Second Year (Lateral Entry) Curriculum

Admission Year 2026-27

Bachelor of Technology (Lateral Entry) Electrical Engineering

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Detailed Syllabus

Semester 3

a. **Course Name:** Fundamental of Electronics
b. **Course Code:** 03010603PC01
c. **Prerequisite:** Knowledge of Physics up to 12^{th} science level
d. **Rationale:** All students are expected to acquire fundamental knowledge of electronics. The aim of this subject is to familiarize students with basic electronic concepts. By the end of the course, students will be able to operate electronic test and measurement instruments such as a multimeter, CRO, DC power supply, and function generator.
e. **Course Learning Objective:**

CLOBJ 1	Identify semiconductor properties and relate PN junction physics to the operation of diodes, LEDs, and sensors.
CLOBJ 2	Evaluate the performance of rectifiers, filters, and wave-shaping circuits through output waveform analysis and calculation.
CLOBJ 3	Differentiate between BJT configurations to implement transistors effectively as either electronic switches or signal amplifiers.
CLOBJ 4	Determine Q-point stability and calculate voltage gain and impedance using small-signal transistor models.
CLOBJ 5	Compare the functional blocks and efficiency ratings of linear regulators and Switched-Mode Power Supplies (SMPS).

f. **Course Learning Outcomes:**

CLO 1	Understand semiconductor fundamentals and the operation and applications of diodes and optoelectronic devices.
CLO 2	Analyse and explain diode-based circuits such as rectifiers, clippers, clampers, filters, and voltage multipliers.
CLO 3	Explain the construction, operation, configurations, biasing, and applications of BJTs as amplifiers and switches.
CLO 4	Analyse transistor biasing and amplifier performance.
CLO 5	Explain the operation and applications of DC regulated power supplies, linear voltage regulators, and SMPS.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **Contents:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**Semiconductor and Diode Theory** Conductors, Semiconductors, Doping, intrinsic & extrinsic semiconductors, barrier potential and effect of temperature Ideal diodes, forward bias, reverse bias, breakdown of diode, PIV, surge	25 %	10

Sr. No.	Topic	Weightage	Teaching Hrs.
	current, Diode as Uncontrolled switch, Special Purpose Diodes: Construction, Characteristics & Application of Zener Diode as Voltage Regulator, Optoelectronic devices (LED and Photo Diode), Seven Segment Display.		
2	**Circuits using PN Junction Diode**: Half-wave, Full-wave and Bridge rectifier, Clipper Clamper and Limiters, Choke and Capacitor input filter, Voltage Multiplier.	15 %	5
3	**Bipolar Junction Transistors (BJTs):** Construction and Working of NPN & PNP Transistors, BJT Operating Modes: Cutoff, Active, and Saturation, Transistor Configurations: Common Emitter, Common Collector and Common Base Configurations, Transistor Biasing: Fixed Base Biasing and Voltage Divider Transistor Biasing, BJT as an Amplifier and Switch	20 %	10
4	**Transistor Biasing & Transistorized Amplifier** Biased and unbiased BJT Voltage divider bias and analysis, VDB load line and Q point, two supply emitter biases, Base and Emitter biased amplifier, small signal operation, Voltage gain, loading effect, multistage amplifier.	20 %	10
5	**DC Regulated Power Supply:** Voltage Regulator-Basic series and shunt regulator, Transistor series Regulator, constant current source. Fixed and adjustable positive and negative linear voltage regulator, IC linear fixed voltage regulator (78XX, 79XX, LM340 Series), Linear Adjustable Regulator (IC LM317, LM337, and IC 723 IC regulator), Switched mode power supply (SMPS).	20 %	10

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. **Reference Books:**

1. Electronic Devices & Circuits By Sanjeev Gupta | Dhanpatrai.
2. Electronic Devices By Thomas L. Floyd | Pearson, Prentice Hall.
3. Electronic Principles By A. P. Malvino | Tata McGraw Hill Publication New Delhi.
4. Linear Electronic Circuits and Devices By James Cox | Delmar Publication.
5. Electronic Devices & Circuit Theory By Boylestad.

a. **Course Name:** Fundamental of Electronics Laboratory

b. **Course Code:** 03010603PC02

c. **Prerequisite:** Knowledge of Physics up to 12^{th} science level.

d. **Rationale:** The course will give ideas about practical design aspects about the Fundamental of Electronics.

e. **Course Learning Objective:**

CLOBJ 1	Evaluate the electrical behaviour of semiconductor junctions by experimentally validating the V–I characteristics of signal and regulation diodes.
CLOBJ 2	Design and test AC-to-DC conversion systems by optimizing rectifier and filter configurations for minimized ripple voltage.
CLOBJ 3	Analyse non-linear diode networks to manipulate signal DC levels and pulse shapes using clamping and clipping techniques.
CLOBJ 4	Characterize the operational boundaries of Bipolar Junction Transistors by mapping input and output transfer curves across different circuit topologies.
CLOBJ 5	Construct a complete regulated DC power supply system by integrating discrete components with integrated circuit regulators for stable voltage output.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate V–I characteristics of PN junction and Zener diodes.
CLO 2	Execute half-wave and full-wave rectifier circuits with and without filters.
CLO 3	Distinguish the operation of positive and negative clamping circuits.
CLO 4	Apply BJT configurations (CB and CE) to study input–output characteristics.
CLO 5	Analyse the performance of a DC power supply using regulator ICs.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **List of Practical's:**

1	V-I characteristics PN junction diode Characteristic.
2	V-I characteristics Zener Diode characteristics.
3	Half-Wave Rectifier Circuits without Filters.
4	Half wave Rectifier with (L, C) filter.
5	Full-Wave Rectifier Circuits without Filters.
6	Full - wave Rectifier with (L, C) filter.

7	To Observe Response of Clipping circuits using diodes. (a) Diode Positive Clipper without and with Biased clipper (b) Diode Negative Clipper without and with Biased clipper.
8	To Observe Response Clamping circuits using diodes: Positive clamper and Negative clamper.
9	To Plot and Study input-output characteristics of common Base (CB) configuration of Transistor.
10	To Plot and Study input-output characteristics of common Emitter (CE) configuration of Transistors.
11	Designing of DC power supply using regulator IC circuit.

a. **Course Name:** Electrical Machines - I
b. **Course Code:** 03010603PC03
c. **Prerequisite:** Knowledge of Basic Electrical Engineering
d. **Rationale:** Electrical Machines–I introduces students to the principles, construction, and operation of transformers and induction machines, which form the backbone of AC power systems and industrial applications.
e. **Course Learning Objective:**

CLOBJ 1	Evaluate the operational efficiency and voltage stability of single-phase transformers by synthesizing experimental test data with equivalent circuit modelling.
CLOBJ 2	Recommend optimal three-phase transformer configurations and protection schemes for specific industrial power applications based on vector group requirements and cooling demands.
CLOBJ 3	Assess the electromechanical performance of three-phase induction motors by interpreting torque-speed characteristics and equivalent circuit parameters.
CLOBJ 4	Differentiate between single-phase AC motor types by applying double-field revolving theory to determine their starting torque and suitability for domestic or light-industrial loads.

f. **Course Learning Outcomes:**

CLO 1	Analyse the performance of single-phase transformers by examining equivalent circuits, losses, efficiency, voltage regulation, testing methods, and load-sharing behaviour under different operating conditions.
CLO 2	Evaluate different three-phase transformer configurations, vector groups, and cooling and protection schemes to recommend suitable transformers for specific power system applications.
CLO 3	Analyse the operating characteristics of three-phase induction motors using equivalent circuits, test results, torque–speed characteristics, and performance under various operating conditions.
CLO 4	Analyse the starting and running performance of single-phase AC motors using double-field revolving theory and equivalent circuits to compare their suitability for different applications.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. Contents:

Sr. No.	Topic	Weightage	Teaching Hrs.
1	**Single-Phase Transformers** Construction, Working Principle, E.M.F. equation, Equivalent circuit, phasor diagram for different power factor, Losses, separation of no-load losses, conditions for maximum efficiency, Determination of equivalent circuit parameters to calculation of efficiency and voltage regulation using 1) O.C. and S.C. Test, 2) Sumpner's test. Polarity test, Determination of Efficiency and Voltage regulation by direct load test, Concept of all-day efficiency. Parallel operation of transformers and Load sharing under different operating conditions. Auto transformer, saving of copper and applications. Numerical based on the above topics.	25 %	11
2	**Three Phase Transformer:** Construction, types of connection and their comparative features, Vector groups, Phase conversion - Scott connection, Parallel operation of three phase transformers, Types of Transformers, terminal marking and nomenclature, protective and safety devices fitted on Transformers, Magnetizing current, Off-load and On-load tap-changing transformers, Three winding transformers. Cooling of transformers. Application of transformers in various electrical systems.	25 %	11
3	**Three Phase Induction Machine:** Construction details, classification, Production of rotating magnetic field, principle of operation, equivalent circuit, Phasor-diagram, Losses and efficiency, Tests on Induction Motor: No load and blocked rotor test-determination of equivalent circuit parameters. Predetermination of performance under different operating conditions using a circle diagram. Torque equations for starting, full load and maximum operating conditions, condition for maximum-output, slip for maximum-output, Torque-slip characteristics, Effect of parameter variation on torque speed characteristics (variation of rotor and stator, resistances, stator voltage, frequency), Effect of Harmonics, Crawling and Cogging of induction motor, Methods of starting and speed control for induction motors with conventional methods and static convertors. Energy Efficient three phase induction motor. Numerical based on the above topics. Induction Generator: Principle of operation, equivalent circuit and application.	38 %	17
4	**Single Phase AC Motor:** Double field revolving theory, Starting & running performance of 1-phase induction Motor, Equivalent circuit of 1- induction motor, Types of single-phase motors, Principle and operation of split phase, Resistance start, Capacitor start and capacitor start & run induction motor, Shaded pole induction motor, Universal motor. Repulsion motor. Applications of various single phase induction motors.	12 %	6

