ANNEXURE-II

Scheme of Studies and Examination
B. Tech (Electrical Engineering) – 3rd Semester
w.e.f. 2025-26

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal Assessment	External Examination	Practical	Total	
1	Humanities and Social science, including Management Courses	HSMC-02A	Economics for Engineers	3	0	0	3	3	40	60		100	3
2	Professional Core Courses	PCC-EE-201A	Analog Electronics	3	0	0	3	3	40	60		100	3
3	Professional Core Courses	PCC-EE-203A	Electric Circuit Analysis	3	1	0	4	4	40	60		100	3
4	Professional Core Courses	PCC-EE-205A	Measurement and Instrumentation	3	0	0	3	3	40	60		100	3
5	Professional Core Courses	PCC-EE-207A	Electrical Machines-I	3	0	0	3	3	40	60		100	3
6	Professional Core Courses	PCC-EE-209A	Electrical Engineering Materials	3	0	0	3	3	40	60		100	3
7	Mandatory Courses	MC-201A	Environmental Science	2	0	1	-	0	40		60		3
8	Professional Core Courses	LC-EE-211A	Analog Electronics Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses	LC-EE-213A	Electric Circuit Analysis Lab	0	0	2	2	1	25		25	50	3
10	Professional Core Courses	LC-EE-215A	Measurement and Instrumentation Lab	0	0	2	2	1	25		25	50	3
11	Professional Core Courses	LC-EE-217A	Electrical Machines-I Lab	0	0	2	2	1	25		25	50	3
		TOTAL CREDIT						**23**				**800**	

Scheme of Studies and Examination
B. Tech (Electrical Engineering) – 4th Semester
w.e.f. 2025-26

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal Assessment	External Examination	Practical	Total	
1	Basic Science Course	BSC-MEE-202A	Engineering Mathematics-III	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-EE-204A	Electrical Machines-II	3	0	0	3	3	40	60		100	3
3	Professional Core Courses	PCC-EE-206A	Digital Electronics	3	0	0	3	3	40	60		100	3
4	Professional Core Courses	PCC-EE-208A	Transmission and Distribution	3	0	0	3	3	40	60		100	3
5	Professional Elective Courses	-	Refer to Table-I	3	0	0	3	3	40	60		100	3
6	Engineering Science Course	PCC-CSE-207A	Python Programming (Common with CSE 3rd Sem)	3	0	0	3	3	40	60		100	3
7	Professional Core Courses (Lab Courses)	LC-EE-210A	Electrical Machines-II Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses (Lab Courses)	LC-EE-212A	Digital Electronics Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses (Lab Courses)	LC-EE-214A	Transmission and Distribution Lab	0	0	2	2	1	25		25	50	3
10	Engineering Science Course (Lab Courses)	LC-CSE-215A	Python Programming Lab	0	0	2	2	1	25		25	50	3
		TOTAL CREDIT						**23**				**800**	

Note: Each Student has to undergo for industrial training related to core electrical engineering areas for the duration of 4 to 6 weeks after the end of semester exam. Students must submit training report along with certificate from the organization, which will be evaluated in 5th sem.

Table I (Professional Elective Courses)

Sr. No.	Course Code	Course
1	PEC-EE-216A	Wind and Solar Energy Systems
2	PEC-EE-218A	Electromagnetic Field Theory
3	PEC-EE-220A	Special Electrical Machines
4	PEC-EE-222A	High Voltage Engineering

Course Code	**HSMC-02A**				
Category	Humanities and Social Science including Management Courses				
Course Title	**Economics for Engineers**				
Scheme and Credits	L	T	P	**Credits**	**Semester- III**
	3	0	0	3	
Course Objectives	The objectives of this course are to • Introduce the basic concepts of economics and their relevance to science, engineering, and national development. • Develop a foundational understanding of microeconomic principles such as demand, supply, production, cost, and market structures. • Equip students with tools to apply economic reasoning to real-world pricing, output, and market decisions. • Familiarise students with macroeconomic elements like the Indian economy, banking system, privatization, and globalization.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe economic concepts, the connection between economics and engineering and technological development, along with economic laws relevant to resource-based decision making in society.	Level 1: Remember
CO2	Explain economic growth theories and illustrate the role of engineering and technology in supporting economic development.	Level 2: Understand
CO3	Apply theories of consumption and production to the design and development of engineering products.	Level 3: Apply
CO4	Analyze market conditions, evaluate cost structures and financial aspects to assess the feasibility of engineering projects.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Definition of Economics: Various Definitions, Types of Economics, Micro and Macro Economics, Nature of Economic Problem, Production Possibility Curve, Economic Laws and their Nature, Relationship between Science, Engineering, Technology and Economic Development.

