B.Tech Curriculum for Electrical Engineering					
Semester-III					
Subject Name	**Type**	**Subject Code**	**L-T-P**	**Credit**	**Contact Hours**
	HSS-2		3-0-0	3	3
Electrical Measurements	SDC-2	EE2L008	2-0-2	3	4
Signals and Linear Systems	DC-2	EE2L005	3-1-0	4	4
Electric Machines-I	DC-3	EE2L006	3-1-0	4	4
Electromagnetic Engineering	DC-4	EE2L007	3-0-0	3	3
Analog and Digital Electronic Circuits Lab	DC Lab-1	EE2P002	0-0-3	2	3
Electrical Machines Laboratory – I	DC Lab-2	EE2P003	0-0-3	2	3
			Total	21/22	24/25
Semester-IV					
Subject Name	**Type**	**Subject Code**	**L-T-P**	**Credit**	**Contact Hour**
	HSS-3		3-0-0	3	3
SDC-3	SDC-3		2-0-2	3	4
Elective-1	OE-1		3-0-0	3	3
Electric Machines-II	DC-5	EE2L009	3-1-0	4	4
Network Analysis	DC-6	EE2L010	3-1-0	4	4
Embedded Systems	DC-7	EC2L107	2-0-2	3	4
Electrical Machines Laboratory – II	DC Lab-3	EE2P004	0-0-3	2	3
			Total	22	25

SDC Basket (Minimum ONE subject will be offered by the Department)					
Electrical Energy Utilisation and Safety Practices	SDC-3	EE2L012	2-0-2	3	4
Instrumentation Engineering	SDC-3	EE2L013	2-0-2	3	4
Open Elective Basket (Minimum ONE subject will be offered by the Department)					
Transducers, Sensors and Actuators	OE-1	EE2L014	3-0-0	3	3

Subject Code: EE2L005	Name: Signals and Linear Systems	L-T-P-C: 3-1-0-4

Prerequisite: None

Module 1: (Introduction to Signals) (5 hours)
Definition and classification of signals, Standard signals: Unit impulse, unit step, unit ramp, exponential, sinusoidal; Operations on signals: Time-shifting, time-scaling, time-reversal, Addition, multiplication, and integration of signals, Signal transformation.

Module 2: (Systems and Their Properties) (6 hours)
Definition and classification of systems, System representation, Impulse response, Convolution integral (continuous-time), Convolution sum (discrete-time), Properties of convolution, Interconnection of systems.

Module 3: (Fourier Series) (11 hours)
Fourier Series: Trigonometric and exponential forms, Conditions for convergence (Dirichlet's conditions), Properties of Fourier Series.

Module 4: (Fourier Transform) (10 hours)
Continuous-Time Fourier Transform (CTFT), Properties of Fourier Transform; Frequency response of LTI systems, Parseval's theorem, Fourier transform of discrete signals.

Module 5: (Discrete-time Fourier Transform) (5 hours)
Definition, existence, DTFT of basic signals, properties, Frequency response and applications.

Module 6: (Laplace Transform) (10 hours)
Definition and region of convergence (ROC), Properties and theorems, Inverse Laplace Transform, Transfer function and system analysis.

Module 7: (Z Transform) (9 hours)
Principle of Sampling, Definition of Z-transform, region of convergence, Properties and theorems, Inverse Z-Transform, System function of discrete-time LTI systems.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	Signals and Systems: An Indian Adaptation **by S. Haykin and B. Van Veen, Wiley, India.**	2021
2.	Signals and Systems **by A. V. Oppenheim, A. S. Willsky, and S. H. Nawab Prentice Hall.**	1997

Reference Books:

1.	Linear Systems and Signals **by B. P. Lathi and R. A. Green**, **Oxford University Press**	2018
2.	Signals and Systems: A Primer with MATLAB **by M. N. O. Sadiku, W. H. Ali, and S. M. Musa, CRC Press**	2024
3.	Fundamentals of Signals and Systems **by M. J. Roberts and G. Sharma, McGraw-Hill Education**	2010

Subject Code: EE2L006	Name: Electric Machines-I	L-T-P-C: 3-1-0-4

Prerequisite: None

Module 1: (Magnetic Circuits) (8 hours)

Magnetic field and magnetic flux, Magneto motive force (MMF) and reluctance, Permeability and magnetic materials, Comparison between electric and magnetic circuits, Magnetic hysteresis and B-H curve, Magnetic core losses: hysteresis loss and eddy current loss, Magnetic leakage and fringing, Series and parallel magnetic circuits, Energy stored in magnetic fields.

