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Writing a Ladder Logic Program Directly from a Narrative Description. **Programming Timers:** Mechanical Timing Relays, Timer Instructions, On-Delay Timer Instruction, Off-Delay Timer Instruction, Retentive Timer, Cascading Timers.
Module-3 **03 Hrs**
Programming Counters: Counter Instructions, Up-Counter, Down-Counter, Cascading Counters, Incremental Encoder-Counter Applications, Combining Counter and Timer Functions. **Program Control Instructions:** Master Control Reset Instruction, Jump Instruction, Subroutine Functions, Immediate Input and Immediate Output Instructions, Forcing External I/O Addresses, Safety Circuitry, Selectable Timed Interrupt, Fault Routine, Temporary End Instruction, Suspend Instruction.
Module-4 **03 Hrs**
Data Manipulation Instructions: Data Manipulation, Data Transfer Operations, Data Compare Instructions, Data Manipulation Programs, Numerical Data I/O Interfaces, Closed-Loop Control. **Math Instructions:** Math Instructions, Addition Instruction, Subtraction Instruction, Multiplication Instruction, Division Instruction, Other Word-Level Math Instructions, File Arithmetic Operations.
Module-5 **03 Hrs**
Sequencer and Shift Register Instructions: Mechanical Sequencers, Sequencer Instructions, Sequencer Programs, Bit Shift Registers, Word Shift Operations. **Process Control, Network Systems, and SCADA:** Types of Processes, Structure of Control Systems, On/Off Control, PID Control, Motion Control, Data Communications, Supervisory Control and Data Acquisition (SCADA).
Course outcomes: At the end of the course the student will be able to: CO1: Discuss the history, hardware components, and operating modes of PLCs, along with basic PLC programming. CO2: Describe commonly used field devices such as relays, contactors, motor starters, and sensors with I/O modules. CO3: Analyze PLC ladder logic programs using timers, counters, and program control instructions. CO4: Explain data transfer, data comparison, and closed-loop control operations in PLC systems. CO5: Describe the operation of mechanical sequencers, shift registers, and communication between control system processes.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Programmable Logic Controllers	Frank D Petruzella	McGraw Hill,	4th Edition, 2011
Reference Books				
1	Programmable Logic Controllers an Engineer's Guide	E A Parr	Newnes	3rd Edition, 2013
2	Introduction Programmable Logic Controllers	Gary Dunning	Cengage	3rd Edition, 2006

ENERGY CONSERVATION AND AUDIT			
Subject Code	23EEE563	CIE Marks	50
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Credits	01	Exam Marks	50

Course objectives:

1. Understand the current energy scenario and importance of energy conservation. (2)
2. Understand the methods of improving energy efficiency in different electrical systems.
3. Realize energy auditing.

4. Explain about various pillars of electricity market design.
5. To explain the scope of demand side management, its concept and implementation issues and strategies.

Module-1	**03 Hrs**
Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.	
Module-2	**03 Hrs**
Energy Efficiency in Electrical Systems: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Electronic ballast, Energy efficient lighting and measures of energy efficiency in lighting system.	
Module-3	**03 Hrs**
Energy auditing: Introduction, Elements of energy audits, different types of audit, energy use profiles, measurements in energy audits, presentation of energy audit results.	
Module-4	**03 Hrs**
Electricity v/s Other Commodities: Distinguishing features of electricity as a commodity, four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Framework of Indian power sector and introduction to the availability-based tariff (ABT).	
Module-5	**03 Hrs**
Energy Audit Applied to Buildings: Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. **Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM.	

Course outcome (Course Skill Set)

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

CO-1. Analyze the national and global energy scenario and outline the features of the Energy Conservation Act.
CO-2. Discuss load management techniques and principles of energy efficiency.
CO-3. Explain the need for energy audits and describe standard audit methodologies.
CO-4. Understand the fundamental pillars of electricity market design.
CO-5. Conduct energy audits of electrical systems and buildings, and apply demand-side management strategies for energy conservation.

Suggested Learning Resources:

Textbooks

1. Energy Management Handbook, W.C. Turner, John Wiley, and Sons.
2. Energy Efficient Electric Motors and Applications, H.E. Jordan Plenum Pub Corp.
3. Energy Management W. R. Murphy, G. Mckay Butterworths.

Reference Books

1. Energy Science Principles, Technologies and Impact, J. Andrews, N. Jelley Oxford University Press.
2. Market operations in power systems: Forecasting, Scheduling, and Risk Management, Shahedepour M., Yamin H., Zuyi Li, John Wiely & Sons, New York. Energy Conservation, Diwan, P, Pentagon Press, (2008)

ADVANCED APTITUDE			
Course Code	23AAE570	CIE Marks	50
Teaching Hours/Week (L:T:P)	2:0:0	SEE Marks	50
Credits	01	Exam Hours	01
Total Hours of Pedagogy	15	Total Marks	100

Pre-requisites:
1. Fundamentals of Mathematics
2. Basic knowledge of Reasoning

Module – 1: Numerical Ability Based **03 Hours**

Simplifications, Squares and Square Roots, Cubes and Cube roots, BODMAS Rule, LCM, HCF, Fractions and Decimals

Module – 2: Percentage Based **03 Hours**

Percentages, Profit and Loss, Discounts, Simple Interest and Compound Interest

Module – 3: Time Based **03 Hours**

Time and Work, Pipes and Cisterns, Time and Distance, Trains, Boats and Streams

Module – 4: Ratio Based **03 Hours**

Ratio-proportion, Partnership, Averages and Ages

Module – 5: Logical and Analytical Based **03 Hours**

Seating Arrangement, Series, Analogy, Odd man out and Blood Relations

Course Outcomes:
At the end of course students will be able to
1. Analyze and solve questions based on logical thinking and critical reasoning.
2. Analyze and solve quantitative aptitude problems
3. Solve aptitude problems using fast track techniques
4. Solve puzzle based questions
5. Analyze and solve problems on numerical computation and numerical estimation

NATIONAL SERVICE SCHEME (NSS)			
Subject Code	23NSE58	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Hours	00
Credits	00	Exam Marks	100

Course objectives:
National Service Scheme (NSS) will enable the students to:
1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem –solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

General Instructions - Pedagogy:

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied social and cultural skills.
2. State the need for NSS activities and its present relevance in the society and Provide real-life examples.
3. Support and guide the students for self-planned activities.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
5. Encourage the students for group work to improve their creative and analytical skills.

National Service Scheme (NSS) – Contents:

1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.
2. Waste management– Public, Private and Govt organization, 5 R's.
3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4. Water conservation techniques – Role of different stakeholders– Implementation.
5. Preparing an actionable business proposal for enhancing the village income and approach for implementation.
6. Helping local schools to achieve good results and enhance their enrolment in Higher / technical / vocational education.
7. Developing Sustainable Water management system for rural areas and implementation approaches.
8. Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swatch Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.,
9. Spreading public awareness under rural outreach programs.(minimum5 programs).
10. Social connect and responsibilities.
11. Plantation and adoption of plants. Know your plants.
12. Organize National integration and social harmony events / workshops / seminars. (Minimum 02 programs).
13. Govt. school Rejuvenation and helping them to achieve good infrastructure.

NOTE:

- Student / s in individual or in a group should select any one activity in the beginning of each semester till end of that respective semester for successful completion as per the instructions of NSS officer with the consent of HOD of the department.
- At the end of every semester, activity report should be submitted for evaluation.

Semester wise from 3rd to 6th semester

DISTRIBUTION OF ACTIVITIES

Semester	Topics / Activities to be Covered
3rd Sem.	1. Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing. 2. Waste management– Public, Private and Govt organization, 5 R's. 3. Setting of the information imparting club for women leading to contribution in social and economic issues.
4th Sem.	4. Water conservation techniques – Role of different stakeholders– Implementation.5 5. Preparing an actionable business proposal for enhancing the village income and approach for implementation. 6. Helping local schools to achieve good results and enhance their enrolment in Higher / technical / vocational education.
5th Sem.	7. Developing Sustainable Water management system for rural areas and implementation approaches. 8. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc., 9. Spreading public awareness under rural outreach programs. (minimum5 programs).

6th Sem.	11. Plantation and adoption of plants. Know your plants. 12. Organize National integration and social harmony events / workshops / seminars. (Minimum 02 programs). 13. Govt. school Rejuvenation and helping them to achieve good infrastructure.

Pedagogy – Guidelines, it may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

SN	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	Organic farming, Indian Agriculture (Past, Present and Future) Connectivity for marketing.	May be individual or team	Farmers Land / Villages / Roadside / Community Area / College Campus Etc.,	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
2.	Waste management– Public, Private and Govt. organization, 5 R's.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,,	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
3.	Setting of the information imparting club for women leading to contribution in social and economic issues.	May be individual or team	Women Empowerment Groups / Consulting NGOs & Govt. Teams / College Campus Etc.,	Group selection / pro per consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
4.	Water conservation techniques – Role of different stakeholders– Implementation.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
5.	Preparing an actionable business proposal for enhancing the village income and approach for implementation.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Group selection / pro per consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
6.	Helping local schools to achieve good results and enhance their enrolment in Higher / technical / vocational education.	May be individual or team	Local Government / Private / Aided Schools / Government Schemes Officers / Etc.,	School selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer

7.	Developing Sustainable Water management system for rural areas and implementation approaches.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Site selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
8.	Contribution to any national level initiative of Government of India. For eg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc.,	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Group selection / pro per consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
9.	Spreading public awareness under rural outreach programs (minimum5 programs) / Social connect and responsibilities.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Group selection / pro per consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
10.	Plantation and adoption of plants. Know your plants.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
11.	Organize National integration and social harmony events / workshops / seminars. (Minimum 02 programs).	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government Schemes Officers / Campus Etc.,	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer
12.	Govt. school Rejuvenation and helping them to achieve good infrastructure.	May be individual or team	Villages / City Areas / Grama Panchayat / Public Associations / Government/ Schemes Officers / Campus Etc.,	Place selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by NSS officer

Plan of Action (Execution of Activities for Each Semester)

SN	Practice Session Description
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

- In every semester from 3rd semester to 6th semester, each student should do activities according to the scheme and syllabus.
- At the end of every semester student performance has to be evaluated by the NSS officer for the assigned activity progress and its completion.
- At last in 6th semester consolidated report of all activities from 3rd to 6th semester, compiled report should be submitted as per the instructions.