Demand: Meaning of Demand, Law of Demand, Elasticity of Demand, Meaning, and Factors affecting the Elasticity of Demand, Practical Application and Importance.

Unit-II

Production: Meaning of Production and Factors of production, Law of Variable Proportions, Returns to Scale, Internal and External Economies and Diseconomies of Scale, Various concepts of Cost of Production- Fixed Cost, Variable Cost, Money Cost, Real Cost, Accounting Cost, Marginal Cost, Opportunity Cost, Shape of Average Cost, Marginal Cost, Total Cost etc. in short run and long run.

Unit-III

Market: Meaning of Market, Types of Market- Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly (main features).
Supply: Supply and Law of Supply, Role of Demand and Supply in Price Determination and Effect of Changes in Demand and Supply on Prices.

Unit-IV

Indian Economy: Nature and Characteristics of Indian Economy as underdeveloped, developing and mixed economy (brief and elementary introduction).
Privatization: Meaning, Merits and Demerits.
Globalization of the Indian Economy: Merits and Demerits
Banking: Concept of a Bank, Commercial Bank, Central Bank, Functions of a Bank, Difference between Commercial and Central Bank.

Suggested Readings:

- Modern Microeconomics: Theory and Applications by H.L. Ahuja, S. Chand & Company Pvt. Ltd.
- Indian Economy by S.K. Misra & V.K. Puri, Himalaya Publishing House.
- Indian Economy: Principles and Policies by Sri Rangam, Sri Ram, & Rohit Deo, Pearson Education.
- Managerial Economics by R. Cauvery, S. Chand & Company Pvt. Ltd.
- Microeconomic Theory by Andreu, Whinston, D. Michael, Green, R. Jerry, Oxford University Press.
- Principles of Economics by E. Karl, C. Ray, Oster, & E. Sharon, Pearson Education.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Fundamental concepts of microeconomics, including definitions, types, and the nature of economic problems.	https://www.youtube.com/watch?v=IFtOcNbej0o&list=PLFNFJbo2hfBGRTCMuroZGykNzacwmAH2L
Unit-II	Production and Cost of production	https://www.youtube.com/watch?v=VU1zySe-8NA
Unit-III	Theory of Markets	https://www.youtube.com/watch?v=HylqSa58lqQ
Unit-IV	Nature and characteristics of the Indian economy, highlighting aspects of underdevelopment and development.	https://www.youtube.com/watch?v=ME-0GOhhZcs&list=PLFW6lRTa1g83winAoIK92HL4xTytJaW7S

Course Code	**PCC-EE-201A**				
Category	Professional Core Courses				
Course Title	**Analog Electronics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To understand response of BJT and MOSFET. • To develop the ability to design and implement linear and non-linear OP-AMP-based applications • To design oscillator and power amplifier circuits using RC, LC, and crystal-based feedback configurations. • To impart knowledge of feedback principles, including negative feedback properties, feedback topologies				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand the working principles and I-V characteristics of semiconductor devices such as diodes, BJTs, and MOSFETs	Level 2: Understand
CO2	Explain and evaluate the ideal and practical characteristics of operational amplifiers (OP-AMPs**)**	Level 2: Understand
CO3	Apply power amplifiers and voltage regulators for the use of efficient power management in analogue circuits.	Level 3: Apply
CO4	Analyse the process, principles and characteristics of operational amplifiers and IC fabrication for designing electronic circuits and the effect of different feedback topologies on amplifier parameters	Level 4: Analyse

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each, and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

P-N Junction Diode: I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits, BJT & MOSFET: Structure and I-V characteristics, switch, amplifier: small-signal model, biasing circuits, current mirror, Small signal equivalent circuits, high-frequency equivalent circuits

Unit-II

Oscillators: Introduction, Barkhausen Criterion, Oscillator with RC Feedback circuit (RC Phase Shift, Wien Bridge), Tuned Collector, LC Feedback circuits (Hartley, Colpitts), Conditions for Sustained Oscillations & Frequency of Oscillations, Crystal Oscillator.