Module 2: (Transformers) (16 hours)

Principle of operation of single-phase transformers, Construction details: core type and shell type, EMF equation, Ideal and practical transformers, Equivalent circuit of a transformer, Phasor diagrams, Voltage regulation and efficiency, Losses in transformers, Open-circuit, short-circuit and back-to-back tests, Parallel operation of transformers, Auto-transformers.

Module 3: (Electromechanical systems) (5 hours)

Principle of electromechanical energy conversion, Force and torque in magnetic field systems, Concept of energy and co-energy.

Module 4: (DC Generators) (16 hours)

Construction and working principle of DC machines, Types of DC generators: separately excited and self-excited (series, shunt, compound), EMF equation of a DC generator, Characteristics of different types of generators, Applications of DC generators, Armature reaction and commutation, Losses in DC machines, Efficiency and condition for maximum efficiency.

Module 5: (DC Motors) (9 hours)

Working principle and classification of DC motors, Torque and speed equations, Characteristics of DC motors (Shunt, Series, Compound), Starting methods: 3-point and 4-point starters, Speed control methods: Field control, Armature control, Voltage control, Braking. Applications of DC motors. Testing of DC machines.

Module 6: (Permanent Magnet DC Motors) (2 hours)

Permanent Magnet DC Motors (PMDC)- Working principle, construction and characteristics.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	Electric Machinery Fundamentals by **S. J. Chapman, Mc Graw Hill**	2017
2.	Electric Machinery by **A. E.Â Fitzgerald, C. Kingsley, Jr, and S. D. Umans, Mc Graw Hill**.	2017
3.	Electric Machines by **Nagrath and Kothari, Mc Graw Hill.**	2017

Reference Books:

	Electrical Machinery by **P.S Bimbhra, Khanna Publishers.**	2021
2.	The performance and design of Direct Current Machines by **M.G. Say, CBS Publishers**	2004

Subject Code: EE2L007	Name: Electromagnetic Engineering	L-T-P-C: 3-0-0-3

Prerequisite: None

Module 1: (4 hours)

Review of vector algebra, scalar and vector fields, gradient, divergence, curl; line, surface, and volume integrals, divergence theorem, Stokes' theorem, Green's theorem, and different coordinate systems—rectangular, cylindrical, and spherical.

Module 2: (8 hours)

Coulomb's law, concept of electrostatic force, scalar field, electric field intensity, and potential difference; electric dipole, field due to charge distributions (point, line, sheet, volume, and dipole), electric flux density, Gauss's law, application of Gauss's law on different charge distributions, divergence theorem in electrostatic field, voltage distributions, potential gradient, and capacitance estimation in symmetrical geometries due to various charge distributions.

Module 3: (5 hours)

Current density, conduction and displacement current, current continuity equation, conductor properties and boundary conditions, method of images, dielectric materials and boundary conditions, Poisson's and Laplace's equations.

Module 4: (8 hours)

Biot-Savart law, Ampere's circuital law, Stokes' theorem, magnetic flux density, scalar and vector magnetic potential, force on moving charge and differential current element, torque on closed circuit, magnetic materials, inductance and mutual inductance, Faraday's law, estimation of stored energy, and inductance of various symmetric geometries due to current distributions.

Module 5: (11 hours)

Derivation and physical interpretation of Maxwell's equations in integral and differential form. Derivation of various laws/theorems from Maxwell's equations. Solution of Maxwell's equations: selection of coordinate (Cartesian, polar, cylindrical, spherical), symmetry in geometry, and boundary conditions, Electromagnetic Wave propagation, Power, and Poynting Vector.