Course outcomes (Course Skill Set):

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

CO1: Understand the importance of his / her responsibilities towards society.
CO2: Analyse the environmental and societal problems / issues and will be able to design solutions for the same.
CO3: Evaluate the existing system and to propose practical solutions for the same for sustainable development.
CO4: Implement government or self-driven projects effectively in the field.
CO5: Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

SUGGESTED LEARNING RESOURCES:

Books:

NSS Course Manual, Published by NSS Cell, VTU Belagavi. Government of Karnataka, NSS cell, activities reports and its manual. Government of India, NSS cell, Activities reports and its manual.

PHYSICAL EDUCATION (SPORTS & ATHLETICS) – I			
Subject Code	23PEE580	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Hours	00
Credits	00	Exam Marks	100

Course Outcomes:

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

1. Comprehend the fundamental concepts and skills of Physical Education, Health, Nutrition and Fitness
2. Familiarization of health-related Exercises, Sports for overall growth and development
3. Create a foundation for the professionals in Physical Education and Sports
4. Participate in the competition at regional / state / national / international levels.
5. Create consciousness among the students on Health, Fitness and Wellness in developing and maintaining a healthy lifestyle.

Module I: Orientation **05 Hours**

a. Lifestyle
b. Fitness
c. Food & Nutrition
d. Health & Wellness
e. Pre-Fitness test.

Module II: General Fitness & Components of Fitness **15 Hours**

a. Warming up (Free Hand exercises)
b. Strength – Push-up / Pull-ups
c. Speed – 30 Mtr Dash
d. Agility – Shuttle Run
e. Flexibility – Sit and Reach
f. Cardiovascular Endurance – Harvard step Test

Module III: Recreational Activities **10 Hours**

g. Postural deformities.
h. Stress management.
i. Aerobics.
j. Traditional Games.

Semester III
YOGA (3rd to 5th)

Course Code	23YOE580	CIE Marks	100 / Sem.
Teaching Hours / Week (L:T:P)	0:0:2	SEE Marks	---
Total Hours of Pedagogy per semester	24 - 28 hours (Theory + practical)	Total Marks	100 / Sem.
Examination nature (SEE):	Objective type Theory / Practical / Viva-Voce		
Credits	00		

Course objectives:

1. To enable the student to have good health.
2. To practice mental hygiene.
3. To possess emotional stability.
4. To integrate moral values.
5. To attain higher level of consciousness.

The Health Benefits of Yoga

The benefits of various yoga techniques have been supposed to improve

- body flexibility,
- performance,
- stress reduction,
- attainment of inner peace, and
- self-realization.

The system has been advocated as a complementary treatment to aid the healing of several ailments such as

- coronary heart disease,
- depression,
- anxiety disorders,
- asthma, and
- extensive rehabilitation for disorders including musculoskeletal problems and traumatic brain injury.

The system has also been suggested as behavioral therapy for smoking cessation and substance abuse (including alcohol abuse).

If you practice yoga, you may receive these physical, mental, and spiritual benefits:

- **Physical**
  1. Improved body flexibility and balance
  2. Improved cardiovascular endurance (stronger heart)
  3. Improved digestion
  4. Improved abdominal strength
  5. Increased energy levels
  6. Enhanced immune system
- **Mental**
  1. Relief of stress resulting from the control of emotions
  2. Prevention and relief from stress-related disorders
  3. Intellectual enhancement, leading to improved decision-making skills
- **Spiritual**
  1. Life with meaning, purpose, and direction
  2. Inner peace and tranquility
  3. Contentment

Scheme of Teaching and Evaluation for B. Tech., VI Semester Electrical and Electronics Engg. (2023 scheme)

POWER SYSTEM – 1			
Subject Code	23EEE610	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course objectives:

- To introduce the per unit system and one-line diagrams, and apply them to power system analysis.
- To explain the need for and methods of short-circuit analysis in power systems, including symmetrical and unsymmetrical faults.
- To describe symmetrical components, sequence impedances, and their application in analyzing unbalanced three-phase systems.
- To discuss the selection and role of circuit breakers in fault conditions.
- To analyze the dynamics and stability of synchronous machines using the power-angle equation and the equal area criterion.

Module-1 **08 Hrs**

Representation of Power System Components: Introduction, Single-phase Representation of Balanced Three Phase Networks, One-Line Diagram and Impedance or Reactance Diagram, Per Unit (PU) System, Steady State Model of Synchronous Machine, Power Transformer, Transmission of electrical Power, Representation of Loads.

Module-2 **08 Hrs**

Symmetrical Fault Analysis: Introduction, Transient on a Transmission Line, Short Circuit of a Synchronous Machine (On No Load), Short Circuit of a Loaded Synchronous Machine, Selection of Circuit Breakers.

Module-3 **08 Hrs**

Symmetrical Components: Introduction, Symmetrical Component Transformation, Phase Shift in Star-Delta Transformers, Sequence Impedances of Transmission Lines, Sequence Impedances and Sequence Network of Power System, Sequence Impedances and Networks of Synchronous Machine, Sequence Impedances of Transmission Lines, Sequence Impedances and Networks of Transformers, Construction of Sequence Networks of a Power System, Measurement of sequence Impedance of Synchronous Generator.

Module-4 **08 Hrs**

Unsymmetrical Fault Analysis: Introduction, Symmetrical Component Analysis of Unsymmetrical Faults, Single Line-To-Ground (LG) Fault, Line-To-Line (LL) Fault, Double Line-To-Ground (LLG) Fault, Open Conductor Faults.

Module-5 **08 Hrs**

Power System Stability: Introduction, Dynamics of a Synchronous Machine, Power Angle Equation Salient and Non – Salient pole Synchronous Machines, Simple Systems, Steady State Stability, Transient Stability, Equal Area Criterion, Factors Affecting Transient Stability.

PRACTICAL COMPONENT OF IPCC

Sl No	List of Experiments
1	Per Unit (PU) Conversion and Impedance Diagram of a Power System
2	Steady-State Modeling of Synchronous Machine and Transformer
3	Transients in a Transmission Line under Fault Conditions
4	Short Circuit Analysis of Synchronous Machine (No-load and Loaded)
5	Symmetrical Component Transformation Using MATLAB
6	Sequence Network Construction for Synchronous Machine and Transformer
7	Single Line-to-Ground (LG) Fault Analysis Using Sequence Networks
8	Line-to-Line (LL) and Double Line-to-Ground (LLG) Fault Analysis
9	Transient Stability Analysis Using Swing Equation (Point-by-Point Method)

10	Stability Analysis Using Equal Area Criterion

Course outcomes:

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

CO1: Demonstrate understanding of the per unit system, its advantages, and related computations.
CO2: Apply one-line diagrams and perform short circuit analysis for circuit breaker selection.
CO3: Evaluate symmetrical components and analyze unsymmetrical faults using sequence components.
CO4: Analyze synchronous machine dynamics and assess system stability under different fault conditions.
CO5: Apply the equal area criterion to evaluate the stability of a simple power system.

Textbook

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Modern Power System	D. P. Kothari	McGraw Hill	4th Edition, 2011
Reference Books				
1	Elements of Power System	William D. StevensonJr	McGraw Hill	4th Edition, 1982
2	Power System Analysis and Design	J.Duncan Glover et al	Cengage	4th Edition, 2008
3	Power System Analysis	Hadi Sadat	McGraw Hill	1st Edition, 2002

SIGNALS AND DIGITAL SIGNAL PROCESSING			
Subject Code	23EEE620	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course objectives:

(1) To explain basic signals, their classification, basic operations on signals, and the properties of the systems.
(2) To explain the convolution of signals in continuous and discrete time domain and the properties of impulse response representation.
(3) To explain the computation of Discrete Fourier Transform of a sequence by direct method, Linear transformation Method and using Fast Fourier Transformation Algorithms.
(4) To explain design of IIR all pole analog filters and transform them into digital filter using Impulse Invariant and Bilinear transformation Techniques and to obtain their Realization.
(5) To explain design of FIR filters using Window Method and Frequency Sampling Method and to obtain their Realization.

Module-1 **08 Hrs**

Introduction: Definitions of a Signal and a **System**, Classification of Signals, Basic Operations on Signals, Basic Elementary Signals, properties of systems.

Module-2 **08 Hrs**

Discrete Fourier Transforms (DFT):
Introduction to DFT, Properties of DFT, multiplication of two DFTs- the circular convolution, additional DFT properties, use of DFT in linear filtering, overlap-save and overlap-add method.

Module-3 **08 Hrs**

Fast-Fourier-Transform (FFT) algorithms: Direct computation of DFT, need for efficient computation of the DFT (FFT algorithms). Radix-2 FFT algorithm for the computation of DFT and IDFT–decimation-in-time and Decimation-in-frequency algorithms.

Module-4 **08 Hrs**

IIR filter design: Characteristics of commonly used analog filters – Butterworth and Chebyshev Type - I filters, analog to analog frequency transformations. Design of Digital IIR filters from analog filters (Butterworth and Chebyshev) - impulse invariance method. Mapping of transfer functions: Bilinear transformation method. Implementation of

discrete-time systems.
Module-5 **08 Hrs**
FIR filter design: Introduction to FIR filters, design of FIR filters using - Rectangular, Hamming, Hanning and Kaiser windows, FIR filter design using frequency sampling Technique. Implementation of discrete-time systems: Structures for Filters: IIR Filters - direct form I and direct form II, cascade and parallel structures. FIR filters-direct form, cascade and Linear Phase Form.

PRACTICAL COMPONENT OF IPCC	
Sl no	**List of Experiments**
1	Generation of different signals in both continuous and discrete time domains.
2	Verification of Sampling Theorem both in time and frequency domains
3	To perform basic operations on given sequences- Signal folding, evaluation of even and odd
4	Evaluation of impulse response of a system.
5	Solution of a difference equation.
6	Evaluation of linear convolution and circular convolution of given sequences.
7	Computation of N- point DFT and IDFT of a given sequence by use of (a) Defining equation; (b) FFT method.
8	Evaluation of circular convolution of two sequences using DFT and IDFT approach.
9	Design and implementation of IIR filters to meet given specification (Low pass, high pass, band pass and band reject filters).
10	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using different window functions.
11	Design and implementation of FIR filters to meet given specification (Low pass, high pass, band pass and band reject filters) using frequency sampling technique.
12	Realization of IIR and FIR filters.

Course outcome (Course Skill Set)

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

- CO-1. Discuss classification and basic operations that can be performed on both continuous and discrete time signals.
- CO-2. Evaluate Discrete Fourier Transform of a sequence and the convolution of two sequences to determine the output sequence.
- CO-3. Evaluate Discrete Fourier Transform of a sequence by using fast methods.
- CO-4. Design Butterworth and Chebyshev IIR digital filters and FIR filters using different techniques.
- CO-5. Develop different structures for IIR and FIR filters.