Power Amplifier: Definition, Application & Types of Power Amplifiers (Class A, B, C, & D), Push Pull Amplifiers, Distortion & Efficiency of Power Amplifier, Integrated Circuit Power Amplifier.

Unit-III

Operational Amplifier Fundamentals: Block Diagram Representation, Ideal OP-AMP, OP-AMP Equivalent Circuit, Ideal Voltage Transfer Curve, Input Offset Voltage, Input Bias Current, Input Offset Current, Output Offset Voltage, Thermal Drift, Effect of Variation in Power Supply Voltages on Offset Voltage, Common Mode Configuration and CMRR, Frequency Response of OP-AMP: Open Loop Response, Close Loop Response, Input and Output Impedances, Effect of Finite Gain Bandwidth Product, Slew Rate, OP-AMP as Integrator & Differentiator.

Unit-IV

Operational Amplifier Applications and Feedback: Linear and non-linear applications- Instrumentation Amplifier, voltage regulator, Active Filters, ADC and DAC, Square wave and triangular wave generator, Multivibrators. The general feedback structure, properties of negative feedback, the four basic feedback topologies, the series-shunt feedback amplifier, the series-series feedback amplifier, and the shunt-shunt and shunt series feedback amplifier.

Suggested Readings

- Integrated Electronics by Millman Halkias, TMH.
- Electronics Device & Circuit by Robert Boylestad, & Louis Nashelsky, Pearson Education.
- Electronics Device & Circuit Theory by I.J. Nagrath, PHI Learning.
- Electronics Device & Integrated Circuit by A.K. Singh, PHI Learning.
- A Textbook of Electronic Devices and Circuits by J.B. Gupta, S.K. Kataria and Sons.
- Integrated Electronics: Analog and Digital Circuits and Systems by Millman, Jacob, TMH.
- Applications and Design with Analog Integrated Circuits by Jacob, Michael, Pearson Education.

Useful Video Links

Unit No.	Topics	Links
Unit-I	RC Coupled Amplifiers	https://youtu.be/BSR26SU3R2U
Unit-II	Power Amplifiers	https://youtu.be/huDZjQcEBMg
Unit-III	Voltage regulators	https://youtu.be/R_QnIAEk7Go
Unit-IV	Operational Amplifier	https://youtu.be/clTA0pONnMs

Course code	**LC-EE-211A**				
Category	Professional Core Courses				
Course title	**Analog Electronics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objectives of this course are to • Understand the characteristics and AC analysis of RC coupled amplifiers, oscillators, regulators and timers. • Developing Knowledge of Rectifiers, Regulators, and Power Supplies • Analysing and Designing Amplifiers and Oscillators • Application of Operational Amplifiers and Timer Circuits in Signal Processing				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Apply theoretical knowledge to assemble, test, and troubleshoot electronic circuits	Level 3: Apply
CO2	Analyze and interpret the VI characteristics of Zener diodes, MOSFETs, and transistors	Level 4: Analyse
CO3	Able to evaluate the performance of rectifiers and filters by calculating theoretical and practical ripple factors	Level 5: Evaluate
CO4	Able to differentiate and compare various feedback topologies	Level 6: Create

List of Experiments

Sr. No.	**Content**
1	To plot VI characteristics of a Zener diode.
2	To study rectifier and the effect of filters on the output of rectifier. Also, calculate the theoretical and practical ripple factor.
3	To analyze and study different types of feedback topology.
4	To analyze and study RC phase shift oscillator.
5	To analyze and study Wein's bridge oscillator.
6	To plot the characteristics of MOSFET.
7	To plot input and output characteristics of transistor configurations.
8	To analyze and study inverting and non-inverting op-amp amplifiers.
9	To analyze and study the 555 timer as a square wave generator.
10	To analyze and study the frequency response of RC coupled amplifier.