Module 6: (6 hours)

Numerical Methods in Electromagnetics: Introduction to Finite Difference, Finite Element, and Method of Moments.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Introduction to Electrodynamics **by David J. Griffiths, Pearson.**	2015
2	Principles of Electromagnetics **by M. N. O. Sadiku, & S.V. Kulkarni, Oxford University Press.**	2015
3	Engineering Electromagnetics **by W. H. Hayt, J. A. Buck, and J. Kraus, McGraw-Hill Education.**	2019

Reference Books:

1	Electromagnetics with Applications **by J. D. Kraus and D. A. Fleisch, McGraw-Hill Education.**	1999
2	The Finite Element Method in Electromagnetics **by S. S. Rao**, **CRC Press.**	2009

Subject Code: EE2L008	Name: Electrical Measurements	L-T-P-C: 2-0-2-3

Prerequisite: None

Module 1: (**Electromechanical Instruments**) (4 hours)
Permanent magnet moving coil, Electrodynamic, Moving Iron and Electrostatic Instruments-Sensitivity, torque characteristics, damping-eddy current, control systems, true-RMS measurement concepts.

Module 2: (**Ammeter, Voltmeter and Ohmmeters**) (3 hours)
Instrument Range Extension-Shunts and multipliers for ammeters/voltmeters, Rectifier based voltmeter and ammeter.

Module 3: (**Wattmeters & Energy Meters**) (2 hours)
Dynamometer type wattmeter, errors, calibration, compensated wattmeter.

Module 4: (**Bridge and Potentiometer Techniques**) (8 hours)
Resistance measurement using voltmeter and ammeter, high resistance measurement, four terminal resistance. DC Bridges: Wheatstone and Kelvin double bridge. Impedance measurement, AC Bridges: Maxwell, Hay, Schering, Anderson and De-Sauty bridges; Bridge sensitivity and detector selection; DC & AC Potentiometers for precise measurement. Coordinate potentiometer.

Module 5: (**Analog Electronic Instruments**) (5 hours)
Limitations of classical instruments, electronic interface between classical inst. and probe ckt. Electronic voltage, current and resistance measurements-Electronic DC and AC Voltmeters, Linear resistance meter, Programmable gain amplifiers.

Module 6: (**Digital Instruments**) (6 hours)
Digital Voltmeter-ramp, dual-slope, successive approximation types, Digital Multimeter basics. Frequency, time period and phase angle counters. ADC and DAC ramp, dual-slope, successive approximation types flash type. Signal generators-sine, rectangular, ramp.

Practical Component: (28 hours)

1. Measurements Standards; Errors; statistical error analysis; Performance specifications.
2. Cathode Ray Oscilloscope and Digital Storage Oscilloscope working and its use.
3. Electronic Voltmeters for small A.C. and D.C. voltage measurements and study performances.
4. Voltage to frequency and frequency to voltage conversion using IC- LM331.
5. To study the characteristics of an Instrumentation Amplifier.
6. Design 8-bit ADC and DAC circuits using ICs.
7. Development of a linear capacitance meter using IC555.
8. Calibration of an Energy meter.
9. Calibration of a voltmeter and ammeter using DC Potentiometer.
10. Power Measurement in a 1-phase circuit using CT and PT.
11. Measurement of R, L and C using Kelvin Double bridge, Maxwell bridge and Schering bridge
12. Study of LABVIEW based DAS and its applications

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	A Course in Electrical & Electronic Measurements and Instrumentation **by A. K. Sawhney and P. Sawhney, Dhanpat Rai & Co., New Delhi, India.**	2024
2	Electronic Instrumentation and Measurements **by D. A. Bell, Oxford Univ. Press, New York, NY, USA.**	2019

Reference Books:

1	Instrumentation, Measurement and Analysis **by B. C. Nakra and K. K. Chaudhry, McGraw-Hill Education India.**	2016

Subject Code: EE2P002	Name: Analog and Digital Electronic Circuits Lab	L-T-P-C: 0-0-3-2