Textbooks:

1. Dimitris G Manolakis, John G. Proakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, 4th Edition, Pearson India, 2007.
2. V.Udayashankara, “Modern Digital Signal Processing”, Third Edition, PHI 2016

Reference Books:

1. Simon Haykin and Barry Van Veen “Signals and Systems”, John Wiley & Sons, 2nd edition
2. S K Mitra, “Digital Signal Processing”, 4th Edition, McGraw-Hill, Year
3. Avtar Singh, “Digital Signal Processing Implementation”, Brooks Cole

EMBEDDED SYSTEM DESIGN			
Subject Code	23EEE630	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course objectives:

- Identify various components, their purpose, and their application to the embedded system's applicability.
- Program various embedded components using the embedded C program.
- Understand the embedded system's real-time operating system and its application in IoT
- Understand the fundamentals of ARM-based systems, including architecture and its units like registers , debug interface, stack, MPU, Interrupts etc
- Use the various instructions to program the ARM controller.

MODULE-1 **08 Hrs**

Introduction to Embedded System: What is an Embedded Systems? Embedded systems Vs General computing systems, History of Embedded Systems, Classification of Embedded systems, Major Application Areas of Embedded Systems. Purpose of Embedded Systems, The Typical Embedded System, Microprocessor Vs Microcontroller, Differences between RISC and CISC, Harvard V/s Von- Neumann Processor/Controller Architecture, Big-endian V/s Little-endian processors, Memory (ROM and RAM types), Sensors & Actuators, The I/O Subsystem – I/O Devices, Light Emitting Diode (LED), 7- Segment LED Display, Optocoupler, Relay, Piezo buzzer, Push button switch, Communication Interfaces, On-board Communication Interface, External Communication Interface, Embedded Firmware, Other System Components

MODULE-2 **08 Hrs**

Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Hardware Software Co-Design and Program Modeling (excluding UML), Embedded firmware
design and development (excluding C language).

MODULE-3 **08 Hrs**

RTOS and IDE for Embedded System Design: Operating System basics, Types of operating systems, Task, process and threads (Only POSIX Threads with an example program), Thread preemption, Preemptive Task scheduling techniques, Task Communication, Task synchronization issues – Racing and Deadlock. How to choose an RTOS, Integration and testing of Embedded hardware and firmware, Embedded system Development Environment – Block diagram (excluding Keil).

MODULE-4 **08 Hrs**

ARM Embedded Systems:
Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware – AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications. ARM Processor Fundamentals, ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions.

MODULE-5 **08 Hrs**

Introduction to the ARM Instruction set: Introduction, Data processing instructions, Load – Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, ARMv5E extensions, Conditional Execution.

PRACTICAL COMPONENT OF IPCC

Conduct the following experiments on an ARM CORTEX M3 evaluation board to learn Assembly Language Program and using evaluation version of Embedded 'C' & Keil uVision-4 tool/compiler.

Sl no	List of Experiments
1	Write a program to find the sum of the first 10 integer numbers.

2	Write an Assembly Language Program (ALP) to i) Multiply two 16-bit numbers. ii) Add two 32-bit numbers.
3	Write a program to find the factorial of a number.
4	Write a program to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
5	Write a program to find the square of a number (1 to 10) using a look-up table.
6	Write a program to find the largest or smallest number in an array of 32 numbers.
7	Write a program to arrange a series of 32-bit numbers in ascending/descending order.
8	Write a program to count the number of ones and zeros in two consecutive memory locations.
9	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
10	Interface a DAC and generate Triangular and Square waveforms.
11	Display the Hex digits 0 to F on a 7-segment LED interface, with a suitable delay in between.
12	Interface a simple Switch and display its status through Relay, Buzzer and LED

Course outcomes:
The students will be able to do:

CO-1. Describe the architectural features and instruction set of the 32-bit ARM Cortex-M3 microcontroller.
CO-2. Demonstrate the ability to program the ARM Cortex-M3 for a variety of embedded applications.
CO-3. Identify and select appropriate hardware components for embedded systems based on their characteristics and performance attributes.
CO-4. Understand and apply hardware-software co-design principles and firmware development methodologies.
CO-5. Explain the role and importance of real-time operating systems (RTOS) in embedded system applications.

Suggested Learning Resources:

Text Books

1. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education
2. Andrew N Sloss, Dominic System and Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008.

Reference Book

Raj Kamal, "Embedded Systems: Architecture and Programming", Tata McGraw Hill, 2008.

Web links and Video Lectures (e-Resources):

1. https://archive.nptel.ac.in/courses/106/105/106105193/
2. https://developer.arm.com/documentation/dui0068/b/ARM-Instruction-Reference
3. https://www.udemy.com/course/introduction-to-arm-cortex-m3-and-m4-processors/
4. www.Nuvoton .com/websites on Advanced ARM Cortex Processors
5. https://alison.com/tag/embedded-systems Activity Based Learning

RESEARCH METHODOLOGIES & INTELLECTUAL PROPERTY RIGHTS			
Subject Code	23RMI640	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course Objectives:

1. To Understand the knowledge on basics of research and its types.
2. To Learn the concept of Literature Review, Technical Reading, Attributions and Citations.
3. To learn Ethics in Engineering Research.
4. To Discuss the concepts of Intellectual Property Rights in engineering.

Module-1 **08 Hrs**

Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

Module-2 **08 Hrs**

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, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet.

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, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments.

Module-3 **08 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 History of IP in India. 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. Avoid Public Disclosure of an Invention before Patenting. 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. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained? Do I Need First to File a Patent in India? Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

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. Commercialization of a Patent. Need for a Patent Attorney/Agent. Can a Worldwide Patent be Obtained. Do I Need First to File a Patent in India. Patent Related Forms. Fee Structure. Types of Patent Applications. Commonly Used Terms in Patenting. National Bodies Dealing with Patent Affairs. Utility Models.

Module-4 **08 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. Fair Use Doctrine. 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). International Copyright Agreements, Conventions and Treaties. Interesting Copyrights Cases.

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. Prior Art Search. Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

Module-5 **08 Hrs**

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Enforcement of Design Rights. Non-Protectable Industrial Designs India. Protection Term. Procedure for Registration of Industrial Designs. Prior Art Search. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Application Forms. Classification of Industrial Designs. Designs Registration Trend in India. International Treaties. Famous Case Law: Apple Inc. vs. Samsung Electronics Co.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India. Identification of Registered GI. Classes of GI. Non-Registerable GI. Protection of GI. Collective or Certification Marks. Enforcement of GI Rights. Procedure for GI Registration Documents Required for GI Registration. GI Ecosystem in India.

Case Studies on Patents. Case study of Curcuma (Turmeric) Patent, Case study of Neem Patent, Case study of Basmati patent. IP Organizations In India. Schemes and Programmes

Course Outcomes:
At the end of the course, the student will be able to:
CO1. To know the meaning of engineering research.
CO2. To know the procedure of the literature Review and Technical Reading
CO3. To understand the fundamentals of the patent laws and drafting procedure
CO4. Understanding the copyright laws and subject matters
CO5. Understanding the basic principles of design rights

Textbook:

1. Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.

Reference Book:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4
2. Intellectual Property Rights by N.K.Acharya Asia Law House 6th Edition. ISBN: 978-93-81849-30-9

ELECTRICAL MACHINE DESIGN			
Subject Code	23EEE651	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

(1) Discuss design factors, limitations, and modern trends in electrical machine design.
(2) Study properties of materials used in electrical, magnetic, and insulating parts.
(3) Derive output equations and select specific loadings for various electrical machines.
(4) Analyze main dimensions, winding designs, and rotor constructions.
(5) Evaluate machine performance, cooling systems, and the effect of short circuit ratio.

Module-1 **08 Hrs**

Fundamental Aspects of Electrical Machine Design: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques.
Electrical Engineering Materials: Desirabilities of Conducting Materials, Comparison of Aluminium and Copper wires. Ferromagnetic Materials: Soft Magnetic materials – Solid Core Materials, Electrical Sheet and Strip, Cold Rolled Grain Oriented Steel. Insulating Materials: Desirable Properties, Temperature Rise and Insulating Materials, Classification of Insulating materials based on Thermal Consideration.

Module-2 **08 Hrs**

Design of DC Machines: Output Equation, Choice of Specific Loadings and Choice of Number of Poles, Main Dimensions of armature, Design of Armature Slot Dimensions, Commutator and Brushes. Estimation of Ampere Turns for the Magnetic Circuit. Dimensions of Yoke, Main Pole and Air Gap. Design of Shunt and Series Field Windings.

Module-3 **08 Hrs**

Design of Transformers: Output Equations of Single Phase and Three Phase Transformers, Choice of Specific Loadings, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, No Load Current. Expression for the Leakage Reactance of core type transformer with concentric coils, and calculation of Voltage Regulation. Design of Tank and Cooling (Round and Rectangular) Tubes.

Module-4 **08 Hrs**

Design of Three Phase Induction Motors: Output Equation, Choice of Specific Loadings, Main Dimensions of Stator. Design of stator slots and Winding, Choice of Length Air Gap, Estimation of Number of Slots for Squirrel Cage Rotor. Design of Rotor Bars and End Ring. Design of Slip Ring rotor. Estimation of No Load Current and Leakage Reactance.
Module-5 **08 Hrs**
Design of Three Phase Synchronous Machines: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non- salient Pole Rotors. Magnetic Circuit and Field Winding.
Course outcomes: At the end of the course the student will be able to: CO1: Discuss design factors, limitations, modern trends, and material properties used in electrical machines. CO2: Derive output equations and analyze specific loadings and magnetic circuits of electrical machines. CO3: Design field windings of DC and synchronous machines, and stator and rotor circuits of AC and DC machines. CO4: Estimate cooling tube requirements, no-load current, and leakage reactance of core-type transformers. CO5: Design salient and non-salient pole alternators based on given specifications.
Textbook

1	A course in Electrical Machine design	A. K. Sawhney	Dhanpat Rai	6th Edition, 2013
Reference Books				
1	Performance and Design of Alternating Current Machines	M.G. Say	CBS Publisher	3rd Edition, 2002
2	Design Data Handbook	A. Sanmugasundaram Et al	New Age International	1st Edition, 2011

SENSORS AND TRANSDUCERS			
Subject Code	23EEE652	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

1. Understand the need, classification, advantages, and disadvantages of transducers.
2. Learn the working principles of various transducers and sensors.
3. Explore recent trends in sensor technology and selection criteria.
4. Discuss signal conditioning, data acquisition systems, and data conversion.
5. Explain data transmission, telemetry, and measurement of non-electrical quantities

Module-1 **08 Hrs**
Sensors and Transducers: Introduction, Classification of Transducers**,** Advantages and Disadvantages of Electrical Transducers, Transducers Actuating Mechanisms, Resistance Transducers, Variable Inductance Transducers, Capacitive Transducers, Piezoelectric Transducers, Hall Effect Transducers, Thermoelectric Transducers, Photoelectric Transducers.
Module-2 **08 Hrs**
Sensors and Transducers (continued): Stain Gages, Load Cells, Proximity Sensors, Pneumatic Sensors, Light Sensors, Tactile Sensors, Fiber Optic Transducers, Digital Transducers, Recent Trends – Smart Pressure Transmitters, Selection of Sensors, Rotary – Variable Differential Transformer, Synchros and Resolvers, Induction Potentiometers, Micro Electromechanical Systems.
Module-3 **08 Hrs**
Signal Condition: Introduction, Functions of Signal Conditioning Equipment, Amplification, Types of Amplifiers, Mechanical Amplifiers Fluid Amplifiers, Optical Amplifiers, Electrical and electronic Amplifiers. **Data Acquisition Systems and Conversion:** Introduction, Objectives and Configuration of Data Acquisition System, Data Acquisition Systems, Data Conversion.