11	To analyze and study the working of Push-Pull amplifiers.
12	To analyze and study op-amp amplifiers as a differentiator.
13	To analyze and study op-amp amplifiers as an integrator.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To analyze and study op-amp amplifiers as an integrator.	https://ade2-iitr.vlabs.ac.in/exp/mathematical-operations/
To analyze and study op-amp amplifiers as a differentiator	https://ade2-iitr.vlabs.ac.in/exp/mathematical-operations/
555 timer as a square wave generator	https://aec-iitkgp.vlabs.ac.in/exp/monostable-multivibrator/
Inverting and non-inverting op-amp amplifiers	https://ade2-iitr.vlabs.ac.in/exp/characteristic-parameters/

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-EE-203A**				
Category	Professional Core Courses				
Course Title	**Electric Circuit Analysis**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To develop analytical skills for circuit analysis using network theorems and fundamental laws. • To evaluate forced and free responses, time constants, and transient states of RL, RC, and RLC circuits under AC and DC excitations, using classical methods and Laplace transform techniques. • To perform steady-state analysis and power calculations in AC and three-phase circuits. • To acquire the ability to synthesise passive networks and characterized two-port networks.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall Basic electrical laws, terminology and mathematical tools.	Level 1: Remember
CO2	Understand the basic electric circuit and also to synthesise passive networks and characterize two-port networks.	Level 2: Understand
CO3	Apply the fundamental laws (KCL, KVL) and analyse AC circuits using various network theorems.	Level 3: Apply
CO4	Analyse steady state and transient conditions using Laplace transform. Electrical circuit parameters with or without using Laplace Transform.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each Unit.

Unit-I

Network Theorems in AC Circuit: Circuit elements, KCL, KVL, Nodal and mesh Analysis, Independent and dependent sources, Star-delta transformation, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Millman's theorem, Reciprocity theorem, Substitution theorem, Tellegens theorem.

Unit-II

Transient State Analysis: Forced and free response, Time constants, Transient behavior of circuit elements under switching conditions and their representations, Solution of first and second-order circuits, Evaluations of initial and final states in series and parallel RL, RC and RLC circuits with AC and DC excitation, Laplace transform and its adaptation to networks.

Unit-III

Steady State Analysis: Sinusoidal steady state analysis; Sinusoidal response of series and parallel RL, RC and RLC circuits, Phasors and phasor diagrams, Power in AC circuits, Three-phase circuits, Resonance.

Unit-IV

Synthesis of passive networks: Hurwitz polynomials, Positive real functions; definition and properties, Synthesis of LC, RC, RL networks, Foster's I and II form, Cauer's I and II form, Network graphs.
Two Port Network: Impedance parameter, Admittance parameter, Transmission parameter, Hybrid parameter, Inverse hybrid parameter, Inverse transmission parameter, Relationship between parameter sets, Interconnection of two-port networks.

Suggested Readings

- Fundamentals of electric circuits by Alexander, K. Charles, & Matthew Sadiku, McGraw Hill Education.
- Network Analysis by M E. Van-Valkenburg, Prentice Hall.
- Circuits and Networks by A Sudhakar, Tata McGraw-Hill.
- Engineering Circuit Analysis by W. Hayt, Tata McGraw-Hill.
- Electric Circuit by D.A. Bell, Oxford University press.
- Introduction to Modern Network Synthesis by M E. Van-Valkenburg, Wiley and Sons.
- Introduction to Modern Network Synthesis by Suresh Kumar, Dorling Kindsley.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Basic Circuit Elements	https://youtu.be/zkWvL1pPkMY
	Mesh and Nodal Analysis	https://youtu.be/TBmX3d8zuXU
	Network Theorems	https://youtu.be/LPttepJwgNE
Unit-II	Transient State Analysis	https://youtu.be/jT7R1Ez6Vg?list=PLbRMhDVUMngfNnABo5mre45ZbHqJE2sUn
	First and Second Order Circuits	https://youtu.be/alkm4B9JPWw
	Laplace transformation and its application	https://youtu.be/uJujJlkro6s
Unit-III	Sinusoidal steady state Analysis	https://youtu.be/c6U3Vnq6IL4
	Active and Reactive power in A.C circuit	https://youtu.be/4SnFYwxsr8M
Unit-IV	Graph Theory	https://youtu.be/0BQ2yyC6Lc8?list=PLbRMhDVUMngfNnABo5mre45ZbHqJE2sUn
	Two port networks	https://youtu.be/geM6Qz61MBA