Prerequisite: None

1. Introduction to the Lab
2. a) To study response of low pass filter and high pass filter using RC circuit.
2. b) To study diode applications as clipper and voltage doubler circuits.
3. To obtain input and output characteristics of NPN transistors in CE configuration.
4. To measure gain of CE amplifiers at different frequencies.
5. To obtain output and transfer characteristics of MOSFET
6. Implementation of difference amplifier, differentiator and integrator using OPAMP
7. a) To realize logic function using universal gate
7. b) Design and Implementation of Adders and Subtractors using Logic Gates.
8. To generate PWM pulses using 555 Timer IC
9. Design and Implementation of Multiplexer and Demultiplexer using Logic Gates and Study of IC 74150 and IC 74154.
10. Design and Implementation of 3-Bit Synchronous UP/DOWN Counter.
11. Implementation of SISO, SIPO, PISO and PIPO Shift Registers using Flip-Flops.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Microelectronic Circuits **by S. Sedra and K. C. Smith, Oxford University Press, India.**	2005
2	Digital Design **by M. M. Mano and M. D. Ciletti, Pearson Education, NJ, USA.**	2007

Reference Books:

1	Op-Amps and Linear Integrated Circuits **by R. A. Gayakwad, PHI Learning.**	2009
2	Digital Circuits and Logic Design **by Samuel C. Lee, PHI Learning.**	2009

Subject Code: EE2P003	Name: Electric Machines Laboratory - I	L-T-P-C: 0-0-3-2

Prerequisite: None

1. Introduction to the Lab
2. Leakage Impedance of a Single phase three winding Transformer
3. To draw the equivalent circuit and phasor diagram per phase of a Single phase Transformer by back to back test
4. To perform parallel operation of two single phase Transformers
5. Open Circuit and Short Circuit test on 1-Phase Transformer
6. Speed control of D.C. Shunt Motor by Field Flux control and Armature Voltage control method.
7. Open Circuit Characteristics of D.C. Generator
8. External & Internal Characteristics of D.C. Generator
9. To determine torque-speed characteristics of DC shunt motor
10. To determine torque-speed characteristics of DC compound motor
11. To determine torque-speed characteristics of DC series motor

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	Electric Machinery Fundamentals **by S. J. Chapman, Mc Graw Hill**	2017
2.	Electric Machinery **by A. E.Â Fitzgerald, C. Kingsley, Jr, and S. D. Umans, Mc Graw Hill**.	2017
3.	Electric Machines **by Nagrath and Kothari, Mc Graw Hill**.	2017

Reference Books:

1.	Electrical Machinery **by P.S Bimbhra, Khanna Publishers.**	2021
2.	The performance and design of Direct Current Machines **by M.G. Say, CBS Publishers**	2004

Subject Code: EE2L009	Name: Electric Machines-II	L-T-P-C: 3-1-0-4

Prerequisite: None

Module 1: (Magnetic Circuits) (6 hours)
Production of rotating magnetic field with proof, Magneto motive force and flux distribution on AC machines, Induced voltage and torque.

Module 2: (Synchronous Generators) (16 hours)
Generator Construction, Winding configuration, Internal Generated Voltage, Equivalent Circuit, Phasor Diagram, Power and Torque, Losses & Efficiency, Regulation, Effect of Load Changes on a Synchronous Generator operation, Parallel operation of AC Generators, Frequency- power and Voltage-Reactive Power characteristics, Parallel Operation; Equivalent Circuit, Steady state operation of synchronous motor, Power and torque, Torque-Speed characteristic, Losses & Efficiency, Effect of load and field current changes, Different methods of starting.

Module 3: (Induction Motor) (16 hours)
Induction Motor Construction, Basic Induction Motor Concepts, Torque and Power in Induction Motor, Torque-Speed Characteristics, Equivalent Circuit of an Induction Motor, Losses & Efficiency, Starting, Tests. Single phase induction motor, two field theory.

Module 4: (3-phase Transformer) (16 hours)
Construction and operation of 3-phase transformer, Different configurations including Y-Y, Y-Δ , Δ-Y and Δ-Δ, Phase Angle Displacement and Phase Rotation (Different Vector Group), Zigzag Connection, Three-Phase to Two-Phase conversion, Scott Connection, Three winding Transformer.