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Electrical Machinery (Textbook), A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans; McGraw Hill.
2. Electrical Machinery (Textbook), Dr P.S. Bhimbra; Khanna Publishers; Enter Edition.
3. Electrical Machine (Textbook), D P Kothari & I J Nagrath; TATA Mcgraw Hill.
4. Performance and Design of AC Machines, M. G. Say; CBS Publisher.
5. Theory of Alternating Current Machinery Alexander S. Langsdorf; Mcgraw Hill Education.

a. **Course Name:** Electrical Machines - I Lab
b. **Course Code:** 03010603PC04
c. **Prerequisite:** Knowledge of Basic Electrical Engineering
d. **Rationale:** The Electrical Machines–I Laboratory complements the theory course by providing hands-on experience with transformers and induction machines, enabling students to verify theoretical concepts through experimentation. The laboratory enhances students' ability to perform testing, analyse performance parameters, and interpret experimental results, thereby strengthening practical skills essential for industrial and power system applications
e. **Course Learning Objective:**

CLOBJ 1	Execute standard experimental procedures to quantify losses and determine the equivalen circuit parameters necessary for assessing transformer efficiency and regulation.
CLOBJ 2	Evaluate the load-sharing behaviour and phase-transformation efficiency of transformers operating in parallel or specialized configurations like the Scott connection.
CLOBJ 3	Determine the operational parameters of induction motors by synthesizing data from no-load and blocked-rotor tests using circle diagram and equivalent circuit methods.
CLOBJ 4	Analyse the impact of rotor resistance and varying load conditions on the torque-speed characteristics to optimize induction motor performance for specific industrial applications.
CLOBJ 5	Produce rigorous technical reports that document experimental findings and data interpretation while strictly adhering to industrial safety and engineering standards.

f. **Course Learning Outcomes:**

CLO 1	Apply standard testing procedures on single-phase and three-phase transformers to determine losses, equivalent circuit parameters, efficiency, and voltage regulation.
CLO 2	Analyze transformer operation under special conditions such as parallel operation and Scott connection by interpreting experimental results and load-sharing characteristics.
CLO 3	Apply no-load, blocked-rotor, and direct load tests on three-phase and single-phase induction motors to evaluate their performance parameters using equivalent circuit and circle diagram methods
CLO 4	Analyze the torque–speed characteristics of induction motors and assess the effect of rotor resistance and loading on motor performance.
CLO 5	Demonstrate the ability to conduct experiments, record observations, interpret results, and prepare technical reports in accordance with laboratory safety and engineering practices.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P** - Practical, **CE** - Continuous Evaluation

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

h. **Reference Books:**

1. Electrical Machinery (TextBook), A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans; McGraw Hill.
2. Electrical Machinery (TextBook), Dr P.S. Bhimbra; Khanna Publishers; Enter Edition.

3. Electrical Machine (TextBook), D P Kothari & I J Nagrath; TATA Mcgraw Hill.
4. Performance and Design of AC Machines, M. G. Say; CBS Publisher.
5. Theory of Alternating Current Machinery Alexander S. Langsdorf; Mcgraw Hill Education.

i. List of Practical's:

1	To conduct the open and short circuit tests on a single-phase transformer to determine core losses, copper losses, and hence determine regulation, efficiency and the parameters of the equivalent circuit
2	To conduct Sumpner test on two identical single-phase transformers and determine their efficiency at various loads
3	To make Scott connection of two single phase transformers and to verify the three phases to two phase conversion.
4	Connect two single phase transformers in parallel and plot the variation of currents shared by each transformer versus load current.
5	To conduct open circuit and short circuit tests on a three-phase transformer and determine the equivalent circuit parameters.
6	Perform direct load test on a three phase induction motor to find out its performance parameters at different load conditions.
7	Perform no load and blocked rotor test on a three phase induction motor to find out its performance parameters with the help of Equivalent circuit.
8	Perform no load and blocked rotor test on a three phase induction motor to find out its performance parameters with the help of Circle Diagram.
9	To perform no load and blocked rotor test on single phase induction motor to obtain its equivalent circuit.
10	Determination of the effect of rotor resistance on the torque-speed curves of a 3 – phase slip ring induction motor.

a. **Course Name:** Control System Engineering
b. **Course Code:** 03010603PC05
c. **Prerequisite:** Fundamentals of Signals and Systems, Network and Circuits, Basic Engineering Mathematics.
d. **Rationale:** The course shall introduce the fundamentals of modelling and control of linear time invariant systems; primarily from the classical viewpoint of Laplace transforms and a brief emphasis on the state space formulation as well.
e. **Course Learning Objective:**

CLOBJ 1	Synthesize mathematical models of physical systems using differential equations and transfer functions to represent dynamic behaviour in a control framework.
CLOBJ 2	Evaluate the behaviour of open-loop and closed-loop control systems to determine how feedback modifies the system's output and sensitivity.
CLOBJ 3	Determine the absolute and relative stability of control systems by applying algebraic and graphical criteria to the system's characteristic equations.
CLOBJ 4	Predict transient and steady-state performance parameters by analysing system responses to standard impulse, step, and ramp input functions.
CLOBJ 5	Analyse system stability and performance margins in the frequency domain using Bode, Nyquist, or Root Locus techniques.
CLOBJ 6	Develop state-space models to analyse multi-variable systems through internal state variables and modern control theory perspectives.

f. **Course Learning Outcomes:**

CLO 1	Develop the mathematical model of the physical systems.
CLO 2	Analyse the response of the closed and open loop systems.
CLO 3	Analyse the stability of the closed and open loop systems.
CLO 4	Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions.
CLO 5	Formulate different types of analysis in frequency domain to explain the nature of stability of the system.
CLO 6	Develop and analyse state space models.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **Contents:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**INTRODUCTION TO CONTROL SYSTEMS** Historical development, Open and Closed loop systems, Applications, Effects of feedback, Types of feedback control systems, Modelling of electrical networks, Modelling of	15 %	7

Sr. No.	Topic	Weightage	Teaching Hrs.
	mechanical system elements, Analogy between mechanical and electrical systems, Transfer functions, Block diagram algebra, Signal flow graph and Mason's Gain formula.		
2	**TIME DOMAIN ANALYSIS** Standard test signals, Response of linear time-invariant systems to standard test signals: impulse, step, ramp Responses. Transient response and s-plane root locations of second and higher order systems, steady state errors and error constants, effects of adding poles and zeros to transfer functions, Significant or Dominant root concept, Transportation delay/dead time.	25 %	10
3	**CONSEPT OF STABILITY** Stability and its different types, Characteristic equation, Necessary conditions for stability, Routh-Hurwitz stability criteria, Oscillators, Root Locus Technique: The root locus concept, construction of Root Loci, stability analysis using root locus.	20 %	9
4	**FREQUENCY RESPONSE ANALYSIS** Frequency domain specifications, Correlation between time and frequency response, Frequency response analysis of a standard second order system, Polar plots, Stability analysis using polar plot, Bode plots, Concept of gain margin and phase margin, Nyquist stability criterion, Relative stability, Conditionally stable system.	25 %	12
5	**INTRODUCTION TO STATE VARIABLE APPROACH** Concepts of state, state variables and state model, state models for linear continuous-time systems, state transition matrix, controllability and observability, Controllers and Compensators: Proportional, Integral, and Derivative action, PI, PD, and PID controllers, Basics of Nonlinear Control.	15 %	7

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Modern Control Engineering By Katsuhiko Ogata | Pearson Education India | 5th Edition.
2. Control Systems Engineering (Textbook) By Norman S. Nice | John Wiley & Sons, Inc | First, Pub. Year 2011.
3. Control Systems Engineering (Textbook) By Nagrath and Gopal | New Age Publication.

a. **Course Name:** Control System Engineering Lab
b. **Course Code:** 03010603PC06
c. **Prerequisite:** Network Analysis, Electrical Machine-I, Control System Engineering
d. **Rationale:** Control System Engineering laboratory takes care of teaching at the graduate level in basics of control and instrumentation, modelling, simulation, and optimization, intelligent methods, applications in paper, metallurgical and biotechnical processes.
e. **Course Learning Objective:**

CLOBJ 1	Assess the transient and steady-state performance of first and second-order systems by calculating time-constant, damping ratio, and settling time parameters.
CLOBJ 2	Evaluate the stability and frequency response of dynamic systems by interpreting gain margins and phase margins from Bode and Nyquist plots.
CLOBJ 3	Formulate PID controller parameters using analytical tuning methods to meet specific overshoot, rise time, and error requirements for linear plants.
CLOBJ 4	Implement optimized PID control strategies for real-world applications to ensure robust tracking and disturbance rejection.
CLOBJ 5	Utilize MATLAB and Simulink environments to model, simulate, and validate the performance of complex control systems under varying plant conditions.

f. **Course Learning Outcomes:**

CLO 1	Analyse first and second order systems using time domain analysis.
CLO 2	Analyse first and second order systems using frequency domain analysis.
CLO 3	Design PID controller.
CLO 4	Design and Implement PID controller for any applications.
CLO 5	To get acquainted with MATLAB programming, MATLAB-SIMULINK in order to simulate, analyse and design control system design for different plants under consideration.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **List of Practical's:**

1	Write a MATLAB code to find: 1. Step, Ramp and Impulse response of first order systems 2. Step, Ramp and Impulse response of second order systems
2	Write a MATLAB code to study and identify damping in second order systems.
3	Write a MATLAB code to study the time domain analysis for second order systems.