Course code	**LC-EE-213A**				
Category	Professional Core Courses				
Course title	**Electric Circuit Analysis Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objectives of this course are to • Enhance problem-solving abilities by verifying network theorems, Nodal and Mesh analysis techniques for systematic circuit analysis. • Analyse transient responses of RL and RC circuits and interpret their time-domain behaviour. • Learn to synthesise a network from a given network function and experimentally verify its response. • Evaluate and experimentally verify Z, Y, and T parameters of two-port networks.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Apply various circuit analysis techniques, Nodal Analysis, Mesh Analysis and fundamental theorems.	Level 3: Apply
CO2	Analyse the transient response of RL and RC circuits and examine resonance phenomena in series and parallel AC circuits.	Level 4: Analyse
CO3	Evaluate Z, Y, and T parameters of two-port networks and determine equivalent parameters for various interconnections.	Level 5: Evaluate
CO4	Design and verify network responses by synthesising a given network function and interpreting current locus diagrams of RL, RC, and RLC series circuits to correlate theoretical and practical circuit behaviour.	Level 6: Create

List of Experiments

Sr. No.	**Content**
1	To study Nodal Analysis.
2	To study Mesh Analysis.
3	To verify Millman's theorem and Reciprocity theorem.
4	To verify Substitution theorem and Tellegen's theorem.
5	To verify Thevenin's theorem and Norton's theorem.
6	To verify Maximum Power Transfer Theorem.
7	To Study transient state response of RL and RC circuit.
8	To plot current locus diagram of RL, RC and RLC series circuit.
9	To synthesize a network of give network function and verify its response.
10	To study resonance in series and parallel AC circuits.
11	To evaluate and verify Z, Y and T parameters of a two port network.

12	To determine equivalent parameters of various interconnections of a two port network.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To study Nodal Analysis.	https://pltw.multisim.com/content/rhoaBoJsuRZbvGTWpdmz3E/lab-3-kirchhoffs-laws-and-mesh-and-nodal-analysis/
To study Mesh Analysis.	https://pltw.multisim.com/content/rhoaBoJsuRZbvGTWpdmz3E/lab-3-kirchhoffs-laws-and-mesh-and-nodal-analysis/
To verify Millman's theorem and Reciprocity theorem.	https://asnm-iitkgp.vlabs.ac.in/exp/verification-of-network-theorems/
To verify Substitution theorem and Tellegen's theorem.	https://asnm-iitkgp.vlabs.ac.in/exp/verification-of-network-theorems/
To Study transient state response.	https://asnm-iitkgp.vlabs.ac.in/exp/transient-state-response/
To plot current locus diagram of RL, RC and RLC series circuit.	https://asnm-iitkgp.vlabs.ac.in/exp/current-locus-diagrams/
To synthesize a network of give network function and verify its response.	https://asnm-iitkgp.vlabs.ac.in/exp/network-function-synthesis/
To study resonance in circuits.	https://asnm-iitkgp.vlabs.ac.in/exp/resonance-in-circuits/
To evaluate and verify Z, Y and T parameters of a two port network.	https://asnm-iitkgp.vlabs.ac.in/exp/two-port-network/
To determine equivalent parameters of various interconnections of a two port network.	https://asnm-iitkgp.vlabs.ac.in/exp/two-port-network/

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-EE–205A**				
Category	Professional Core Courses				
Course Title	**Measurement and Instrumentation**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To understand the fundamental concepts, standards, and characteristics of electrical measurements, including accuracy, precision, sensitivity, and error analysis. • To impart knowledge of Conventional Measuring Instruments such as PMMC, MI instruments, wattmeters, energy meters, power factor meters, and frequency meters. • To provide knowledge of digital instruments, multimeters, instrument transformers, transducers (resistive, capacitive, inductive, and piezoelectric), and display devices (CROs). • To train students in the use of advanced measurement methods for low and high resistances and AC quantities through Wheatstone, Kelvin Double, Megger, Maxwell, Schering, Wein, and other bridges.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall about Voltage, Current, Power, Power Factor Frequency, instrument standards, error in instruments and transducers.	Level 1: Remember
CO2	Understand AC&DC Instruments, Transducers, CRO and Bridges.	Level 2: Understand
CO3	Apply Bridges and instruments to measure electric circuit parameters.	Level 3: Apply
CO4	Analyses the resistance, inductance, capacitance finding methods, error, Torque etc. in instruments.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Fundamental of Electrical Measurements: Standards, True value, Static and dynamics characteristics of measuring instruments: definitions of accuracy, precision, hysteresis, sensitivity, fidelity.
Static & Dynamics errors: Sources of Errors in measurements, classification of error- techniques to reduce errors, loading effects of instruments.
Classification of Instruments: Absolute& secondary Instruments; Indicating; Recording & Integrating instruments; Based upon principle of instruments, comparison between gravity &spring controls; comparison of damping methods & their suitability, bearing supports, pivot – less supports (simple & taut –band), scale information.