Module-4	**08 Hrs**
Data Transmission and Telemetry: Data/Signal Transmission, Telemetry. **Measurement of Non – Electrical Quantities:** Pressure Measurement.	
Module-5	**08 Hrs**
Measurement of Non – Electrical Quantities (continued): Temperature Measurement, Flow Measurement – Introduction, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Metes, Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity.	

Course outcomes:

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

CO1: Discuss the need, classification, advantages, and disadvantages of transducers.
CO2: Explain the working principles of various transducers and sensors.
CO3: Analyze recent trends in sensor technology and criteria for sensor selection.
CO4: Discuss signal conditioning, data acquisition systems, and data conversion techniques.
CO5: Demonstrate knowledge of data transmission, telemetry, and measurement of non-electrical quantities.

Textbook

1	Electrical and Electronic Measurements and instrumentation	R.K Rajput	S. Chand	3rd Edition, 2013.

Reference Books

1	A Course in Electronics and Electrical Measurements and Instruments	J.B. Gupta	Katson Books	13th Edition, 2008
2	A Course in Electrical and Electronic Measurements and Instrumentation	A. K. Sawheny	DhanpatRai	2015

ARTIFICIAL NEURAL NETWORK FOR POWER SYSTEMS			
Course Code	23EEE653	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	03
Credits	03	Exam Hours	50

Course Learning Objectives:

- To understand the fundamental concepts and models of Artificial Neural Systems.
- To understand neural processing, learning and adaptation, Neural Network learning rules.
- Ability to analyze multilayer feed forward networks.
- Ability to develop various ancillary techniques applied to power system and control of power systems.

Module-1	**08 Hrs**
Fundamental Concepts and Models of Artificial Neural Systems Biological Neurons and their artificial models – Biological Neuron, McCulloch-Pitts Neuron Model, Neuron modeling for Artificial neural systems. Models for Artificial Neural Networks – Feed forward Network, Feedback network.	
Module-2	**08 Hrs**
Neural Processing, Learning and Adaptation, Neural Network Learning Rules Neural Processing. Learning and Adaptation – Learning as Approximation or Equilibria Encoding, Supervised and Unsupervised Learning. Neural Network Learning Rules – Hebbian Learning Rule, Perceptron Learning Rule, Delta Learning Rule, Widrow-Hoff Learning Rule, Correlation Learning Rule, Winner-Take-All Learning Rule, Outstar Learning Rule, Summary of Learning Rules.	
Module-3	**08 Hrs**

Multilayer Feedforward Networks

Feedforward Recall and Error Back-Propagation Training – Feedforward Recall, Error Back-Propagation Training, Training Errors and Multilayer Feedforward Networks as Universal Approximators (Excluding Examples). Learning Factors – Initial Weights, Cumulative Weight Adjustment versus Incremental Updating, Steepness of the Activation Function, Learning Constant, Momentum Method, Network Architectures Versus Data Representation, Necessary Number of Hidden Neurons.

Module-4 **08 Hrs**

Neural Network and its Ancillary Techniques as Applied to Power Systems

Introduction, Learning versus Memorization, Determining the Best Net Size, Network Saturation, Feature Extraction, Inversion of Neural Networks, Alternative Training Method: Genetic Based Neural Network, Fuzzified Neural Network.

Module-5 **08 Hrs**

Control of Power Systems

Introduction, Background, Neural Network Architectures for modeling and control, Supervised Neural Network Structures, Diagonal Recurrent Neural Network based Control System, Convergence and Stability.

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

- Develop Neural Network and apply elementary information processing tasks that neural network can solve.
- Develop Neural Network and apply powerful, useful learning techniques.
- Develop and Analyze multilayer feed forward network for mapping provided through the first network layer and error back propagation algorithm.
- Analyze and apply algorithmic type problems to tackle problems for which algorithms are not available.
- Develop and Analyze supervised/unsupervised, learning modes of Neural Network for different applications.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Introduction to Artificial Neural Systems.	Jacek M. Zurada	JAICO Publishing House	2006
2	Artificial Neural Networks with Applications to Power Systems	Edited by – Mohamed El – Sharkawi and Dagmar Niebur	IEEE, Inc.	1996

COMPUTER AIDED ELECTRICAL DRAWING			
Subject Code	23EEE661	CIE Marks	50
Teaching Hours/Week (L:T:P)	0:0:2	SEE Hours	02
Credits	01	Exam Marks	50

Course objectives:

- To discuss the terminology of DC and AC armature windings.
- To discuss design and procedure to draw armature winding diagrams for DC and AC machines.
- To discuss the substation equipment, their location in a substation and development of a layout for substation.
- To discuss different sectional views of transformers, DC machine, its parts and alternator and its parts.
- To explain development of sectional views of Transformers, DC machine and alternators using the design data, sketches.

Suitable CAD software can be used for drawings

Sl no	List of experiments
1	Experiment on Drawing Simplex Double Layer Lap Winding for a D.C. Armature
2	Experiment on Drawing Simplex Double Layer Wave Winding for a D.C. Armature

3	Experiment on Drawing Integral Slot 3-Phase Lap Winding for an A.C. Machine
4	Experiment on Drawing Fractional Slot 3-Phase Wave Winding for an A.C. Machine
5	Experiment on Drawing Mush Winding for Single Layer Stator
6	Experiment on Preparing a Single Line Diagram of a Thermal Generating Station
7	Experiment on Drawing SLD for Double Bus Double Breaker Substation
8	Experiment on Drawing Ring Main Distribution System
9	Experiment on Sectional Assembly Drawing of a Core-Type Single-Phase Transformer
10	Experiment on Sectional Assembly Drawing of a Shell Type Single-Phase Transformer
11	Experiment on Sectional Drawing of D.C. Machine: Armature with Commutator
12	Experiment on Sectional Drawing of A.C. Machine: Stator and Rotor

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

CO1: Illustrate different winding diagrams for D.C. and A.C. machines.
CO2: Prepare single line diagrams of power generation and distribution systems.
CO3: Draw sectional assembly views of core and shell type transformers.
CO4: Interpret and construct sectional views of D.C. and A.C. machines.
CO5: Analyse substation and distribution layouts through technical drawings.

Text Books

1	A course in Electrical Machine design	A. K. Sawhney	Dhanpat Rai	6th Edition, 2013
2	Electrical Engineering Drawing	K. L. Narang	Satya Prakashan	2014

ELECTRIC VEHICLES			
Subject Code	23EEE662	CIE Marks	50
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Credits	01	Exam Marks	50

Course objectives:

(1) To Understand the fundamental laws and vehicle mechanics.
(2) To Understand working of Electric Vehicles and recent trends.
(3) Ability to analyze different power converter topology used for electric vehicle application.
(4) Ability to develop the electric propulsion unit and its control for application of electric vehicles.

Module-1 **03 Hrs**

Vehicle Mechanics: Roadway Fundamentals, Laws of Motion, Vehicle Kinetics, Dynamics of Vehicle Motion, Propulsion Power, Force-Velocity Characteristics, Maximum Gradability, Velocity and Acceleration, Constant FTR, Level Road, Velocity Profile, Distance Traversed, Tractive Power, Energy Required, Non- constant FTR, General Acceleration, Propulsion System Design.

Module-2 **03 Hrs**

Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.

Module-3 **03 Hrs**

Energy storage f o r EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.
Module-4 **03 Hrs**
Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.
Module-5 **03 Hrs**
Design of Electric and Hybrid Electric Vehicles: Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine /generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.
Course outcome (Course Skill Set) At the end of the course the student will be able to: (1) Explain the roadway fundamentals, laws of motion, vehicle mechanics and propulsion system design. (2) Explain the working of electric vehicles and hybrid electric vehicles in recent trends. (3) Model batteries, Fuel cells, PEMFC and super capacitors. (4) Analyze DC and AC drive topologies used for electric vehicle application. (5) Develop the electric propulsion unit and its control for application of electric vehicles.

Suggested Learning Resources:

Textbooks

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, CRC Press, 2003.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, M. Ehsani, Y. Gao, S.Gay and Ali Emadi, CRC Press, 2005.

Reference Books

1. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Sheldon S. Williamson, Springer, 2013.
2. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, Oxford University, 2001.
3. Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Chris Mi, M. Abul Masrur, David Wenzhong Gao, Wiley Publication, 2011.

TECHNOLOGIES OF RENEWABLE ENERGY SOURCES			
Subject Code	23EEE663	CIE Marks	50
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	02
Credits	01	Exam Marks	50

Course objectives:

(1) To discuss the causes of energy scarcity, explore renewable energy resources, and assess their availability.
(2) To explain the Earth–Sun relationship, solar angles, and the fundamentals of solar radiation reaching Earth.
(3) To describe solar thermal energy systems, types of solar collectors, and the components and operation of solar photovoltaic systems.
(4) To discuss the production, storage, benefits, and limitations of hydrogen energy, along with other renewable sources like wind, biomass, geothermal, tidal, and wave energy.
(5) To explore the principles and applications of energy conversion systems including wind turbines, biomass gasifiers, geothermal systems, and wave energy devices.

Module-1 **03 Hrs**

Introduction: Causes of Energy Scarcity, Solution to Energy Scarcity, Factors Affecting Energy Resource Development, Energy Resources and Classification, Renewable Energy – Worldwide Renewable Energy Availability, Renewable Energy in India.