4	Write a MATLAB code to verify the output response of a Second Order System using RLC circuit.
5	Write a MATLAB code to study stability analysis of linear systems using the Routh-Hurwitz method.
6	Write a MATLAB code to study stability analysis of linear systems using Root Locus.
7	Write a MATLAB code to study frequency response analysis using Polar Plot.
8	Write a MATLAB code to study frequency response analysis using Bode Plot.
9	Using MATLAB simulation, design PID Controller for first order and second order systems.
10	Using MATLAB simulation, design PID Controller for speed control of DC Motor System.

a. **Course Name:** Electrical Measurements & Instrumentation
b. **Course Code:** 03010603PC07
c. **Prerequisite:** Basics of Fundamentals of Electrical Engineering.
d. **Rationale:** The course provides detailed knowledge of different measuring apparatus. The field of electrical measurement continues to grow, with new techniques developed each year. It is also becoming an increasingly "digital" endeavour. The subject introduces the fundamentals-including main terms and definitions, methods of estimating accuracy and uncertainty, and standards of electrical quantities-and the classical methods of measurement
e. **Course Learning Objective:**

CLOBJ 1	Quantify the impact of systematic and random errors within a measurement chain to determine the overall accuracy and reliability of collected data.
CLOBJ 2	Implement statistical methods and hardware compensation techniques to minimize environmental interference and instrumental uncertainties.
CLOBJ 3	Apply specialized sensing principles to accurately measure electrical parameters like impedance and non-electrical variables such as temperature, pressure, and displacement.
CLOBJ 4	Compare the functional mechanisms of analog and digital instruments to select the appropriate apparatus based on resolution, frequency response, and input impedance requirements.

f. **Course Learning Outcomes:**

CLO 1	Understands the role of errors in the measurement system.
CLO 2	Learn different techniques to mitigate errors.
CLO 3	Understands the techniques to measure electrical and non-electrical quantities.
CLO 4	Understands the operation of digital and analog measuring apparatus.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. **Content:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**PHILOSOPHY OF MEASUREMENT:** Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement & its analysis, Standards.	10 %	5
2	**ANALOG & DIGITAL INSTRUMENTS:** Electrodynamic Principle, MI Type Instrument, Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters, Electrodynamic Wattmeter, and Energy-meter. Concept of digital measurement, Block diagram study of Digital	24 %	12

	Voltmeter, Frequency Meter.		
3	**MEASUREMENT OF PARAMETERS:** Different methods of measuring low, medium & high resistances, Principle of AC Bridges, measurement of inductance & capacitance bridges.	20 %	10
4	**INSTRUMENT TRANSFORMERS:** Principle of Instrument transformers. Construction of Current Transformer, Determination of ratio & phase angle errors. Effect of change in burden & power factor on the ratio & phase angle of CTs. Precautions while using a CT. Construction of Potential Transformers. Determination of ratio & phase angle errors of PTs. Effect of change in burden & burden power factor on the ratio & phase angle of PTs.	24 %	12
5	**TRANSDUCERS:** Definition - different types of transducers – criteria for selection – general characteristics (LVDT, RVDT), Thermocouple and RTD method, Hall Effect transducer, Piezoelectric Transducer.	12 %	6

i. Reference Books:

1. Electrical and Electronics Measurement and Instrumentation (Textbook) By A. K. Shawney, Dhanpatrai & sons publications.
2. Electrical Measurement and Measuring Instruments By R.K.Rajput, S. Chand Publication
3. Electrical Measurement and Measuring Instruments By J.B.Gupta, S.K. Kataria & Sons
4. Elements of Electronic Instrumentation and Measurement By Joseph J. Carr Pearson Education, 3rd edition.
5. Modern Electronic instrumentation and Measuring instruments By A.D. Heltric & W.C. Copper, Wheeler Publication

a. Course Name: Electrical Measurements & Instrumentation Lab

b. Course Code: 03010603PC08

c. Prerequisite: Basics of Fundamentals of Electrical Engineering.

d. Rationale: The course provides detailed knowledge of different measuring apparatus. The field of electrical measurement continues to grow, with new techniques developed each year. It is also becoming an increasingly “digital” endeavour. The subject introduces the fundamentals—including main terms and definitions, methods of estimating accuracy and uncertainty, and standards of electrical quantities—and the classical methods of measurement.

e. Course Learning Objective:

CLOBJ 1	Execute precise measurements of resistance, inductance, and capacitance by balancing diverse AC and DC bridge circuits under laboratory conditions.
CLOBJ 2	Quantify measurement uncertainties and the effect of component tolerances to evaluate the overall accuracy of bridge-based instrumentation systems.
CLOBJ 3	Compare the functional performance and sensitivity of analog and digital measuring instruments to determine their suitability for specific engineering applications.
CLOBJ 4	Characterize the transfer functions of displacement and temperature sensors to accurately convert physical phenomena into measurable electrical signals.

f. Course Learning Outcomes:

CLO 1	Operate different bridges for measurement of electrical parameters.
CLO 2	Evaluate errors during measurement in bridges.
CLO 3	Assess the operation of digital and analog measuring apparatus.
CLO 4	Measure the unknown value of displacement and temperature using transducers and sensors.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. List of Practical's:

1.	To measure unknown resistance using Wheatstone Bridge.
2.	To measure low resistance using Kelvin’s Double Bridge.
3.	To measure the unknown value of inductance by Maxwell’s bridge.
4.	To measure the unknown value of inductance by Hay’s bridge.
5.	To measure the unknown value of inductance by Owen’s bridge.
6.	To measure the unknown value of capacitance by De Sauty bridge.
7.	To measure an unknown value of capacitance by Schering bridge.
8.	To measure an unknown value of frequency by Wein’s bridge.
9.	To measure the different range of temperature by thermocouple.
10.	To measure the value of linear displacement by LVDT.

a. **Course Name:** Product Realization
b. **Course Code:** 03010603ES01
c. **Prerequisite:** Knowledge of the Design process of Electrical Engineering.
d. **Rationale:** This course is meant for beginners. The course is designed to imbibe Design Thinking understanding and mind-set for the 3rd-semester students. The course aims to expose students to the primary process and framework of Design Thinking and relevant tools & techniques for Creativity & Innovation.
e. **Course Learning Objective:**

CLOBJ 1	Manage complex engineering projects within a team by effectively sub-dividing tasks, monitoring milestones, and integrating individual contributions into a cohesive final deliverable.
CLOBJ 2	Apply human-centered Design Thinking methodologies to cultivate innovative, entrepreneurial, and socially responsible solutions for contemporary community challenges.
CLOBJ 3	Formulate viable engineering project proposals by synthesizing field data collected from industrial visits, market surveys, and creative brainstorming sessions.
CLOBJ 4	Evaluate the ecological footprint of engineering designs to ensure project implementations align with sustainable development practices and environmental responsibilities.

f. **Course Learning Outcomes:**

CLO 1	Develop group working, including task sub-division and integration of individual contributions from the team.
CLO 2	Importance and understanding of Design Thinking for innovation, entrepreneurship, societal solutions with various learning tools.
CLO 3	Perform various tasks like market survey, industrial visits, creative and innovative techniques, etc to identify projects.
CLO 4	Develop a sense of Environmental responsibility.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	4	2	00	20	00	00	30	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **List of Practical's:**

1.	Introduction of Design Thinking
2.	Ideation Phase
3.	Mind map
4.	Empathy Map
5.	Product Development Phase
6.	Feedback & Final Report

Semester 4

a. Course Name: Power Electronics-1

b. Course Code: 03010604PC01

c. Prerequisite: Knowledge of Physics, Mathematics and Basic Electronics

d. Rationale: This course introduces the fundamentals of power electronics and its practical applications. The primary objective is to enable students to understand energy conversion and processing using power electronic converters, along with the application of power electronics in electric drive systems. By the end of the course, students will be able to explain the operation of various power devices and converters, and derive the relevant mathematical relationships. The laboratory component focuses on guided design-oriented experiments**.**

e. Course Learning Objective:

CLOBJ 1	Evaluate the structural design, switching dynamics, and safe operating areas of the power semiconductor family to select appropriate devices for high-power switching applications.
CLOBJ 2	Analyse the performance parameters, harmonic distortion, and output waveforms of single-phase and three-phase controlled rectifiers under various loading conditions.
CLOBJ 3	Investigate the steady-state operation, duty cycle variations, and energy storage modes of non-isolated DC-DC topologies like Buck, Boost, and Buck-Boost converters.
CLOBJ 4	Design and implement optimized power electronic converter configurations to meet the specific voltage and regulation demands of industrial DC applications, such as motor drives and renewable energy systems.

f. Course Learning Outcomes:

CLO 1	Explain the construction and characteristics of the Power semiconductor devices family.
CLO 2	Analyse controlled rectifier circuits.
CLO 3	Investigate the operation of DC–DC converters.
CLO 4	Demonstrate the knowledge of power electronic converters for different DC applications.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. Contents:

Sr. No.	Topic	Weightage	Teaching Hrs.
1	**Introduction to Power Semiconductor devices:** Introduction to Power Semiconductor Devices Concept of Power Electronics, Applications of Power Electronics, Power Electronics Systems-Block Diagram, Types of Power Electronics Converters, Power Diode, Its V-I Characteristics & Reverse Recovery Characteristic, Types of Power Diodes, Freewheeling Action Using Diode, MOSFET,IGBT: Construction, I-V Characteristics, switching characteristics; Terminal Characteristics of Thyristor, I-V Characteristic of Thyristor ,Switching Characteristics of Thyristor,	25 %	12

Sr. No.	Topic	Weightage	Teaching Hrs.
	Two Transistor Model of Thyristor, Thyristor Turn-On Methods, Thyristor Protection : Design of Snubber Circuit, Over Voltage Protection, Over Current Protection, Construction, Series and parallel operation of SCR, Firing circuit for thyristor, Gate turn off thyristors (GTO). Gate drive circuits for MOSFET and IGBT.		
2	**Thyristor Rectifiers** Single-phase half-wave and full-wave controlled rectifiers with R,RL and RLE load, Single-phase full-bridge thyristor controlled rectifier with R load and highly inductive load and RLE load; Three-phase full-bridge thyristor rectifier with R-load , RL and RLE load; Input current wave shape and power factor. Single phase and three phase semi converters with R load and highly inductive load, Single phase and three phase dual converters, Effect of source and load inductances.	23 %	10
3	**DC-DC buck converter** Introduction, Principle of chopper operation, Elementary chopper with an active switch and diode, control strategies, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.	16 %	7
4	**DC-DC boost converter** Power circuit of a boost converter, analysis and waveforms at steady state, types of chopper, relation between duty ratio and average output voltage. Thyristor DC-DC converter circuits: Voltage commutated, Current Commutated and Load Commutated.	18 %	8
5	**Applications** Regulated power supply, SMPS, Battery charger, DC motor control, DC Circuit Breakers, Overview of HVDC systems, Overview on Application of Power electronics in solar system.	18 %	8

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Power Electronics By Dr P.S. Bhimbra | Khanna and Khanna Publishers, New Dehli
2. Power Electronics - Circuits, Devices and Applications (TextBook) By Muhammad H. Rashid | Prentice Hall of India.
3. Power Electronics – Converters, Applications and Design (TextBook) By Ned Mohan, Undeland and Robbins | John Willey & sons, Inc.
4. Fundamentals of Power Electronics (TextBook) By R. W. Erickson and D. Maksimovic | Springer Science & Business Media, Pub. Year 2007
5. Power Electronics : Essentials & Applications (TextBook) By L. Umanand | Wiley India Pvt Ltd

a. Course Name: Power Electronics Laboratory

b. Course Code: 03010604PC02

c. Prerequisite: Knowledge of Physics up to 12th science level and basic electronics

d. Rationale: The course will give ideas about practical design aspects about Power Electronics converters.

e. Course Learning Objective:

CLOBJ 1	Characterize the operational switching thresholds and forward/reverse conduction regions of Thyristors and MOSFETs through experimental V–I profiling.
CLOBJ 2	Execute phase-angle control in single-phase half-wave and full-wave rectifiers to evaluate the impact of resistive and inductive loads on power quality.
CLOBJ 3	Differentiate between step-up, step-down, and multi-quadrant chopper configurations by analysing their voltage commutation and bi-directional current capability.
CLOBJ 4	Map the input and output transfer characteristics of Common Base (CB) and Common Emitter (CE) BJT circuits to determine parameter gains and saturation limits.
CLOBJ 5	Analyse the line and load regulation performance of DC power supplies by integrating fixed and adjustable three-terminal regulator integrated circuits (ICs).

f. Course Learning Outcomes:

CLO 1	Demonstrate V–I characteristics Thyristor and MOSFET.
CLO 2	Execute half-wave and full-wave controlled rectifier circuits with R and RL load.
CLO 3	Distinguish the operation of chopper circuits.
CLO 4	Apply BJT configurations (CB and CE) to study input–output characteristics.
CLO 5	Analyse the performance of a DC power supply using regulator ICs.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T**- Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. List of Practical's:

1.	To Obtain Static VI characteristic of Thyristor.
2.	To Obtain Static VI characteristic of MOSFET.
3.	To perform a Half controlled rectifier with R load.
4.	To perform a Half controlled rectifier with RL load
5.	To perform a Full controlled rectifier with R load.
6.	To perform a Full controlled rectifier with RL load
7.	To perform a Buck chopper.
8.	To perform a Boost chopper.
9.	To perform a Buck – Boost chopper.
10.	To perform a class A- type chopper.
11.	To perform a class B- type chopper
12.	To perform a class C- type chopper.
13.	To perform a class D- type chopper.
14.	To perform a class E- type chopper.

a. Course Name: Electrical Machines – II

b. Course Code: 03010604PC03

c. Prerequisite: Knowledge of Basic Electrical Engineering, Electrical Machines –I.

d. Rationale: Electrical Machines–II develops understanding of DC and synchronous machines, their characteristics, and their applications in power generation, industrial drives, and control systems.

e. Course Learning Objective:

CLOBJ 1	Evaluate the operational mechanics, speed control mechanisms, and overall efficiency of DC machines by synthesizing core electromechanical torque and EMF equations with internal loss profiles.
CLOBJ 2	Explain the electro physical construction, rotating magnetic field dynamics, and armature reaction effects of synchronous machines across varied excitation states.
CLOBJ 3	Analyse the steady-state performance, voltage regulation, and internal power flow of synchronous generators and motors utilizing equivalent circuit parameters and phasor diagrams.
CLOBJ 4	Assess the synchronization limits, transient stability margins, and power factor correction capabilities of synchronous machines operating under active power grid networks or as synchronous condensers.
CLOBJ 5	Compare the structural design, permanent magnet integration, and torque-speed profiles of special machines including BLDC, PMSM, stepper, switched reluctance, and servo motors to determine their optimal application in automation and high-precision drives.

f. Course Learning Outcomes:

CLO 1	Analyse the construction, operating principles, EMF and torque equations, performance characteristics, speed control methods, losses, and efficiency of DC machines.
CLO 2	Explain the construction, working principles, rotating magnetic field, EMF equations, winding factors, armature reaction effects, and excitation systems of synchronous machines.
CLO 3	Analyse equivalent circuits, phasor diagrams, voltage regulation, and power flow characteristics of synchronous generators and motors.
CLO 4	Explain stability, synchronization, power factor control, and practical applications of synchronous machines including condenser operation.
CLO 5	Explain the construction, working principles, and operating characteristics of special machines such as BLDC motors, PMSMs, stepper motors, SRMs, and servo motors.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T**- Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. Contents:

Sr. No.	Topic	Weightage	Teaching Hrs.
1	**DC Machines** Construction and working: Basic construction and operating	20 %	9

Sr. No.	Topic	Weightage	Teaching Hrs.
	principles. DC Generator: Induced EMF in an armature coil, field excitation types, Voltage builds up in a self-excited generator, Critical field resistance and speed. DC Motor: Derivation of back EMF equation, derivation of torque equation, Performance Characteristics, speed control methods, Armature circuit equations, Losses and efficiency.		
2	**Fundamentals of Synchronous machines:** Constructional Details, Working Principle, Types of rotor (cylindrical and salient pole), Rotating Magnetic Field, EMF equation for full pitched winding, EMF equation for fractional pitched winding, pitch factor, EMF equation for concentrated and distributed winding, distribution factor, Winding factor Armature Reaction and its effects and remedies (damper windings), Excitation systems for Synchronous Machines.	18 %	8
3	**Synchronous Machine – Modelling, Phasor Analysis & Performance** Flux and MMF phasors in synchronous machines, Development of equivalent circuit and phasor diagrams of a synchronous generator, Operation at unity, lagging, and leading power factor loads, Phasor diagrams of cylindrical rotor alternator, Open-circuit characteristic (OCC), Short-circuit characteristic (SCC), Zero power factor (ZPF) characteristic, Voltage regulation of synchronous generators: Definition and significance, Methods of voltage regulation: Synchronous impedance (EMF) method, MMF method, Zero power factor (ZPF) method, Short Circuit Ratio (SCR): Definition, significance, and effects on performance, Equivalent circuit and phasor diagrams of synchronous motor: Operation at unity, lagging, and leading power factor loads, Operating characteristics of synchronous machines.	24 %	11
4	**Synchronous Machine – Power Flow, Stability, Control & Applications** Power flow and power transfer equations: Synchronous generator, Synchronous motor, Reactive power concepts, Power factor control of synchronous machines: V-curves, Inverted V-curves, Salient pole synchronous machine: Two-reaction theory, Phasor diagram analysis, Power angle characteristics: Steady-state stability, Effect of excitation and loading, Stability of synchronous machines: Hunting phenomenon, Damper windings and their role, Measurement of direct-axis and quadrature-axis reactances (Xd and Xq), Losses and efficiency of synchronous machines, Power factor correction using synchronous motor (Synchronous condenser operation), Synchronous generator capability curve, Starting methods of synchronous motor, Parallel operation and synchronization of alternators: Conditions for synchronization, Synchronization methods, Synchronizing power and synchronizing torque.	24 %	11
5	**Special Machines:** Brushless DC Motor (BLDC): Construction, working principle, control techniques, and applications.	14 %	6

Sr. No.	Topic	Weightage	Teaching Hrs.
	Permanent Magnet Synchronous Machine (PMSM): Types (SPMSM, IPMSM), operation, and applications. Stepper Motor: Types (Variable reluctance, Permanent Magnet, Hybrid), working principle and applications. Switched Reluctance Motor (SRM): Construction, working, and applications. Servo Motor: AC & DC servo motors, working, and industrial applications.		