Unit-II

Measuring Instruments: Classification of instruments, working principle of potentiometers, measurements of voltage, current, power, working principle and construction, torque equation, Damping, range extension of PMMC, Moving Iron (MI) & loading effects.
Wattmeter & Energy Meter: Construction, operating principle, torque equation, Errors. Single phase energy meter & Compensation, & Creep in energy meter. Single Phase Induction Type Wattmeter.
Power Factor & Frequency Meters: Construction, operating, Principle, Torque equation, Advantages & disadvantages of single-phase power factor meters (Electrodynamics & Moving Iron types) & Frequency meters (Electrical Resonance Types, Ferro dynamics & Electrodynamics types).

Unit-III

Digital Instruments: Comparison of Analog & Digital techniques – Digital Voltmeter –Multimeter's Instruments Transformer.
Transducers and Display Devices: Classification of Transducers- Resistive, Capacitive, & Inductive transducers – Piezoelectric and Digital Transducers. Working principle and specifications of Analog CRO and digital CRO.

Unit-IV

Low & High Resistance Measurements: Limitations of Wheatstone bridge, Kelvin Double bridge (DC Bridge), Difficulties in high resistance measurements, measurements of high resistance by direct deflection, loss of charge methods, Megohm Bridge, Meggar.
AC Bridges: General balance equation, circuit diagram, phasor diagram, advantages, disadvantages, applications of Maxwell's, inductance–capacitance, Hay's, Owen's, Schering & Wein's bridges, Shielding & earthing, Wagner's device.

Suggested Readings

- A course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, & Puneet Sawhney, Dhanpat Rai & Company.
- LabVIEW graphical programming by Jennings, Richard, & Fabiola De La Cueva, McGraw-Hill Education.
- Electronic Instrumentation and Measurements by A. David Bell, Oxford University Press.
- Electrical Measurements and Measuring Instruments by E. W. Golding, F. C. Widdis, 6th Edition, Medtech.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Sources of Errors in measurements	https://www.jove.com/v/14506/types-of-errors-detection-and-minimization
	Loading effects of instruments	https://www.electricalengineering.xyz/loading-effect-of-electrical-measurement-instruments/
Unit-II	Single phase energy meter	https://emimnit.wordpress.com/2016/10/16/single-phase-energy-meter/?utm_source=chatgpt.com
	Introduction of virtual instruments	https://www.youtube.com/watch?v=iGYOlnOP6vw
Unit-III	Comparison of analog & digital techniques	https://www.youtube.com/watch?v=rkOWP9oVaXk
	Oscilloscope & its application	https://www.tek.com/en/documents/primer/oscilloscope-basics?utm_source=chatgpt.com
Unit-IV	Limitation of Wheatstone bridge	https://www.shiksha.com/online-courses/articles/learning-wheatstone-bridge-principle/?utm_source=chatgpt.com
	General balance equation , CKT diagram, phasor diagram	https://www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/

Course code	**LC-EE-215A**				
Category	Professional Core Courses				
Course title	**Measurement and Instrumentation Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objectives of this course are to • To understand the construction, working principles, and proper connections of various electrical and electronic measuring instruments. • To develop the ability to calibrate electrical measuring instruments for accurate measurement. • To acquire practical skills in measuring electrical quantities, power, power factor, and circuit parameters using conventional and advanced methods. • To understand the application of transducers for the measurement of physical parameters and their characteristics.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand the construction, working and connection of different types of meters, transducers, strain gauges and star delta starters.	Level 2: Understand
CO2	Calibrate standard electrical measuring instruments such as voltmeters, ammeters, wattmeters, and energy meters using appropriate calibration techniques to ensure accurate measurements.	Level 3: Apply
CO3	Measure electrical quantities such as resistance, inductance, capacitance, power, and power factor using bridges, CT/PT arrangements, and analyze the accuracy of measurements.	Level 4: Analyse
CO4	Determine the characteristics of transducers such as LVDTs and capacitive sensors, and apply them for displacement and liquid level measurements.	Level 4: Analyse

List of Experiments

Sr. No.	**Content**
1	To study construction of different types of meters & study how to connect them in a circuit.
2	To calibrate a Voltmeter & an ammeter using a potentiometer.
3	Calibration of AC Wattmeter by Standard Voltmeter and Ammeter.
4	Calibration of single-phase energy meter.
5	To Measure Power & P.F by using 3 ammeter & 3 voltmeter methods.
6	To Measure Power & P.F by two wattmeter method.
7	To measure low resistance by Kelvin double bridge.
8	Measurement of Inductance using Maxwell Bridge.
9	To Measure capacitance by De Sauty bridge.