Energy from Sun: Sun- earth Geometric Relationship, Layer of the Sun, Earth – Sun Angles and their Relationships, Solar Energy Reaching the Earth's Surface, Solar Thermal Energy Applications.

Module-2 **03 Hrs**

Solar Thermal Energy Collectors: Types of Solar Collectors, Configurations of Certain Practical Solar Thermal Collectors, Material Aspects of Solar Collectors, Concentrating Collectors, Parabolic Dish – Stirling Engine System, Working of Stirling or Brayton Heat Engine, Solar Collector Systems into Building Services, Solar Water Heating Systems, Passive Solar Water Heating Systems, Applications of Solar Water Heating Systems, Active Solar Space Cooling, Solar Air Heating, Solar Dryers, Crop Drying, Space Cooing, Solar Cookers, Solar pond.

Solar Cells: Components of Solar Cell System, Elements of Silicon Solar Cell, Solar Cell materials, Practical Solar Cells, I – V Characteristics of Solar Cells, Efficiency of Solar Cells, Photovoltaic panels (series and parallel arrays).

Module-3 **03 Hrs**

Hydrogen Energy: Benefits of Hydrogen Energy, Hydrogen Production Technologies, Hydrogen Energy Storage, Use of Hydrogen Energy, Advantages and Disadvantages of Hydrogen Energy, Problems Associated with Hydrogen Energy.

Wind Energy: Windmills, Wind Turbines, Wind Resources, Wind Turbine Site Selection.

Geothermal Energy: Geothermal Systems, Classifications, Geothermal Resource Utilization, Resource Exploration, Geothermal Based Electric Power Generation, Associated Problems, environmental Effects.

Solid waste and Agricultural Refuse: Waste is Wealth, Key Issues, Waste Recovery Management Scheme, Advantages and Disadvantages of Waste Recycling, Sources and Types of Waste, Recycling of Plastics.

Module-4 **03 Hrs**

Biomass Energy: Biomass Production, Energy Plantation, Biomass Gasification, Theory of Gasification, Gasifier and Their Classifications, Chemistry of Reaction Process in Gasification, Updraft, Downdraft and Cross-draft Gasifiers, Fluidized Bed Gasification, Use of Biomass Gasifier, Gasifier Biomass Feed Characteristics, Applications of Biomass Gasifier, Cooling and Cleaning of Gasifiers.

Biogas Energy: Introduction, Biogas and its Composition, Anaerobic Digestion, Biogas Production, Benefits of Biogas, Factors Affecting the Selection of a Particular Model of a Biogas Plant, Biogas Plant Feeds and their Characteristics.

Tidal Energy: Introduction, Tidal Energy Resource, Tidal Energy Availability, Tidal Power Generation in India, Leading Country in Tidal Power Plant Installation, Energy Availability in Tides, Tidal Power Basin, Turbines for Tidal Power, Advantages and Disadvantages of Tidal Power, Problems Faced in Exploiting Tidal Energy.

Module-5 **03 Hrs**

Sea Wave Energy: Introduction, Motion in the sea Waves, Power Associated with Sea Waves, Wave Energy Availability, Devices for Harnessing Wave Energy, Advantages and Disadvantages of Wave Power.

Ocean Thermal Energy: Introduction, Principles of Ocean Thermal Energy Conversion (OTEC), Ocean Thermal Energy Conversion plants, Basic Rankine Cycle and its Working, Closed Cycle, Open Cycle and Hybrid Cycle, Carnot Cycle, Application of OTEC in Addition to Produce Electricity, Advantages,
Disadvantages and Benefits of OTEC.

Course outcomes

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

1. Discuss causes of energy scarcity and its solution, energy resources and availability of renewable energy. Outline energy from sun, energy reaching the Earth's surface and solar thermal energy applications.
2. Discuss types of solar collectors, their configurations, solar cell system, its characteristics and their applications.
3. Explain generation of energy from hydrogen, wind, geothermal system, solid waste and agriculture refuse.
4. Discuss production of energy from biomass, biogas.
5. Summarize tidal energy resources, sea wave energy and ocean thermal energy.

Books

Textbook

1. Nonconventional Energy Resources, Shobh Nath Singh, Pearson, 1st Edition, 2015.

Reference Books

1. Nonconventional Energy Resources, B.H. Khan, McGraw Hill, 3rd Edition.
2. Renewable Energy; Power for a sustainable Future, Godfrey Boyle, Oxford, 3rd Edition, 2012.
3. Renewable Energy Sources: Their Impact on global Warming and Pollution, Tasneem Abbasi S.A. Abbasi, PHI,1st Edition, 2011.

INDIAN KNOWLEDGE SYSTEMS			
Subject Code	23IKS680	CIE Marks	100
Teaching Hours/Week (L:T:P)	1:0:0	SEE Hours	00
Credits	00	Exam Marks	00

Course Learning Objectives: The students will be able to

1	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2	To make the students understand the traditional knowledge and analyse it and apply it To their day-to-day life.

Unit-I	**05Hrs**
Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-à-vis indigenous knowledge, Traditional knowledge vs. western knowledge.	
Unit-II	**05Hrs**
Traditional Knowledge in Humanities and Sciences: Lingistics, Number and measurements-Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.	
Unit-III	**05Hrs**
Traditional Knowledge in Professional domain: Town planning and architecture Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Provide an overview of the concept of the Indian Knowledge System and its importance.
CO2:	Appreciate the need and importance of protecting traditional knowledge.
CO3:	Recognize the relevance of Traditional knowledge in different domains.
CO4:	Establish the significance of Indian Knowledge systems in the contemporary world.
Reference Books	
1	**Introduction to Indian Knowledge System-concepts and applications**, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
2	**Traditional Knowledge System in India**, Amit Jha, 2009, Atlantic Publishers and Distributors (P)Ltd., ISBN-13:978-8126912230,
	Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh,Vol.1, 2005, DK Print World (P) Ltd., ISBN81-246-0334,
Suggested Web Links:	
1	**https://www.youtube.com/watch?v=LZP1StpYEPM**

2.	**http://nptel.ac.in/courses/121106003/**
3.	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63(Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
4.	https://www.wipo.int/pressroom/en/briefs/tk_ip.html
5.	https://unctad.org/system/files/official-document/ditcted10_en.pdf
6.	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
7.	https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

Scheme of Teaching and Evaluation for B. Tech., VII Semester Electrical and Electronics Engg. (2023 scheme)

POWER SYSTEM– 2			
Subject Code	23EEE710	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course objectives:

- To explain formulation of network models and bus admittance matrix for solving load flow problems.
- To discuss solution of nonlinear static load flow equations by different numerical techniques and methods to control voltage profile.
- To discuss optimal operation of generators on a bus bar, optimal unit commitment, reliability considerations and optimum generation scheduling.
- To explain formulation of bus impedance matrix for the use in short circuit studies on power systems.

Module-1 **08 Hrs**

Load Flow Studies: Introduction, Network Model Formulation, Formation of Y_{bus} by Singular Transformation, Load Flow Problem, Gauss-Seidel Method.

Module-2 **08 Hrs**

Load Flow Studies (continued): Newton-Raphson Method, Decoupled Load Flow Methods, Comparison of Load Flow Methods, Control of Voltage Profile.

Module-3 **08 Hrs**

Optimal System Operation: Introduction, Optimal Operation of Generators on a Bus Bar, Optimal Unit Commitment, Reliability Considerations, Optimum Generation Scheduling.

Module-4 **08 Hrs**

Optimal System Operation (continued): Optimal Load Flow Solution, Optimal Scheduling of Hydrothermal System, Power System Security, Maintenance Scheduling, Power System Reliability.

Module-5 **08 Hrs**

Symmetrical Fault Analysis: Algorithm for Short Circuit Studies, Z_{bus} Formulation.

Power System Stability: Numerical Solution of Swing Equation, Multimachine Stability.

PRACTICAL COMPONENT OF IPCC

Sl no	List of Experiments
1	Per Unit (PU) Conversion and Impedance Diagram of a Power System
2	Steady-State Modeling of Synchronous Machine and Transformer
3	Transients in a Transmission Line under Fault Conditions
4	Short Circuit Analysis of Synchronous Machine (No-load and Loaded)
5	Symmetrical Component Transformation Using MATLAB
6	Sequence Network Construction for Synchronous Machine and Transformer
7	Single Line-to-Ground (LG) Fault Analysis Using Sequence Networks
8	Line-to-Line (LL) and Double Line-to-Ground (LLG) Fault Analysis
9	Transient Stability Analysis Using Swing Equation (Point-by-Point Method)
10	Stability Analysis Using Equal Area Criterion

Course outcomes:

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

CO1: Formulate network matrices and apply models to solve load flow problems.

CO2: Perform steady-state power flow analysis using numerical iterative techniques.

CO3: Analyze optimal operation of generators, unit commitment, and hydro-thermal scheduling.

CO4: Evaluate short circuit faults using the bus impedance matrix.

CO5: Perform numerical solutions of the swing equation for multi-machine stability analysis.

Textbook				
1	Modern Power System Analysis	D. P. Kothari	McGraw Hill	4th Edition, 2011
Reference Books				
1	Computer Methods in Power Systems Analysis	Glenn W Stagg Ahmed H Ei - Abiad	McGraw Hill	1stEdition, 1968
2	Computer Techniques in Power System Analysis	M.A. Pai	McGraw Hill	2ndEdition, 2006
3	Power System Analysis	HadiSaadat	McGraw Hill	2ndEdition, 2002

SWITCHGEAR PROTECTION AND HIGH VOLTAGE ENGINEERING			
Subject Code	23EEE720	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	03
Credits	04	Exam Marks	50

Course Learning Objectives:

- To discuss conduction and breakdown in gases, liquid dielectrics.
- To discuss breakdown in solid dielectrics.
- To discuss generation of high voltages and currents and their measurement.
- To discuss overvoltage phenomenon and insulation coordination in electric power systems.

Module-1 **08 Hrs**

Introduction to Power System Protection: Need for protective schemes, Nature and Cause of Faults, Types of Fault, Effects of Faults, Fault Statistics, Zones of Protection, Primary and Backup Protection, Essential Qualities of Protection, Performance of Protective Relaying, Classification of Protective Relays, Automatic Reclosing, Current Transformers for protection, Voltage Transformers for Protection.

Relay Construction and Operating Principles: Introduction, Electromechanical Relays, Static Relays – Merits and Demerits of Static Relays, Numerical Relays, Comparison between Electromechanical Relays and Numerical Relays.