Module 5: (Introduction to special machines) (2 hours)
Brushless DC Motor, stepper motor, Switched reluctance motor.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	Electric Machinery Fundamentals by **S. J. Chapman, Mc Graw Hill**	2017
2.	Electric Machinery by **A. E.Â Fitzgerald, C. Kingsley, Jr, and S. D. Umans, Mc Graw Hill**.	2017
3.	Electric Machines by **Nagrath and Kothari, Mc Graw Hill.**	2017

Reference Books:

1.	Electrical Machinery by **P.S Bimbhra, Khanna Publishers.**	2021
2.	The performance and design of Direct Current Machines by **M.G. Say, CBS Publishers**	2004

Subject Code: EC2L107	Name: Embedded Systems	L-T-P-C: 2-0-2-3

Prerequisite: None

Module 1: (8 hours)
Introduction to embedded systems and microcontrollers: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems. Embedded System design flow, Hardware-Software Co-Design.
Module 2: (12 hours)
Architecture of ARM Cortex-M: ARM Instruction set architecture, Register Set, Interrupts, Memory and Peripherals
Module 3: (18 hours)
Assembly Language Programming: Basics of Assembly Programming, Data Processing Instructions, Memory Access Instructions, Branch and Control Instructions.
Module 4: (9 hours)
Interfacing: Fundamentals of Input-Output interfacing, GPIO, I/O Synchronization, Interrupt programming, Timing Interfaces.
Module 5: (9 hours)
Serial communication interfaces: UART, I2C, SPI, CAN; Analog Interfacing: A/D and D/A Converters

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	ARM microprocessor systems: cortex-M architecture, programming, and interfacing by **Tahir, Muhammad, and Kashif Javed, 1st edition, 2017, CRC Press. ISBN: 978-1482259384**	2017
2.	Embedded systems with arm cortex-m microcontrollers in assembly language and C. by **Zhu, Yifeng, Fourth Edition**	2023

Reference Books:

1.	The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors. Yiu, Joseph, 2nd edition, 2015, Newnes. ISBN: 0128032774	2015
2.	Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers: A Practical Approach by Dean, Alexander G., 1st edition, 2017, ARM Education Media. ISBN: 9781911531036	2017
3.	ARM Assembly Language: Fundamentals and Techniques by Hohl, William, and Christopher Hinds, 2nd edition, 2014, CRC Press. ISBN: 978-1482229851	2014

Subject Code: EE2L010	Name: Network Analysis	L-T-P-C: 3-1-0-4

Prerequisite: None

Module 1: (Nodal and Loop Analysis) (4 hours)
review, modified nodal analysis.
Module 2: (Series and Parallel Resonance) (4 hours)
Resonance definition, Characteristics-resonant frequency, bandwidth, selectivity and Q-factor.
Module 3: (Magnetically Coupled Circuits) (5 hours)
Dot convention, Self and Mutual inductance; coupling coefficient, stored magnetic energy, circuit analysis.
Module 4: (Network Theorems) (8 hours)
Substitution theorem, Compensation theorem, Reciprocity theorem, Maximum power transfer theorem for DC and AC circuits, Millman's theorem, Tellegen's theorem.
Module 5: (Time and Frequency domain analysis) (11 hours)
Transient analysis of RLC circuit and higher order circuits in time domain; Frequency domain analysis of dynamic circuits using Fourier series, Fourier transforms and Laplace transforms;
Module 6: (Network functions) (8 hours)
poles and zeros, driving point and transfer functions, restrictions on poles and zeros for network functions, time domain behaviour, frequency response plots;
Module 7: (Two-port networks) (9 hours)
z-parameters, y-parameters, h-parameters, and ABCD parameters; reciprocity and symmetry in two-port networks.
Module 8: (State variable analysis of networks) (7 hours)
Network topology: Tree, Co-tree, links, fundamental loops and cut-sets, state-variable modelling and analysis.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Network Analysis **by M.E. Van Valkenburg, Pearson Education**.	2019
2	Engineering Circuit Analysis **by William H. Hayt, Jack Kemmerly, and Steven M. Durbin, McGraw-Hill Education**	2020
3	Network Analysis and Synthesis **by Franklin F. Kuo, John Wiley & Sons**.	2006

Reference Books:

1	Networks and Systems **by D. Roy Choudhury, New Age International Publishers**.	2013
2	Linear Circuit Analysis **by Raymond A. DeCarlo and Pen-Min Lin, Oxford University Press**.	2001
3	Circuit Theory: Analysis and Synthesis **by Abhijit Chakrabarti, Dhanpat Rai & Co.**	2018

Subject Code: EE2P004	Name: Electric Machines Laboratory - II	L-T-P-C: 0-0-3-2

Prerequisite: None

1. Introduction to the Lab
2. Perform Scott connection on two single-phase transformers.
3. Vector group test and Open delta connection of 3 single phase transformer
4. Study the power factor improvement of a 3-phase load by a capacitor bank
5. Perform No-load and Blocked rotor test of a 3-phase induction motor and draw a Circle diagram
6. Determine the regulation of 3-phase alternator by the synchronous impedance method using the open-circuit & short-circuit tests
7. Determine the Direct & Quadrature Axis Synchronous Reactance of a 3-Phase Alternator
8. Determine the regulation of 3-phase alternator by the Zero Power Factor (ZPF) method
   Or 'V' curves of a synchronous machine
9. Determine the Negative sequence & zero sequence impedance of a three-phase Alternator
10. Determine starting and performance characteristics of single-phase Induction motor
11. Determine the performance characteristics of BLDC motor

Text Books:

	Name of the Book, Author & Publisher	Year of Publication / Reprint
1.	Electric Machinery Fundamentals **by S. J. Chapman, Mc Graw Hill**	2017
2.	Electric Machinery **by A. E.Â Fitzgerald, C. Kingsley, Jr, and S. D. Umans, Mc Graw Hill**.	2017
3.	Electric Machines **by Nagrath and Kothari, Mc Graw Hill**.	2017

Reference Books:

1.	Electrical Machinery **by P.S Bimbhra, Khanna Publishers.**	2021
2.	The performance and design of Direct Current Machines **by M.G. Say, CBS Publishers**	2004

Subject Code: EE2L012	Name: Electrical Energy Utilisation and Safety Practices	L-T-P-C: 2-0-2-3

Prerequisite: None

Module 1:(**Power System Overview and Generation**) (4 hours)

Typical power system (generation–transmission–distribution–utilisation); conventional generation (hydro, thermal, nuclear); non-conventional generation (solar, wind, tidal, geothermal, biomass/biogas).

Module 2: (**Variable Load, Economics of Power Generation, Electric Power Supply and Utilisation**) (7 hours)

Variable load: load curve, demand factor, maximum demand, diversity factor, plant use factor; selection of generation type based on load characteristics. Economics of generation: cost of electrical energy, expressions for cost of electrical energy, methods of determining depreciation, importance of high load factor. Tariffs and billing: types of tariff, energy charge, demand charge, TOD concept, bill estimation. kW–kVA–PF relationships, reactive power, low PF causes/effects, power factor improvement—capacitor basics, benefits, cautions.

Module 3: (**Illumination Engineering and Lighting Design Skills**) (5 hours)

Photometry—lumen, lux, candela; efficacy (intro); laws of illumination—inverse-square law, cosine law. Lamps and lighting schemes—incandescent, CFL, LED; selection criteria and applications. Lighting design basics—mounting height, spacing, uniformity; room illumination design and modelling.

Module 4: (**Electric Heating Technologies and Efficiency Analysis**) (5 hours)

Heating methods—resistance, induction, dielectric, arc heating; Joule law and applications. Heating calculations—energy, efficiency, temperature rise; thermal energy balance; electrical vs thermal efficiency; losses and error sources. Dielectric heating (insulation-oriented)—complex permittivity, tan δ, dielectric loss mechanism; dielectric loss heating computation; furnace basics (intro).

Module 5: (**Electrical Safety, Earthing, Wiring, Instruments**) (5 hours)

Common hand tools and their uses, care and maintenance. Wires, cables, wire splicing and termination. Electrical hazards, PPE, safe working practices, shock protection. Protection devices, electric earthing and shock protection. Measurement of earth resistance and testing of installations.