***Continuous Evaluation:**

It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Electrical Machinery (Textbook), A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans; McGraw Hill.
2. Electrical Machinery (Textbook), Dr P.S. Bhimbra; Khanna Publishers; Enter Edition .
3. Electrical Machine (Textbook), D P Kothari & I J Nagrath; TATA Mcgraw Hill.
4. Performance and Design of AC Machines, M. G. Say; CBS Publisher.
5. Theory of Alternating Current Machinery Alexander S. Langsdorf; Mcgraw Hill Education.

a. **Course Name:** Electrical Machines - II Lab
b. **Course Code:** 03010604PC04
c. **Prerequisite:** Knowledge of Basic Electrical Engineering, Electrical Machines -II
d. **Rationale:** The Electrical Machines–II Laboratory provides practical exposure to the operating principles, characteristics, and testing methods of DC and synchronous machines. The course enables students to apply theoretical knowledge to real machines by performing standard tests related to performance, efficiency, voltage regulation, and synchronization. It strengthens skills in experimental investigation, data analysis, and interpretation of results under different operating conditions. The laboratory familiarizes students with industry-relevant testing practices and safe operation of electrical machines.
e. **Course Learning Objective:**

CLOBJ 1	Determine the critical field resistance and voltage build-up conditions of DC generators by experimentally mapping their magnetizing, internal, and external performance curves.
CLOBJ 2	Evaluate the mechanical efficiency and speed-torque dynamics of DC shunt motors through direct brake testing and load curve analysis.
CLOBJ 3	Quantify the overall efficiency and temperature rise of identical DC shunt machines under full-load conditions using the Hopkinson's regenerative testing method.
CLOBJ 4	Compute the voltage regulation of synchronous generators by applying and comparing the Synchronous Impedance (EMF), MMF, and Zero Power Factor (ZPF/Potier triangle) predictive methods.
CLOBJ 5	Demonstrate proper grid synchronization using the lamp method while analysing the impact of excitation variations on armature current via V-curve profiling.

f. **Course Learning Outcomes:**

CLO 1	Analyse the magnetizing, internal, and external characteristics of DC generators and determine the critical field resistance.
CLO 2	Evaluate the performance characteristics of DC shunt motors using brake test results and speed–torque curves.
CLO 3	Determine the efficiency of DC shunt machines using the Hopkinson's (regenerative) test.
CLO 4	Compute the voltage regulation of synchronous generators using synchronous impedance, MMF, and zero power factor methods.
CLO 5	Demonstrate the synchronization and operational characteristics of synchronous machines through lamp method and V-curve studies.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation
***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

h. **Reference Books:**

1. Electrical Machinery (Textbook), A E Fitzgerald, Charles Kingsley, Jr. Stephen D. Umans; McGraw Hill.
2. Electrical Machinery (Textbook), Dr P.S. Bhimbra; Khanna Publishers; Enter Edition.
3. Electrical Machine (Textbook), D P Kothari & I J Nagrath; TATA Mcgraw Hill.
4. Performance and Design of AC Machines, M. G. Say; CBS Publisher.
5. Theory of Alternating Current Machinery Alexander S. Langsdorf; Mcgraw Hill Education.

i. List of Practical's:

1.	Obtain Magnetizing Characteristics, Internal & External Characteristics of Self Excited DC Shunt Generator. Also obtain the critical field resistance of the machine from magnetizing characteristics.
2.	Obtain Internal & External Characteristics of DC Series Generator.
3.	Obtain Internal & External Characteristics of DC Cumulatively Compound Generator.
4.	Perform Brake Test on DC Shunt Machine. And plot Speed-Torque characteristics of DC Shunt Motor.
5.	Determine the efficiency of two similar DC shunt machines by regenerative method. (Hopkinson's Test).
6.	Perform open circuit, short circuit and resistance measurement test on synchronous Generator. Find out voltage regulation of synchronous machines by Synchronous impedance method.
7.	Find out voltage regulation of synchronous machine by MMF method.
8.	Demonstrate the synchronization of a three-phase alternator with a grid using two bright one dark lamp methods.
9.	Find out voltage regulation of synchronous machines by ZPF method.
10.	To plot the V-curve and Inverted V-curve of a synchronous motor by operating the motor at constant input power and constant field current, respectively, and to study the relationship between armature current, field current, and power factor of the motor.

a. **Course Name:** Electromagnetic
b. **Course Code:** 03010604PE01
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level.
d. **Rationale:** The course imparts knowledge of electric fields, magnetic fields, energy, potential, conductors, dielectrics, capacitance, and mathematical equations like Poisson's, Laplace's, and Maxwell's. It emphasizes Indian industrial contexts such as RF systems in telecommunications, EMI/EMC in power electronics, and antenna applications in defence and space sectors.
e. **Course Learning Objective:**

CLOBJ 1	Apply vector calculus and computational tools to model the spatial distribution and behaviour of static electric and magnetic fields within complex industrial geometries.
CLOBJ 2	Interpret the physical significance of gradient, divergence, and curl operators to analyse charge accumulation, vortex dynamics, and potential fields in electromagnetic systems.
CLOBJ 3	Analyze electromagnetic wave propagation and field distributions by solving Maxwell's, Poisson's, and Laplace equations using divergence and Stokes' theorems.
CLOBJ 4	Calculate electrostatic and magneto static field parameters to optimize the design of high-frequency antennas and evaluate the efficacy of industrial EMI shielding materials.

f. **Course Learning Outcomes:**

CLO 1	Apply vector calculus to understand the behaviour of static electric fields and static magnetic fields in standard configurations, including industrial simulations.
CLO 2	Identify the physical explanation and application of divergence, curl, and gradient operators in electromagnetic systems.
CLO 3	Analyse electromagnetic waves using divergence, Stokes' theorem, Maxwell's, Poisson's, and Laplace equations for practical applications.
CLO 4	Calculate electrostatic and magneto static fields, with emphasis on industrial contexts like EMI shielding and antenna design.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **Contents:**

Sr.	Topic	Weightage	Teaching Hrs.
1	**Vector Analysis** Scalars and Vectors, Vector Algebra, The rectangular coordinate system, Vector components and unit vectors, The vector field, The dot product, The cross product, Circular cylindrical coordinates, Spherical coordinate system, vector operator del, gradient, divergence, curl and Examples, Applications in antenna radiation patterns and field simulations.	16 %	7
2	**Coulomb's law and Electric Field Intensity** The experimental law of Coulomb, Electric field intensity, Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge, Industrial examples in electrostatic	20 %	9

Sr.	Topic	Weightage	Teaching Hrs.
	discharge (ESD) protection for electronics manufacturing.		
3	**Electric Flux Density, Gauss law and Divergence** Electric flux density, Gauss's law, Examples and Application of Gauss law, Use in capacitor design and high-voltage equipment per BIS standards.	20 %	9
4	**Energy and Potential** Energy expended in moving a point charge in an electric field, The line integral, Definition of potential and potential difference, The potential field of a point charge, The potential field of a system of charges, An Electric Dipole, Examples, Applications in energy storage devices and potential mapping in power systems.	20 %	9
5	**Current and Conductors** Current and current density, Continuity of current, Metallic conductors, The nature of dielectric materials, Capacitance, Capacitance examples, EMI/EMC considerations in Indian telecom and automotive industries.	10 %	5
6	**The Steady Magnetic Field** Biot-Savart law, Ampere's circuital law, Curl, Magnetic flux and magnetic flux density, scalar and vector magnetic potentials, Case studies on magnetic materials in transformers and motors for the renewable energy sector.	14 %	6

***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Engineering Electromagnetics By William H Hayt and John A Buck | Tata McGraw-Hill Publishing Company Limited | Seventh Edition.
2. CBS Problems & Solutions Series: Problems & Solutions of Engineering Electromagnetics (Textbook) By Experienced Teachers | CBS Publisher.
3. Engineering Electromagnetics (Textbook) By Nathan Ida | Springer India Pvt Ltd.
4. Elements of Electromagnetic (Textbook) By Matthew N. O. Sadiku | Oxford University Press.
5. Electromagnetic Compatibility Engineering by Henry W. Ott | Wiley (emphasizing Indian standards for electronics).
6. Antennas and Wave Propagation by G.S.N. Raju | Pearson Education (Indian edition, for telecom applications).