Module-2 **08 Hrs**

Overcurrent Protection Introduction, Time – current Characteristics, Current Setting, Time Setting. Overcurrent Protective Schemes, Reverse Power or Directional Relay, Protection of Parallel Feeders, Protection of Ring Mains, Earth Fault and Phase Fault Protection, Combined Earth Fault and Phase Fault Protective Scheme, Phase Fault Protective Scheme, Directional Earth Fault Relay, Static Overcurrent Relays, Numerical Overcurrent Relays.

Microprocessor -based Protective Relays: Introduction, Overcurrent relays, Impedance relay.

Module-3 **08 Hrs**

Conduction and Breakdown in Gases: Gases as Insulating Media, Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges. **Conduction and Breakdown in Liquid Dielectrics:** Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids. **Breakdown in Solid Dielectrics:** Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.

Module-4 **08 Hrs**

Generation of High Voltages and Currents: Generation of High Direct Current Voltages, Generation of High Alternating Voltages, Generation of Impulse Voltages, Generation of Impulse Currents, Tripping and Control of Impulse Generators.

Module-5 **08 Hrs**

Measurement of High Voltages and Currents: Measurement of High Direct Current Voltages, Measurement of High AC and Impulse Voltages, Measurement of High Currents – Direct, Alternating and Impulse, Cathode Ray Oscillographs for Impulse Voltage and Current Measurements.

IPCC component

Sl no	List of experiments
1	Over Current Relay: (a) Inverse Definite Minimum Time (IDMT) Non - Directional Characteristics (b) Directional Features (c) IDMT Directional.
2	IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).
3	Operation of Negative Sequence Relay.
4	Operating Characteristics of Microprocessor Based (Numeric) Over –Current Relay.
5	Operating Characteristics of Microprocessor Based (Numeric) Distance Relay.
6	Operating Characteristics of Microprocessor Based (Numeric) Over/Under Voltage Relay.
7	Motor Protection against Faults.
8	Spark Over Characteristics of Air subjected to High Voltage AC with Spark Voltage Corrected to Standard Temperature and Pressure for Uniform [as per IS1876: 2005]and Non-uniform [as per IS2071(Part 1) : 1993] Configurations: Sphere – Sphere, Point –Plane, Point – Point and Plane – Plane.
9	Spark Over Characteristics of Air subjected to High voltage DC.
10	Measurement of HVAC and HVDC using Standard Spheres as per IS 1876 :2005
11	Measurement of Breakdown Strength of Transformer Oil as per IS 1876 :2005

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

CO1: Explain the need, types, and characteristics of protective relays and schemes used in power systems.
CO2: Analyze overcurrent and directional protection schemes, including microprocessor-based relays.
CO3: Describe conduction and breakdown mechanisms in gases, liquids, and solid dielectrics.
CO4: Explain various methods for generating high voltages and impulse currents.
CO5: Illustrate techniques for measuring high voltages and currents using appropriate instruments.

Text Book

1	High Voltage Engineering	M.S. Naidu, V.Kamaraju	McGraw Hill	5th Edition, 2013.

Reference Books

1	High Voltage Engineering Fundamentals	E. Kuffel, W.S. Zaengl, J. Kuffel	Newnes	2nd Edition, 2000
2	High Voltage Engineering	Wadhwa C.L.	New Age International	3rd Edition, 2012
3	High-Voltage Test and Measuring Techniques	Wolfgang Hauschild Eberhard Lemke	Springer	1st Edition2014
4	High Voltage Engineering	Farouk A.M. Rizk	CRC Press	1st Edition2014
5	Fundamental of High Voltage Engineering	Ravindra Arora, Bharat Singh Rajpurohit	Wiley	2019

INDUSTRIAL DRIVES AND APPLICATIONS			
Subject Code	23EEE730	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:2	SEE Hours	02
Credits	04	Exam Marks	50
Course objectives:			

1. To define electric drive, its parts, advantages, and explain the choice of electric drive.
2. To explain the dynamics and modes of operation of electric drives.
3. To explain the selection of motor power ratings and control of DC motors using rectifiers.
4. To analyze the performance of induction motor drives under different conditions.
5. To explain the control of induction motor, synchronous motor, and stepper motor drives.
6. To discuss typical applications of electrical drives in the industry.

Module-1 **08 Hrs**

Electrical Drives: Electrical Drives, Advantages of Electrical Drives. Parts of Electrical Drives, Choice of Electrical Drives, Status of dc and ac Drives.

Dynamics of Electrical Drives: Fundamental Torque Equations, Speed Torque Conventions and Multi quadrant Operation. Equivalent Values of Drive Parameters, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization.

Control Electrical Drives: Modes of Operation, Speed Control and Drive Classifications, Closed loop Control of Drives.

Module-2 **08 Hrs**

Selection of Motor Power Ratings: Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

Direct Current Motor Drives: Controlled Rectifier Fed dc Drives, Single Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Single Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Fully Controlled Rectifier Control of dc Separately Excited Motor, Three Phase Half Controlled Rectifier Control of dc Separately Excited Motor, Multi quadrant Operation of dc Separately Excited Motor Fed Form Fully Controlled Rectifier, Rectifier Control of dc Series Motor, Supply Harmonics, Power Factor and Ripple in Motor Current, Chopper Control of Separately Excited dc Motor, Chopper Control of Series Motor.

Module-3 **08 Hrs**

Induction Motor Drives: Analysis and Performance of Three Phase Induction Motors, Operation with Unbalanced Source Voltage and Single Phasing, Operation with Unbalanced Rotor Impedances, Analysis of Induction Motor Fed from Non-Sinusoidal Voltage Supply, Starting, Braking, Transient Analysis. Speed Control Techniques-Stator Voltage Control, Variable Voltage Frequency Control from Voltage Sources.

Module-4 **08 Hrs**

Induction Motor Drives (continued): Voltage Source Inverter (VSI) Control, Cyclo converter Control, Closed Loop Speed Control and Converter Rating for VSI and Cyclo converter Induction Motor Drives, Variable Frequency Control from a Current Source, Current Source (CSI) Control, current regulated voltage source inverter control, speed control of single-phase induction motors.

Synchronous Motor Drives: Operation from fixed frequency supply-starting, synchronous motor.

Module-5 **08 Hrs**

Synchronous Motor Drives (continued): Self-controlled synchronous motor drive employing load commutated thruster inverter, Starting Large Synchronous Machines, Permanent Magnet ac (PMAC) Motor Drives, Sinusoidal PMAC Motor Drives, Brushless dc Motor Drives.

Stepper Motor Drives: Variable Reluctance, Permanent Magnet, Important Features of Stepper Motors, Torque Versus Stepping rate Characteristics, Drive Circuits for Stepper Motor.

Industrial Drives: Textile Mills, Steel Rolling Mills, Cranes and Hoists, Machine Tools.

IPCC component

Sl no	List of experiments
1	Simulation of Speed Control in a Separately Excited DC Motor Using a Fully Controlled Rectifier
2	Performance Analysis of a DC Motor Using Class-A and Class-B Chopper Configurations

3	Modeling and Simulation of Starting and Braking Techniques in DC Motor Drives
4	Speed-Torque Characteristics of a Three-Phase Induction Motor Under Stator Voltage Control
5	Implementation of Scalar Control (V/f Control) for Speed Regulation of a Three-Phase Induction Motor
6	Study of Rotor Resistance Variation in Slip Ring Induction Motor for Speed Control
7	Design and Simulation of a Closed-Loop Speed Control System for an Induction Motor Using a PI Controller
8	Simulation of Synchronous Motor Drive Fed Through a Voltage Source Inverter with Fixed Frequency Supply
9	Dynamic Simulation and Control of Brushless DC (BLDC) Motor Using Hall Sensor Feedback
10	Modeling and Torque-Speed Analysis of Stepper Motor Drives Using Variable Stepping Rates

Course outcomes:

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

CO-1. Explain the advantages and selection criteria of electric drives.
CO-2. Analyze the dynamics and different modes of operation of electric drives.
CO-3. Select and control DC motors using controlled rectifiers for drive applications.
CO-4. Analyze the performance of induction motor drives under various operating conditions.
CO-5. Control induction motor, synchronous motor, and stepper motor drives for industrial applications.

Textbook

1	Fundamentals of Electrical Drives	Gopal K. Dubey	Narosa Publishing House	2nd Edition,2001
2	Electrical Drives: Concepts and Applications (Refer to chapter 07 for Industrial Drives undermodule5.)	Vedum Subrahmanyam	McGraw Hill	2nd Edition,2011

Reference Books

1	Electric Drives	N.K De ,P.K. Sen	PHI Learning	1st Edition,2009

SOLAR AND WIND ENERGY			
Subject Code	23EEE741	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- To understand the significance of energy in human life and its relationship with the economy and environment.
- To explore renewable energy sources, energy management, audits, efficiency, intensity, and conservation efforts in India.
- To explain the principles and applications of energy storage systems and devices.
- To study the fundamentals of solar energy, including radiation characteristics, solar cells, PV system design, and applications.
- To understand wind energy systems, including conversion principles, system components, performance evaluation, and environmental impact.

Module-1 **08 Hrs**

Fundamentals of Energy Science and Technology: Introduction, Energy, Economy and Social Development, Classification of Energy Sources, Importance of Non -conventional Energy Sources, Salient features of Non-conventional Energy Sources, World Energy Status, Energy Status in India.

Energy Conservation and Efficiency: Introduction, Important Terms and Definitions, Important Aspects of Energy Conservation, Global Efforts, Achievements and Future Planning, Energy Conservation/Efficiency Scenario in India, Energy Audit, Energy Conservation Opportunities.

Energy Storage: Introduction, Necessity of Energy Storage, Specifications of Energy Storage Devices.

Solar Energy-Basic Concepts: Introduction, The Sun as Source of Energy, The Earth, Sun, Earth Radiation Spectrum, Extra-terrestrial and Terrestrial Radiations, Spectral Power Distribution of Solar Radiation, Depletion of Solar Radiation

Module-2 **08 Hrs**

Solar Energy-Basic Concepts (continued): Measurement of Solar Radiation, Solar Radiation Data, Solar Time, Solar Radiation Geometry, Solar Day Length, Extraterrestrial Radiation on Horizontal Surface, Empirical Equations for Estimating Terrestrial Solar Radiation on Horizontal Surface, Solar Radiation on Inclined Plane Surface.

Solar Thermal Systems: Introduction, Solar Collectors, Solar Water Heater, Solar Passive Space Heating and Cooling Systems, Solar Industrial Heating Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers.