Module 6: (**Electrical Estimation, House Wiring Layout and Substation Layout (Intro)**) (4 hours)

General electrical accessories and insulating materials. Internal wiring systems and lamp circuits. Estimating and costing of material in electrical installations for residential buildings, workshops and halls. Substation layout (intro).

Laboratory syllabus (28 hours)

1. Load Curve and Tariff Billing Exercise — To prepare a daily load curve, estimate energy consumption (kWh), and calculate electricity bill based on tariff.
2. kW–kVA Study and Power Factor Improvement — To study the relationship among kW, kVA and power factor, and determine capacitor requirement for power factor correction.
3. Brake Test of Motor — To study plugging, dynamic braking and regenerative braking of separately excited DC motor.
4. Lux Measurement + Illumination Law Verification — To measure illuminance (lux) and verify the inverse-square and cosine laws of illumination.
5. Room Light Design (Room Modelling + Report) — To design indoor lighting using room modelling and obtain lux distribution, uniformity and lighting power density.
6. Resistance Heating Efficiency Test — To correlate electrical energy input with temperature rise and determine heating efficiency of a resistance heater.
7. Tan δ Measurement → Dielectric Loss Heating Computation — To measure capacitance and tan δ of an insulation sample and compute dielectric loss heating power.
8. Distribution Box (DB) Layout and Connections — To identify DB components and perform correct wiring connections with safety checks and verification.
9. Electrical Layout of 1-BHK House — To prepare the electrical point layout, circuit grouping and single line diagram (SLD) for a 1-BHK house.
10. 1-BHK Estimate and Implementation — To prepare a bill of quantities and implement the planned house wiring on a trainer board with testing and checks.

Text Books:

Sl. No.	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Generation, Distribution and Utilization of Electrical Energy **by C.L. Wadhwa, New Age International**	2015
2	Utilization of Electric Power and Electric Traction **by J.B. Gupta, S.K. Kataria & Sons.**	2013
3	Utilization of Electrical Power **by R.K. Rajput, Laxmi Publications**	2006
4	Electrical Wiring Estimating and Costing **by S. L. Uppal and G. C. Garg**	2025

Reference Books:

Sl. No.	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Utilization of Electrical Energy **by E. Openshaw Taylor, Orient Blackswan**	1971
2	Art and Science of Utilization of Electrical Energy **by H. Partab, Dhanpat Rai & Sons**	2017

Subject Code: EE2L013	Name: Instrumentation Engineering	L-T-P-C: 2-0-2-3

Prerequisite: None

Module 1: (**Introduction**) (2 hours)

Applications of measurement instrumentation, general configuration of measuring instruments. Errors and uncertainties in performance parameters, propagation of uncertainties.

Module 2: (**Static Performance Characteristics of Instruments**) (3 hours)

Static calibration, static error, static performance parameters: range, span, accuracy, precision, resolution, sensitivity, linearity, hysteresis, dead time etc. , loading effect. Instrument specifications and selection.

Module 3: (**Dynamic Characteristics of Instruments**) (3 hours)

Modelling- formulating governing equations for systems. Dynamic response of zero, first and second order systems. Frequency response of systems. Response of systems to transient inputs. Compensation Techniques.

Module 4: (**Transducer Elements**) (3 hours)

Analog transducers: resistive, inductive, capacitive. Piezoelectric, strain gauge, optical and digital transducers.

Module 5: (**Motion and Vibration Measurement**) (3 hours)

Relative motion measurement using electromechanical devices-LVDT etc. , Seismic devices for absolute motion measurement. Gyroscopic devices.

Module 6: (**Temperature Measurement**) (3 hours)

Electrical method: RTD, thermistor, and thermocouple. Radiation method: Pyrometer.

Module 7: (**Flow Measurement**) (3 hours)

Flow measurement with orifice meter, venturi meter, rotameter, weirs and pitot's static tube.

Module 8: (**Pressure Measurement**) (3 hours)

manometers and elastic elements-bourdon gauge, Low pressure measurement with McLeod, pirani, ionization gauges and radiation pyrometers, high pressure measurement with Birdman gauge.

Module 9: (**Force and Torque Measurement**) (3 hours)

Load cell and electromechanical measurement methods, strain gauge torque meters.