a. Course Name: Electromagnetic Lab

b. Course Code: 03010604PE02

c. Prerequisite: Knowledge of basics of field theory and mathematics.

d. Rationale: The lab will impart the knowledge of electric field, magnetic field, Energy, Potential, conductors, dielectric capacitance and various mathematical equations like Poisson's and Laplace's equations and Maxwell's equations.

e. Course Learning Objective:

CLOBJ 1	Calculate electrostatic and magneto static field parameters in standard physical configurations by applying fundamental electromagnetic governing laws.
CLOBJ 2	Apply vector algebra to predict the trajectories and force vectors of moving charges within magnetic fields for application in particle accelerators and mass spectrometers.
CLOBJ 3	Characterize the magnetization behaviour, permeability variations, and hysteresis loops of diamagnetic, paramagnetic, and ferromagnetic materials under diverse electrical environments.
CLOBJ 4	Utilize vector calculus theorems to model the spatial distribution, flux density, and potential boundaries of static electric and magnetic fields.

f. Course Learning Outcomes:

CLO 1	Calculate the electrostatic and magneto static fields.
CLO 2	Apply mathematical knowledge of vector algebra to determine charge behaviour in magnetic fields and its applications.
CLO 3	Describe the magnetic behaviour of various materials in different electric conditions and its applications.
CLO 4	Apply vector calculus to understand the behaviour of static electric fields and static magnetic fields in standard configurations.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. List of Practical's:

1.	Solve the examples of the coordinate systems. (Cartesian, cylinder and spherical coordinate system).
2.	Solve the examples of dot & cross product and product of three vectors.
3.	Solve the examples based on Coulomb's law.
4.	Solve the examples based on Electrical field intensity and Field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.
5.	Solve the examples based on the Electric field due to a continuous volume charge distribution, Field of a line charge, Field of a sheet charge.
6.	Solve the examples based on Electric flux density and Application of Gauss's law.
7.	Solve the examples based on the Potential field of a point charge, line charge, surface charge, and volume charge.

8.	Solve the examples based on Current density and Conductors.
9.	Solve the examples based on the application of Dielectrics and Capacitances.
10.	Solve the examples based on the Finite Element Method using software.

a. **Course Name:** Analog Electronics Circuits

b. **Course Code:** 03010604PE03

c. **Prerequisite:** Knowledge of Basic Electrical Engineering, Basic Electronics

d. **Rationale:** The main objective of this subject is to inculcate basic concepts of Op-Amps & analog electronics circuits and system, which leads to design of complex analog systems.

e. **Course Learning Objective:**

CLOBJ 1	Evaluate the electrical performance of Operational Amplifiers by analysing critical data sheet parameters, including open-loop gain, input offset voltage, slew rate, and common-mode rejection ratio (CMRR).
CLOBJ 2	Design and analyse linear op-amp circuits—including differentiators, integrators, active filters, and lead-lag compensators—to execute precise continuous-time mathematical operations on analog signals.
CLOBJ 3	Implement non-linear op-amp configurations, such as comparators, Schmitt triggers, peak detectors, and relaxation oscillators, to achieve signal threshold detection and wave-shaping.
CLOBJ 4	Formulate component values for IC 555 timer networks operating in astable, monostable, and bistable modes to generate precise time delays, clock pulses, and multi-vibrator waveforms.
CLOBJ 5	Explain the sequential stages of sampling, quantization, and encoding inherent in Analog-to-Digital and Digital-to-Analog conversion architectures to bridge analog environments with digital systems.

f. **Course Learning Outcomes:**

CLO 1	Describe characteristics, specifications & parameters of Op-AMP.
CLO 2	Apply operational amplifiers in linear applications such as differentiators, integrators, filters, and compensators.
CLO 3	Apply operational amplifiers in non-linear applications such as comparators, waveform generators, detectors, and Schmitt triggers.
CLO 4	Design IC 555 timer circuit including astable, monostable, and bistable modes.
CLO 5	Describe the process of Analog to Digital conversion and Digital to Analog conversion.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. **Contents:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**Differential, Multi-Stage and Operational Amplifiers Differential** Amplifier; Power Amplifier; Direct Coupled Multi-Stage Amplifier; Block diagram representation of a typical op-amp, Internal Structure of An Operational Amplifier, Ideal Op-Amp,	16 %	7

Sr. No.	Topic	Weightage	Teaching Hrs.
	Non-Idealities in an Op-Amp (Output Offset Voltage, Input Bias Current, Input Offset Current, Slew Rate, Gain Bandwidth Product, CMRR, Slew Rate etc.), types of ICs, Manufacturers' designations and package types for ICs, Power supplies for ICs		
2	**Linear Applications of Op-Amp** Idealized Analysis of Op-Amp Circuits. Inverting And Non-Inverting Amplifier, Differential Amplifier, Instrumentation Amplifier, Integrator, peaking amplifier, Summing, Scaling and Averaging amplifier, Voltage-to-current converter, Integrator, Differentiator	24 %	11
3	**Nonlinear Applications of Op-Amp** Comparator, Zero Crossing Detector, Schmitt Trigger, Voltage Limiters, Absolute Value Output Circuit, Peak Detector, Sample and Hold Circuit, Precision Rectifier – Half/Full Wave, Square, Triangular and Saw tooth Wave Generator, Log/ Antilog Amplifier.	24 %	11
4	**Active Filters, Oscillators & 555 Timer Integrated Circuit** Introduction, 1st Order LPF, HPF Filters, Band Pass, Band Reject and All Pass Filters. Oscillator Types and Principle of Operation - RC, Wien and Quadrature Type. Introduction To 555 Timer, Functional Diagram, Monostable and Astable Operations and Applications, Schmitt Trigger. PLL - Introduction, Block Schematic, Principles and Description of Individual Blocks Of 565.	24 %	11
5	**D-A And A-D Converters** Introduction, Basic DAC Techniques, Weighted Resistor DAC, R-2R Ladder DAC, Inverted R2R DAC, And IC 1408 DAC, Different Types of ADCs - Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC And Slope ADC. DAC And ADC Specifications	10 %	5

***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Op-Amps & Linear ICs (Textbook) By Ramakanth A. Gayakwad | PHI.
2. Operational Amplifiers and Linear IC's By David A. Bell | Oxford University Press | 3rd edition.
3. Linear Integrated Circuits (Textbook) By D. Roy Chowdhury | New Age International(p) Ltd.
4. Operational Amplifiers & Linear Integrated Circuits: Theory & Applications By Denton J. Daibey | TMH.

a. **Course Name:** Analog Electronics Circuits Laboratory

b. **Course Code:** 03010604PE04

c. **Prerequisite:** Knowledge of Basic Electronics

d. **Rationale:** The course will give ideas about practical design aspects about Analog electronics.

e. **Course Learning Objective:**

CLOBJ 1	Measure critical operational amplifier parameters—including input/output offset voltages, slew rate, and input bias currents—using standard laboratory instrumentation and test configurations.
CLOBJ 2	Analyze the frequency response and transient behaviour of linear op-amp networks, including active low-pass filters, integrators, differentiators, and compensators.
CLOBJ 3	Implement non-linear op-amp circuits, such as relaxation oscillators and Schmitt triggers, to evaluate threshold detection and automated waveform generation.
CLOBJ 4	Design and test precise time-delay and pulse-generation networks by configuring the IC 555 timer into astable and monostable multivibrator topologies.

f. **Course Learning Outcomes:**

CLO 1	Measure different parameters of Op-Amp like input and output offset voltage, Slew rate & Bias Current.
CLO 2	Analyze linear applications of Op-Amp like low pass filters, integrator, differentiator & Compensator.
CLO 3	Implement various Non-linear applications of Op-Amp like waveform generation, Schmitt Trigger & Compensator.
CLO 4	Design astable and monostable multi vibrator using 555 timer IC

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation.

h. **List of Practical's:**

1.	To Measurement of input and output offset voltage of 741 ICs.
2.	To configure the op-amp in voltage follower mode and to measure its slew rate.
3.	To configure op-amp in inverting amplifier mode and measure their gain.
4.	To configure op-amp in non-inverting amplifier mode and measure their gain.
5.	To configure op-amp in Integrator amplifier mode and measure their gain.
6.	To configure op-amp in Differentiator amplifier mode and measure their gain.
7.	To configure op-amp in summing amplifier mode in inverting and noninverting configuration.
8.	To design Schmitt trigger circuit using op-amp and take measurements.
9.	To observe Op-Amp as a function generator, square wave generator and triangular wave generator.
10.	To observe Op-Amp as Voltage comparator, peak detector and zero crossing detectors.
11.	To Perform Monostable multi-vibrators using 555 timer IC and verify their operation by observing waveforms.