Module-3 **08 Hrs**

Solar Photovoltaic Systems: Introduction, Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell Technologies, Solar Cell, Module, and Array Construction, Maximizing the Solar PV Output and Load Matching. Maximum Power Point Tracker. Balance of System Components, Solar PV Systems, Solar PV Applications.

Module-4 **08 Hrs**

Wind Energy: Introduction, Basic Principles of Wind Energy Conversion, History of Wind Energy, Wind Energy Scenario – World and India. The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations

Wind energy systems: Environment and Economics Environmental benefits and problems of wind energy, Economics of wind energy, Factors influence the cost of energy generation, machine parameters, Life cycle cost analysis.

Module-5 **08 Hrs**

Basic Components of a Wind Energy Conversion (WEC) System: Classification of WEC systems, Advantages and Disadvantages of WECS, Types of Wind Machines (Wind Energy Collectors), Analysis of Aerodynamic Forces Acting on the Blade, Performance of Wind- machines, Generating Systems, Energy Storage, Applications of Wind Energy, Environmental Aspects.

Course outcomes:

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

- CO1: Discuss the importance of energy, its relationship with the economy and environment, and the growing role of renewable energy.
- CO2: Explain the concept and principles of energy storage devices.
- CO3: Analyze solar radiation characteristics, measurement, and data analysis for horizontal and tilted surfaces.
- CO4: Describe the process of harnessing solar energy and its applications in heating, cooling, and PV systems.
- CO5: Explain wind energy conversion principles, site selection, performance analysis, and environmental impact.

Textbook

1	Non-Conventional Energy Resources	B. H. Khan	McGraw Hill	2nd Edition 2017
2	Non-Conventional Sources of Energy	Rai, G. D	Khanna Publishers	4th Edition, 2009

Reference Books

1	Non-Conventional Energy Resources	ShobhNath Singh	Pearson	1st Edition, 2015

2	Solar Energy – Principles of Thermal Collections and Storage	S.P. Sukhatme J.K.Nayak	McGraw Hill	3rd Edition, 2008
3	Wind Turbine Technology	Ahmad Hemami	Cengage	1st Edition, 2012

SMART GRID			
Subject Code	23EEE742	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- To define the smart grid and highlight the progress made by various stakeholders in its design and development.
- To explain measurement and analysis techniques using PMUs, smart meters, and performance tools like state estimation and stability analysis.
- To explore classical optimization and computational methods for smart grid design, planning, and operation.
- To discuss the development of predictive control technologies and environmentally responsible solutions for enhanced grid performance.
- To describe strategies for promoting smart grid awareness and upgrading the existing transmission system with advanced technologies.

Module-1 **08 Hrs**

Smart Grid Architectural Designs: Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Computational Intelligence, Power System Enhancement, Communication and Standards, Environment and Economics, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components.

Smart Grid Communications and Measurement Technology: Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, GIS and Google Mapping Tools, Multiagent Systems (MAS) Technology, Microgrid and Smart Grid Comparison.

Performance Analysis Tools for Smart Grid Design: Introduction to Load Flow Studies, Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design, DSOPF Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingencies and Their Classification, Contingency Studies for the Smart Grid.

Module-2 **08 Hrs**

Stability Analysis Tools for Smart Grid: Introduction to Stability, Strengths and Weaknesses of Existing Voltage Stability Analysis Tools, Voltage Stability Assessment, Voltage Stability Assessment Techniques, Voltage Stability Indexing, Analysis Techniques for Steady-State Voltage Stability Studies, Application and Implementation Plan of Voltage Stability, Optimizing Stability Constraint through Preventive Control of Voltage Stability, Angle Stability Assessment, State Estimation.

Module-3 **08 Hrs**

Computational Tools for Smart Grid Design: Introduction to Computational Tools, Decision Support Tools, Optimization Techniques, Classical Optimization Method, Heuristic Optimization, Evolutionary Computational Techniques, Adaptive Dynamic Programming Techniques, Pareto Methods, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges.

Pathway for Designing Smart Grid: Introduction to Smart Grid Pathway Design, Barriers and Solutions to Smart Grid Development, Solution Pathways for Designing Smart Grid Using Advanced Optimization and Control Techniques for Selection Functions, General Level Automation, Bulk Power Systems Automation of the Smart Grid at Transmission Level, Distribution System Automation Requirement of the Power Grid, End User/Appliance Level of the Smart Grid, Applications for Adaptive Control and Optimization.

Module-4	**08 Hrs**
Renewable Energy and Storage: Renewable Energy Resources, Sustainable Energy Options for the Smart Grid, Penetration and Variability Issues Associated with Sustainable Energy Technology, Demand Response Issues, Electric Vehicles and Plug-in Hybrids, PHEV Technology, Environmental Implications, Storage Technologies, Tax Credits. **Interoperability, Standards, and Cyber Security:** Introduction, Interoperability, Standards, Smart Grid Cyber Security, Cyber Security and Possible Operation for Improving Methodology for Other Users.	
Module-5	**08 Hrs**
Research, Education, and Training for the Smart Grid: Introduction, Research Areas for Smart Grid Development, Research Activities in the Smart Grid, Multidisciplinary Research Activities, Smart Grid Education, Training and Professional Development. **Case Studies and Test beds for the Smart Grid:** Introduction, Demonstration Projects, Advanced Metering, Microgrid with Renewable Energy, Power System Unit Commitment (UC) Problem, ADP for Optimal Network Reconfiguration in Distribution Automation, Case Study of RER Integration, Test beds and Benchmark Systems, Challenges of Smart Transmission, Benefits of Smart Transmission.	

Course outcomes:

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

CO1: Discuss the progress made by various stakeholders in the design and development of smart grids.
CO2: Explain measurement techniques using Phasor Measurement Units (PMUs) and smart meters.
CO3: Analyze tools and techniques for smart grid design, operation, and performance.
CO4: Apply classical optimization techniques and computational methods for smart grid planning and operation.
CO5: Explain predictive grid management, control technologies, and methods to enhance smart grid performance.

Textbook

1	Smart Grid, Fundamentals of Design and Analysis	James Momoh	Wiley	1st Edition, 2012

FACTS AND HVDC TRANSMISSION			
Subject Code	23EEE743	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- To discuss transmission interconnections, flow of Power in an AC System, limits of the loading capability, dynamic stability considerations of a transmission interconnection and controllable parameters.
- To explain the basic concepts, definitions of flexible ac transmission systems and benefits from FACTS technology.
- To describe shunt controllers, Static Var Compensator and Static Compensator for injecting reactive power in the transmission system in enhancing the controllability and power transfer capability.
- To explain advantages of HVDC power transmission, overview and organization of HVDC system.
- To describe the basic components of a converter, the methods for compensating the reactive power demanded by the converter.
- Explain converter control for HVDC systems, commutation failure, control functions.

Module-1	**08 Hrs**
FACTS Concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What Limits 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, Checklist of Possible Benefits from FACTS Technology, In Perspective: HVDC or FACTS.	

Module-2	**08 Hrs**
Static Shunt Compensators: Objectives of Shunt Compensation - Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability. Methods of Controllable Var Generation –Thyristor controlled Reactor (TCR) and Thyristor Switched Reactor (TSR), Thyristor Switched Capacitor (TSC). Operation of Single Phase TSC – TSR. Switching Converter Type Var Generators, Basic Operating Principles, Basic Control Approaches. Static VAR Compensators: SVC and STATCOM, the Regulation Slope. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time.	
Module-3	**08 Hrs**
Static Series Compensators: Objectives of Series Compensation, Concept of Series Capacitive Compensation, Voltage Stability, Improvement of Transient Stability. GTO Thyristor-Controlled Series Capacitor, Thyristor-Switched Series Capacitor, Thyristor-Controlled Series Capacitor, The Static synchronous Series Compensator, Transmitted Power Versus Transmission Angle Characteristic.	
Module-4	**08 Hrs**
Development of HVDC Technology: Introduction, Advantages of HVDC Systems, HVDC System Costs, Overview and Organization of HVDC Systems, HVDC Characteristics and Economic Aspects. **Power Conversion:** 3-Phase Converter, 3-Phase Full Bridge Converter, 12-Pulse Converter.	
Module-5	**08 Hrs**
Control of HVDC Converter and System: Converter Control for an HVDC System, Commutation Failure, HVDC Control and Design, HVDC Control Functions, Reactive Power and Voltage Stability.	

Course outcomes:

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

CO1: Discuss transmission interconnections, power flow, loading limits, dynamic stability, and controllable parameters.

CO2: Explain the concepts, definitions, and benefits of Flexible AC Transmission Systems (FACTS).

CO3: Describe shunt controllers such as SVC and STATCOM for reactive power injection and enhanced power transfer.

CO4: Explain series controllers like TCSC and SSSC for transmission line current control.

CO5: Discuss HVDC transmission systems, converter components, reactive power compensation, and control techniques.

Textbooks

1	Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems	Narain G Hingorani, Laszlo Gyugyi	Wiley	1st Edition, 2000
2	HVDC Transmission: Power Conversion Applications in Power Systems	Chan-Ki Kim et al	Wiley	1st Edition, 2009

Reference Books

1	Thyristor Based FACTS Controllers for Electrical Transmission Systems	R. Mohan Mathur, Rajiv K. Varma	Wiley	1st Edition, 2002

Scheme of Teaching and Evaluation for B. Tech., VIII Semester Electrical and Electronics Engg. (2023 scheme)

POWER SYSTEM OPERATION AND CONTROL			
Subject Code	23EEE810	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- To describe various levels of controls in power systems and the vulnerability of the system.
- To explain components, architecture and configuration of SCADA.
- To define unit commitment and explain various constraints in unit commitment and the solution methods
- To explain issues of hydrothermal scheduling and solutions to hydro thermal problems
- To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control
- To explain automatic generation control, voltage and reactive power control in an interconnected power system.
- To explain reliability and contingency analysis, state estimation and related issues.

Module-1 **08 Hrs**

Introduction: Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centres.
Supervisory Control and Data acquisition (SCADA): Introduction to SCADA and its Components, Standard SCADA Configurations,
Unit Commitment: Introduction, Simple Enumeration Constraints, Priority List Method, Dynamic Programming Method for Unit Commitment.

Module-2 **08 Hrs**

Hydro-thermal Scheduling: Introduction, Scheduling Hydro Systems, Discrete Time Interval Method, Short Term Hydro Thermal Scheduling Using $\gamma - \lambda$ Iterations, Short Term Hydro Thermal Scheduling Using Penalty Factors.
Automatic Generation Control (AGC): Introductions, Basic Generator Control Loops, Commonly used Terms in AGC, Functions of AGC, Speed Governors.