Module 10: (**Recent developments in Instrumentation and measurements**) (2 hours)

Fiber optic transducers, micro and smart sensors, etc.

Practical Component: (28 hours)

1. Measurement of displacement by LVDT
2. Measurement of Inductance by LVIT
3. Measurement of strain using Strain Gauge
4. Measurement of tension and compression using load cell module
5. Measurement of deflection torque by torque transducer
6. Study of opto-electric transducers and measurement of speed.
7. Study of RTD, thermistor characteristics
8. Study of Capacitive transducers
9. Study of signal conditioning circuits with different sensors.
10. Design and development of measurement system with signal conditioning elements and Data acquisition using LABVIEW.

Text Books:

	Name of the Book, Author & Publisher	Year of Publication
1	Instrumentation, Measurement and Analysis by **B. C. Nakra and K. K. Chaudhry, McGraw-Hill Education India.**	2016
2	Electronic Instrumentation and Measurements **by E. O. Doeblin and D.N. Manik, McGraw-Hill Education India.**	2019

Reference Books:

1	A Course in Electrical & Electronic Measurements and Instrumentation **by A. K. Sawhney and P. Sawhney, Dhanpat Rai & Co., New Delhi, India.**	2024
2	Electronic Instrumentation and Measurements **by D. A. Bell, Oxford Univ. Press, New York, NY, USA.**	2019

Subject Code: EE2L014	Name: Transducers, Sensors and Actuators	L-T-P-C: 3-0-0-3

Prerequisite: None

Module 1: (**Fundamentals of Measurement and Transducers**) (8 hours)
Measurement system; classification of transducers; active/passive, analog/digital, primary/secondary transducers. Static characteristics: Static calibration, static error, correction, range, span, accuracy, precision, sensitivity, linearity, hysteresis, dead time, dead zone, resolution, loading effect. Dynamic characteristics: Modelling a sensor, zero, first and second order systems, calibration and uncertainty.

Module 2: (**Resistive, Inductive and Capacitive Transducers**) (6 hours)
Resistance-based transducers: Potentiometer, strain gauge, RTD, thermistor. Inductive transducers: LVDT, variable reluctance, eddy-current sensor. Capacitive transducers: Differential capacitive sensors; displacement, position and proximity measurement; practical applications.

Module 3: (**Magnetic, Electromagnetic and Optical Sensors**) (6 hours)
Hall-effect sensors; magneto-resistive sensors; electromagnetic pickup; tacho-generators; optical sensors—photodiode, phototransistor, LDR, encoder; incremental and absolute encoders.

Module 4: (**Temperature, Pressure, and Force Sensors**) (6 hours)
Temperature Sensors: Thermocouples, RTDs, thermistors, semiconductor temperature sensors. Pressure Sensors: strain-gauge, piezoresistive and capacitive; force and torque sensors; load cells; piezoelectric sensors.

Module 5: (**Signal Conditioning**) (8 hours)
Sensor excitation and bridge circuits; instrumentation amplifier; filtering and noise reduction; linearization; isolation; ADC/DAC and sampling; sensor interfacing with microcontrollers; digital sensors and communication interfaces.

Module 5: (**Actuators and Integrated Sensor–Actuator Systems**) (8 hours)
Actuator classification; electromagnetic actuators; DC motors, BLDC motors and stepper motors; servo actuators; piezoelectric actuators; pneumatic and hydraulic actuators; selection and sizing of actuators; actuator drive circuits; sensors–controllers–actuators interaction; applications in robotics, Electric Vehicles, drones and industrial automation.

Text Books:

Sl. No.	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Sensors and Transducers **by D. Patranabis, PHI Learning**	2003
2	Introduction to Mechatronics and Measurement Systems **by David G. Alciatore and Michael B. Histand**	2011

Reference Books:

Sl. No.	Name of the Book, Author & Publisher	Year of Publication / Reprint
1	Sensors and Signal Conditioning by **R. Pallàs-Areny and J. G. Webster, Wiley & Sons**	2000
2	Process Control Instrumentation Technology **by Curtis D. Johnson**	2005