12.	To Perform Astable multi-vibrators using 555 timer IC and verify their operation by observing waveforms.
13.	To Perform Butterworth 1st order low-pass filter (Sallen-key circuit), construct the same circuit on breadboard and take necessary measurements.
14.	To Perform Butterworth 1st order High-pass filter (Sallen-key circuit), construct the same circuit on breadboard and take necessary measurements.

a. **Course Name:** Solar Photovoltaic Systems
b. **Course Code:** 03010604PE05
c. **Prerequisite:** Basic knowledge of Renewable Energy Sources.
d. **Rationale:** Course provides to the students an exposure to solar power generation systems along with their applications. Knowledge of the solar energy system and its fundamentals are also covered. Students will also be able to design solar power generation systems used to supply smaller installations. The subject will also help students understand different components used in Solar PV systems in detail.
e. **Course Learning Objective:**

CLOBJ 1	Explain the atmospheric physics of solar radiation and the quantum-mechanical principles of electron-hole pair generation that govern photovoltaic conversion within semiconductor junctions.
CLOBJ 2	Analyze the electrical performance profiles of solar cells, modules, and scaled arrays by evaluating their current-voltage (I-V) and power-voltage (P-V) characteristics under varying irradiance and temperature conditions.
CLOBJ 3	Specify the technical functional roles, operational mechanisms, and selection criteria for critical solar PV balance-of-system components, including charge controllers, inverters, and energy storage systems.
CLOBJ 4	Design optimized small-scale solar photovoltaic systems by calculating load demands, sizing array capacities, and matching structural components to meet localized energy requirements.

f. **Course Learning Outcomes:**

CLO 1	Explain the principles of solar radiation and photovoltaic conversion.
CLO 2	Analyse the performance characteristics of solar cells, modules and arrays.
CLO 3	Describe different components required in a Solar PV System in detail.
CLO 4	Design Small Scale Solar PV System.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T**- Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. **Contents:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**SOLAR ENERGY SYSTEM FUNDAMENTALS** Basic characteristics of sunlight, fundamentals of solar energy system, solar radiation spectra, solar geometry, earth sun angles, observer sun angles, solar day length, estimation of solar energy availability, applications, Solar radiation measurement instruments like pyranometer, pyrheliometer.	6 %	3
2	**SOLAR PHOTO VOLTAIC CELL** Basic of semiconductor physics, PN Junction and Photovoltaic Effect, Solar Cell Types: Mono Crystalline, Poly Crystalline,	18 %	8

Sr. No.	Topic	Weightage	Teaching Hrs.
	Thin Film, Emerging PV Technologies, Solar Cell Construction and Working Principle, Solar Cell I-V and P-V Characteristics, Solar Cell Parameters: Open Circuit Voltage (Voc), Short Circuit Current (Isc), Fill Factor (FF), Efficiency, Power Output, Limits to Cell Efficiency, Factors affecting Solar Cell Performance like Temperature, Irradiance, Shading, Equivalent circuit of Solar Cells, Examples.		
3	**SOLAR PHOTO VOLTAIC MODULE AND ARRAYS** Advantages and disadvantages of Solar PV System, PV Module, Ratings for Solar PV Module, Series and Parallel connections, PV Array, Bypass and Blocking Diodes, Effect of Temperature, Irradiance and shading on Solar Array performance, Types of Solar PV system connections.	22 %	10
4	**SOLAR PHOTO VOLTAIC SYSTEM COMPONENTS** Solar PV Module and Array, Power Conditioning/Converting Equipments, Solar Inverter, Charge Controller, Battery Charger, Maximum Power Point Tracking (MPPT), Uninterrupted Power Supply, Energy Storage Devices: Lead-Acid Storage Battery, Nickel Cadmium Storage Battery, Other Battery Systems, Protection Components: Fuse, Grounding, Surge Protection.	28 %	12
5	**DESIGN AND APPLICATIONS OF SOLAR PV & SOLAR ENERGY SYSTEM** Solar PV System types: Standalone, Grid Connected and Hybrid, Design of solar PV installation, examples, Emerging trends in Solar PV system, Integration with other renewables (e.g., wind-PV hybrids), Solar PV applications like rooftop systems, street lighting, water pumping, solar thermal power generation.	26 %	12

***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Solar Photovoltaic Fundamentals, Technologies and Applications by Chetan Singh Solanki | PHI Learning Private Limited.
2. Photovoltaic Systems Engineering by Roger A. Messenger and Jerry Ventre | CRC Press.
3. Wind and Solar Power Systems Design, Analysis, and Operation by Mukund R. Patel | Taylor & Francis.
4. Principles of Solar Engineering by D. Yogi Goswami | CRC Press.
5. Renewable Energy Sources and Emerging Technologies by D. P. Kothari, K. C. Singal and Rakesh Ranjan | PHI Learning Private Limited.
6. Handbook of Photovoltaic Science and Engineering by Antonio Luque and Steven Hegedus | John Wiley & Sons Ltd.

a. **Course Name:** Solar Photovoltaic Systems Laboratory
b. **Course Code:** 03010604PE06
c. **Prerequisite:** Basic knowledge of Renewable Energy Sources.
d. **Rationale:** Course will provide practical knowledge of parameters affecting output of Solar PV System along with their I-V and P-V characteristics. Students will also be able to design solar power generation systems used to supply small scale demand. The syllabus will also help students understand how to simulate solar PV systems through software**.**
e. **Course Learning Objective:**

CLOBJ 1	Analyze the operational impact of environmental variables—such as solar irradiance, ambient temperature, shading, and tilt angles—on the power output of solar PV cells, modules, and arrays.
CLOBJ 2	Evaluate the electrical efficiency, fill factor, and maximum power point (MPP) of photovoltaic devices by experimentally mapping and interpreting their I-V and P-V characteristic curves.
CLOBJ 3	Design optimized small-scale solar PV installations by accurately sizing arrays, selecting appropriate balance-of-system components, and accounting for localized load demands.
CLOBJ 4	Synthesize raw performance data collected from renewable energy testbeds into rigorous, publication-grade technical reports that feature clear graphical data illustrations and error analyses.
CLOBJ 5	Demonstrate the operational integration and power-sharing dynamics of wind-solar hybrid energy systems operating under varying weather and grid conditions.

f. **Course Learning Outcomes:**

CLO 1	Analyse parameters affecting output of Solar PV Cell, Modules and Arrays.
CLO 2	Analyse I-V and P-V characteristics of Solar PV Cell, Modules and Arrays.
CLO 3	Design Small Scale Solar PV System.
CLO 4	Illustrate experimental data from performance and prepare technical reports.
CLO 5	Demonstrate working of Wind and Solar hybrid energy systems.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **List of Practicals:**

1.	To demonstrate I-V and P-V characteristics of PV modules with varying radiation and temperature levels.
2.	To demonstrate I-V and P-V characteristics of a series combination of PV modules.
3.	To demonstrate I-V and P-V characteristics of parallel combination of PV modules.
4.	To demonstrate the Effect of shading on PV module output power.
5.	Analysis of I-V and P-V characteristics of Solar PV systems using MATLAB.
6.	Design of Solar PV System using MATLAB.
7.	Simulation of standalone PV system using MATLAB.
8.	Demonstration of hybrid energy system - Wind and Solar hybrid system.
9.	MATLAB programming of different examples of solar PV systems.
10.	Visit to the Solar PV power generation facility.

a. **Course Name:** Signals and Systems

b. **Course Code:** 03010604PE07

c. **Prerequisite:** Inclination to learn mathematics, basic knowledge of differential equations and difference equations, electrical circuits and networks.

d. **Rationale:** The course will provide a strong foundation on signals and systems which will be useful for creating the foundation of communication and signal processing. The students will learn basic continuous time and discrete time signals and systems. Students will understand the application of various transforms for analysis of signals and systems both continuous time and discrete time.

e. **Course Learning Objective:**

CLOBJ 1	Analyze the internal hardware architecture, register organization, and instruction execution cycles of microcontrollers to perform fundamental arithmetic and logic operations.
CLOBJ 2	Develop efficient assembly-level programs by selecting appropriate addressing modes and data transfer instructions to optimize memory utilization and execution speed.
CLOBJ 3	Design and interface external electronic circuitry such as sensors, actuators, displays, and switches with microcontroller I/O ports while ensuring electrical compatibility.
CLOBJ 4	Evaluate high-level C programs and assembly code routines to compile, debug, and flash executable machine code onto a target controller for solving real-world embedded control problems.

f. **Course Learning Outcomes:**

CLO 1	Solve basic operations using the different instructions of microprocessors/microcontrollers and explain the different microcontroller's internal architecture and its operation.
CLO 2	Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microcontroller.
CLO 3	Design and develop electrical circuitry for the microcontroller I/O ports in order to interface the controller to external devices.
CLO 4	Evaluate and analyse C language and assembly language programs, select the appropriate assembler, and download the machine code that will provide solutions for the real-world control problems.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. **Contents:**

Sr. No.	Topic	Weightage	Teaching Hrs.
1	**Introduction to Signals and Systems** Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties, Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential,	29 %	13