Module-3 **08 Hrs**

Automatic Generation Control (continued): Mathematical Model of Automatic Load Frequency Control, AGC Controller, and Proportional Integral Controller.
Automatic Generation Control in interconnected Power system: Introductions, Tie - Line Control with Primary Speed Control, Frequency Bias Tie - Line Control, State-Space Models.

Module-4 **08 Hrs**

Automatic Generation Control in interconnected Power system (continued): State-Space Model for Two - Area System, Tie-Line Oscillations, Related Issues in Implementation of AGC. **Voltage and Reactive Power Control:** Introduction, Production and Absorption of Reactive Power, Methods of Voltage Control, Dependence of Voltage on Reactive Power , Sensitivity of Voltage to Changes in P And Q, Cost Saving, Methods of Voltage Control by Reactive Power Injection, Voltage Control Using Transformers, Voltage Stability.

Module-5 **08 Hrs**

Power System Reliability and Security: Introduction, Security Levels of System, Reliability Cost, Adequacy Indices, Functions of System Security, Contingency Analysis, Linear Sensitivity Factors, Contingency Selection and Ranking.
State estimation of Power Systems: Introduction, Linear Least Square Estimation, DC State Estimator, Other Issues in State Estimation.

Course outcomes:

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

CO1: Describe control levels in power systems, SCADA components, architecture, and configuration.
CO2: Solve unit commitment and hydrothermal scheduling problems.
CO3: Explain generator control loops, automatic generation control (AGC), and speed governor functions.
CO4: Develop and analyze mathematical models of Automatic Load Frequency Control (ALFC).
CO5: Explain reliability, security, contingency analysis, and state estimation in power systems.

Textbook

1	Power System Operation and Control	K. Uma Rao	Wiley	1st Edition, 2012

Reference Books

1	Power Generation Operation and Control	Allen J Wood etal	Wiley	2nd Edition,2003
2	Power System Stability and Control	Kundur	McGraw Hill	8th Reprint, 2009

TESTING AND COMMISSIONING OF ELECTRICAL EQUIPMENT			
Subject Code	23EEE821	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course objectives:

- Describe the process to plan, control and implement commissioning of electrical equipment's.
- Differentiate the performance specifications of transformer and induction motor.
- Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears.
- Identification of tools and equipment's used for installation and maintenance of electrical equipment.
- Explain the operation of an electrical equipment's such as isolators, circuit breakers, insulators and switchgears.

Module-1 **08 Hrs**

Electrical Tools, accessories: Tools, Accessories and Instruments required for Installation, Maintenance and Repair Work, India Electricity Rules, Safely Codes Causes and Prevention of Accidents, Artificial Respiration, Workmen's Safety Devices.

Transformers: Installation, Location Site Selection, Foundation Details, Code of Practice for Terminal Plates, Polarity and Phase Sequence, Oil Tanks, Drying of Winding sand General Inspection. Commissioning Tests As Per National and International Standards - Volts Ratio Earth Resistance, Oil Strength, Insulation Tests, Impulse Tests Polarizing Index, Load Temperature Rise Tests. Specific Tests for Determination of Performance Curves like Efficiencies, Regulation Etc., Determination Mechanical Stress Under Normal and Abnormal Conditions.

Module-2 **08 Hrs**

Synchronous Machines: Specifications as per BIS Standards. Installation - Physical Inspection, Foundation Details, Alignments, Excitation Systems, Cooling and Control Gear, Drying Out.

Commissioning Tests - Insulation, Resistance Measurement of Armature and Field Windings, Wave Form and Telephone Interference Tests, Line Charging Capacitance. Performance Tests -Various Tests to Estimate the Performance of Generator Operations, Slip Test, Maximum Lagging Current, Maximum Reluctance Power Tests, Sudden Short Circuit Tests, Transient Sub Transient Parameters, Measurement of Sequence Impedances, Capacitive Reactance, and Separation Of Losses, Temperature Rise Test, and Retardation Tests. Factory Tests -Gap Length, Magnetic Eccentricity, Balancing Vibrations, Bearing Performance.

Module-3 **08 Hrs**

Induction Motor: Specifications. Installation- Location of Motors and its Control Apparatus, Shaft Alignment for Various Coupling, Fitting of Pulleys and Coupling, Drying of Windings. Commissioning Tests -Mechanical Tests For Alignment, Air Gap Symmetry, Tests for Bearings, Vibrations and Balancing. Specific Tests - Performance and Temperature Raise Tests, Stray Load Losses, Shaft Alignment, Re-Writing and Special Duty Capability, Site Test
Module-4 **08 Hrs**
Laying of Underground Cables: Inspection, Storage, Transportation and Handling of Cables, Cable Handing Equipment, Cable Laying Depths and Clearances from other Services such as Water Sewerage, Gas, Heating and other Mains, Series of Power and Telecommunication Cables and Coordination with these Services, Excavation of Trenches, Cable Jointing and Terminations Testing and Commissioning. Location of Faults using Megger, Effect of Open or Loose Neutral Connections, Provision of Proper Fuses on Service Lines and Their Effect on System, Causes and Dim, and Flickering Lights.
Module-5 **08 Hrs**
Switchgear and Protective **Devices:** Standards, Types, Specification, Installation, Commissioning Tests, Maintenance Schedule, Type and Routine Tests. **Domestic Installation:** Introduction, Testing of Electrical Installation of a Building, Testing of Insulation Resistance to Earth, Testing of Insulation and Resistance between Conductors Continuity or Open Circuit Test, Short Circuit Test, Testing of Earthing Continuity, Location of Faults, IE Rules for Domestic Installation.
Course outcomes: At the end of the course the student will be able to: • Describe the process to plan, control and implement commissioning of electrical equipment's. • Differentiate the performance specifications of transformer and induction motor. • Demonstrate the routine tests for synchronous machine, induction motor, transformer & switchgears. • Describe corrective and preventive maintenance of electrical equipment's. • Explain the operation of an electrical equipment's such as isolators, circuit breakers, induction motor and synchronous machines.
Text/ Reference Books

1	Testing, Commissioning, Operation and Maintenance of Electrical Equipment	S. Rao	Khanna Publishers	6th Edition, 19th Reprint, 2015
2	Testing and Commissioning of Electrical Equipment	R.L.Chakrasali	Prism Books Pvt Ltd	1st Edition,2014
3	Preventive Maintenance of Electrical Apparatus	S.K.Sharotri	Katson Publishing House	1st Edition, 1980
4	Handbook of Switchgears	BHEL	McGraw Hill	1st Edition, 2005
5	Transformers	BHEL	McGraw Hill	1st Edition, 2003
6	The J&P Transformer Book	Martin J. Heathcote	Newnes	12th Edition, 1998

ELECTRIC VEHICLE TECHNOLOGIES			
Course Code	23EEE822	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Marks	03
Credits	03	Exam Hours	50

Course Learning Objectives:

- To understand working of Electric Vehicles and recent trends.
- Ability to analyze different power converter topology used for electric vehicle application.
- Ability to develop the electric propulsion unit and its control for application of electric vehicles.
- Ability to design converters for battery charging and explain transformer less topology.

Module-1 **08 Hrs**

Electric and Hybrid Electric Vehicles: Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.
Module-2 **08 Hrs**
Energy storage for EV and HEV: Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Supercapacitors.
Module-3 **08 Hrs**
Electric Propulsion: EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives.
Module-4 **08 Hrs**
Design of Electric and Hybrid Electric Vehicles: Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design.
Module-5 **08 Hrs**
Power Electronic Converter for Battery Charging: Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z- converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology.
Course Outcomes: At the end of the course the student will be able to: CO1: Explain the working principles and recent trends in electric vehicles. CO2: Analyze various power converter topologies used in electric vehicle applications. CO3: Develop electric propulsion units and control strategies for electric vehicles. CO4: Design converters for battery charging in electric vehicles. CO5: Explain transformer-less topologies used in electric vehicle systems.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals,	M. Ehsani, Y. Gao, S. Gay and Ali Emadi	CRC Press	2005
2	Electric and Hybrid Vehicles: Design Fundamentals	Iqbal Husain	CRC Press	2003
Reference Books				
1	Energy Management Strategies for Electric and Plug-in Hybrid Electric	Sheldon S. Williamson	Springer	2013
2	Modern Electric Vehicle Technology	C.C. Chan and K.T. Chau	Oxford University	2001
3	Hybrid Electric Vehicles Principles And Applications With Practical Perspectives	Chris Mi, M. Abul Masrur, David Wenzhong Gao	Wiley Publication	2011

ELECTRICAL POWER QUALITY			
Subject Code	23EEE823	CIE Marks	50
Teaching Hours/Week (L:T:P)	3:0:0	SEE Hours	03
Credits	03	Exam Marks	50

Course Learning Objectives:

- Review definitions and standards of common power quality phenomena.
- Understand power quality monitoring and classification techniques.
- Investigate different power quality phenomena causes and effects.
- Understand different techniques for power quality problems mitigation.
- Understand the various power quality phenomenon, their origin and monitoring and mitigation methods.
- Understand the effects of various power quality phenomenon in various equipment.

Module-1 **08 Hrs**

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

Module-2 **08 Hrs**

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

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

Module-3 **08 Hrs**

Transient over voltages: Fundamentals of harmonics: Harmonic distortion, voltage versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from Industrial loads, effects of harmonic distortion, intra harmonics.

Module-4 **08 Hrs**

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

Power Quality Benchmark: Introduction, benchmark process, power quality contract.

Module-5 **08 Hrs**

Power quality benchmark: power quality state estimation, including power quality in distribution planning.

Distributed generation and quality: DG technologies, interface to utility system, power quality issues, interconnection standards.

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

CO-1. Define Power quality; evaluate power quality procedures and standards.
CO-2. Estimate voltage sag performance; explain principles of protection and Sources of transient over voltages.
CO-3. Identify various sources of harmonics, explain effects of harmonic distortion.
CO-4. Evaluate harmonic distortion, control harmonic distortion.
CO-5. Estimate power quality in distribution planning. Identify power quality issues in utility system.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Text book				
1	Electric Power Quality	Dugan, Roger C	McGraw-Hill	2003
Reference Books				
1	Electric Power Quality	G.T.Heydt	Stars in a circle publications	1991
2	Understanding power quality problems voltage sags and interruptions	Math H. J. Bollen.	IEEE Press	2000
3	Power quality in power systems and electrical machines	Ewald F Fuchs, Mohammad, A.S., Masoum	Academic Press, Elsevier	2009