Sr. No.	Topic	Weightage	Teaching Hrs.
	some special time-limited signals; continuous and discrete time signals, Continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift invariance, causality, stability, reliability. Examples.		
2	**Behaviour of continuous and discrete-time LTI systems** Impulse response and step response, convolution, Characterization of causality and stability of LTI systems.	20 %	8
3	**Fourier, Laplace and Z- Transforms** Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT). Fast Fourier Transform (FFT) and its properties, Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behaviour. The z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, z domain analysis.	36 %	17
4	**Sampling and Reconstruction** The Sampling Theorem and its implications. Reconstruction: ideal interpolator, zero- order hold. Aliasing and its effects.	5 %	2
5	**Hilbert Transform and processing of band pass signals** Representation of band pass signals: In phase and quadrature phase components, Hilbert transform-pre and complex envelopes. Processing of band pass signals through band pass systems.	10 %	5

***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Digital Signal Processing: Principles, Algorithms, & Applications", By Proakis, J.G., & Manolakis, D.G., | Prentice Hall of India.
2. Signals And Systems by Alan V. Oppenheim | Pearson Education.
3. Signals and systems By H. P. Hsu | Schaum's series, McGraw Hill Education, Pub. Year 2010.
4. Signals and Systems by Simon Haykin and Bary Van Veen | Wiley.

a. Course Name: Signals and Systems Lab

b. Course Code: 03010604PE08

c. Prerequisite: Basic knowledge of Renewable Energy Sources.

d. Rationale: Course will provide practical knowledge of parameters affecting output of Solar PV System along with their I-V and P-V characteristics. Students will also be able to design solar power generation systems used to supply small scale demand. The syllabus will also help students understand how to simulate solar PV systems through software**.**

e. Course Learning Objective:

CLOBJ 1	Characterize fundamental continuous-time and discrete-time signals including steps, impulses, sinusoids, and exponentials—by evaluating their mathematical properties, symmetry, periodicity, and energy profiles.
CLOBJ 2	Apply core mathematical techniques, including linear convolution, amplitude modulation, and the Nyquist sampling theorem, to manipulate and process signals without aliasing distortion.
CLOBJ 3	Analyze the stability, causality, and impulse response of Linear Time-Invariant (LTI) systems in both time and frequency domains using differential and difference equations.
CLOBJ 4	Simulate complex signals and systems using software tools to visually evaluate the real-world effects of time-shifting, scaling, and transform-domain filtering operations.

f. Course Learning Outcomes:

CLO 1	Generate and characterize various continuous and discrete time signals.
CLO 2	Development of the mathematical skills to solve problems involving convolution, modulation and sampling.
CLO 3	Design and analyse linear time-invariant (LTI) systems and compute its response.
CLO 4	Carry simulation on signals and systems for observing effects of applying various properties and operations.

g. Teaching and Examination Scheme:

Teaching Scheme (Hrs / Week)			Credit	Examination Scheme					Total
				External		Internal			
L	T	P		Theory	Practical	Theory	CE	Practical	
0	0	2	1	00	30	00	00	20	50

L- Lectures, **T**- Tutorial, **P** - Practical, **CE** - Continuous Evaluation

h. List of Practicals:

1.	Familiarize with MATLAB software, general functions and signal processing toolbox functions.
2.	Write a MATLAB program to generate and plot common continuous time signals.
3.	Write a MATLAB program to generate and plot common discrete time signals.
4.	Write a MATLAB program for observing the effects of lower sampling rate and higher sampling rate on continuous time signal.
5.	Write a MATLAB program to Perform Delaying and Advancing of signals.
6.	Write a MATLAB program to Perform Folding in Time Domain.
7.	Write a MATLAB program to perform various operations on the signals using computational software.
8.	Write a MATLAB program to generate even and odd parts of signals.

9.	Write a MATLAB program to find Impulse Response of a system.
10.	Write a MATLAB program to find the convolution of two signal.

a. **Course Name:** Power Plant Engineering
b. **Course Code:** 03010604BS01
c. **Prerequisite:** Basic Electrical Engineering.
d. **Rationale:** The course provides introductory treatment of the field of Power Plant Engineering to the students of various branches of engineering.
e. **Course Learning Objective:**

CLOBJ 1	Classify conventional and renewable energy generation sources based on resource availability, economic factors, and grid-integration constraints within identified energy system frameworks.
CLOBJ 2	Analyze the operational mechanics, thermodynamic cycles, auxiliary systems, and environmental site-selection criteria for thermal, hydro, nuclear, and gas turbine power stations.
CLOBJ 3	Evaluate the conversion technologies, structural configurations, and power harvesting capabilities of utility-scale solar photovoltaic and wind energy generation systems.
CLOBJ 4	Compare the electrochemistry, operating temperatures, and fuel efficiencies of diverse fuel cell technologies including PEMFC, SOFC, and MCFC for stationary and mobile power generation.
CLOBJ 5	Explain the technical specifications, protective roles, and operational conditions of critical electrical substation equipment, including transformers, circuit breakers, isolators, and bus bar arrangements.

f. **Course Learning Outcomes:**

CLO 1	Classify various sources of energy generation under conditions of energy system identification.
CLO 2	Explain working of Thermal, Hydro, Nuclear, and Gas Turbine power plants with their auxiliaries, environmental aspects of site selection.
CLO 3	Describe solar power generation and wind power generation.
CLO 4	Discuss power generation through different types of fuel cells.
CLO 5	Explain different types of equipment used in substations under operational conditions.

g. **Teaching and Examination Scheme:**

Teaching Scheme (Hrs / Week)			**Credit**	**Examination Scheme**					**Total**
				External		**Internal**			
L	**T**	**P**		**Theory**	**Practical**	**Theory**	**CE**	**Practical**	
3	0	0	3	60	00	20	20	00	100

L- Lectures, **T-** Tutorial, **P -** Practical, **CE -** Continuous Evaluation

h. **Contents:**

Sr. No.	**Topic**	**Weightage**	**Teaching Hrs.**
1	**Introduction** Generation of electric power from Conventional and non-conventional sources of energy. Resources and Development of Power in India Calculation of gross calorific and Net calorific value of fuel, Bomb calorimeter application, Power crisis in India.	7 %	3
2	**Thermal Power Plant** Schematic arrangement, advantages and disadvantages, choice of	13 %	6

Sr. No.	Topic	Weightage	Teaching Hrs.
	site, efficiency of steam power station, Rankine cycle and its improvements Boilers: types, construction, working, Boiler accessories and mountings, Condensers and cooling towers, Ash handling and coal handling systems, Top ten thermal plant in India with Installed Capacity.		
3	**Hydro Power Plant** Hydrological cycle and water power development, Classification of hydro power plants, Calculation of Power developed and Hydrograph, Layout and components, Hydraulic turbines (Pelton, Francis, and Kaplan) advantages and disadvantages, choice of site, efficiency of steam power station.	12 %	5
4	**Nuclear Power Plants** Schematic arrangement, advantages and disadvantages, selection of site, Nuclear Reaction, Nuclear fission and chain reaction, Types of nuclear reactors (PWR, BWR, PHWR, FBR) Nuclear reactor main parts and their function, pollution from nuclear power plants.	12 %	5
5	**Gas and Diesel Power Plants** Brayton cycle and its modifications, Open and closed cycle gas turbines, Combined cycle power plants, Performance analysis, Two-stroke and four-stroke engines, Applications, advantages, and limitations.	9 %	4
6	**Solar Power Plant :** Solar radiation spectrum, Radiation measurement, Applications of solar thermal systems, schematic arrangement of solar power plant, Solar Photovoltaic (SPV) systems Operating principle, Photovoltaic cell concepts, Types of solar cells, fabrication of SPV cells, Cell, module, array (Series and parallel connections), SPV system components and their characteristics.	13 %	6
7	**Wind Power Generation :** Basic principles of wind energy conversion , forces on the blade, power in the wind maximum power, Basic components of wind energy conversion systems, classifications of WECS-HAWT, VAWT, Schemes of electric generation, Squirrel Cage Induction Generators (SCIG), wound rotor (WRIG), doubly-fed (DFIG), wound rotor synchronous generator (WRSG), Permanent magnet synchronous generator (PMSG)., Site selection considerations**.**	12 %	6
8	**Fuel cell based power plant :** Introduction, concept, types, Electrochemical Reactions, Hydrogen, Oxygen Fuel cells, Phosphoric Acid Fuel cells, Molten Carbonate Fuel cells, Methanol fuel cells, Medium temperature, fuel cell, Fuels, Commercial plants in the world.	8 %	3
9	**Substation and Economics of Power Generation :** Classification of Substations, substation equipment, Specification and selection of equipment, Site selection of substation, Load curves, Load duration curves, Connected load, Maximum load, Peak load, Base load and peak load power plants, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor, Cost of power plant, Performance and operating characteristics of power plant, Tariff for electric energy.	13 %	6

***Continuous Evaluation:** It consists of Assignments/Seminars/Presentations/Quizzes/Surprise Tests (Summative/MCQ) etc.

i. Reference Books:

1. Renewable Energy Sources for Sustainable Development by N. S. Rathore ; New India Publishing Agency.
2. A Textbook of Power System Engineering by A. Chakrabarti , M.L. Soni , U.S. Bhatnagar , P.V. Gupta ; Dhanpat Rai & Co.
3. Wind power in Power Systems by Thomas Ackermann ; John Willy and sons.
4. Electrical Power system by Mehta, V.K. ; S. Chand & Co., New Delhi.
5. Non-Conventional Energy Sources by G. D. Rai ; khanna publishers ; fifth.