10	To Measure power with help of CT & PT.
11	Determine output characteristics of LVDT and Measure displacement using LVDT.
12	Measurement of liquid level; using capacitive transducer.
13	To Measure high resistance by loss of charge methods.
14	Determine the unknown Inductance & Q factor by Hay's bridge.
15	Study blocks wise construction of analog Oscilloscope & function generator.
16	To study LAB VIEW.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To study LAB VIEW.	https://www.iitk.ac.in/oscillations/index.html
Study blocks wise construction of analog Oscilloscope & function generator.	https://aec-iitkgp.vlabs.ac.in/?utm_source=chatgpt.com
Determine output characteristics of LVDT and Measure displacement using LVDT.	https://virtual-labs.github.io/exp-lvdt-coep/index.html?utm_source=chatgpt.com
To Measure power with help of CT & PT.	https://vp-dei.vlabs.ac.in/vp-dei/Dreamweaver/?utm_source=chatgpt.com
To measure low resistance by Kelvin double bridge.	https://elms-iitr.vlabs.ac.in/exp/kelvin-sdouble-bridge/simulation/index.html
To measure high resistance by the loss of charge methods.	https://virtual-labs.github.io/exp-loss-of-charge-method

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-EE-207A**				
Category	Professional Core Courses				
Course Title	**Electrical Machines-I**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To learn the basic principles of converting electrical and mechanical energy in machines. • To study the construction, operation, and performance of DC machines. • To understand the working, testing, and efficiency of transformers.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall key concepts of electromechanical energy conversion and machine structures.	Level 1: Remember
CO2	Explain the operation of DC machines and transformers.	Level 2: Understand
CO3	Apply theoretical concepts to solve practical problems related to voltage, EMF, torque, efficiency, and testing of DC machines and transformers.	Level 3: Apply
CO4	Analyze performance characteristics of DC machines and transformers, such as torque-speed curves, voltage regulation, and losses.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Introduction to Magnetic Circuit: Faraday's Law of Electromagnetic Induction, Lenz's Law and Fleming's rule, Basic construction of a DC machine: magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation - Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

Unit-II

DC Machine: Armature circuit equation for motoring and generation, Types of field excitations - separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed, V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing and back-to-back testing of DC machines.

Unit-III

Transformers: Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses, Autotransformers - construction, principle, applications and comparison with two winding transformers.

Unit-IV

Three-Phase Transformer: Construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

Suggested Readings

- Electric Machinery by A. E. Fitzgerald and C. Kingsley, McGraw Hill Education.
- Performance and design of DC machines by A. E. Clayton and N. N. Hancock, CBS Publishers.
- Performance and design of AC machines by M. G. Say, CBS Publishers.
- Electrical Machinery by P. S. Bimbhra, Khanna Publishers.
- Electric Machines by I. J. Nagrath and D. P. Kothari, McGraw Hill Education.
- Electric Machines by Ashfaq Husain and Haroon Ashfaq, Dhanpat Rai & Co.
- A Text Book of Electrical Technology by B.L. Theraja & A.K. Theraja, S.Chand.
- DC Machines and Transformers by Deshveer Narwal, M. Balasubbareddy, Atul Katiyar, & Nitish Kumar, SIPH.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Principle of Rotating Electrical Machines	https://youtu.be/Rd5q7a7IXvs
	Pitch factor and Winding Factor	https://youtu.be/cyl9uLt4swo
Unit-II	Introduction to DC Machine	https://youtu.be/PRdLNTQ2fRE
	Armature Winding	https://youtu.be/GdwG6Padf2M
Unit-III	Starting of DC Motor	https://youtu.be/DgQE286XwHw
	Speed Control of DC Shunt Motor	https://youtu.be/J3EUw7J16c8
Unit-IV	Short Circuit Test	https://youtu.be/puQ7lzZJ_3s
	Voltage Regulation	https://youtu.be/NnBbKE7VHRQ

Course code	**LC-EE-217A**				
Category	Professional Core Courses				
Course title	**Electrical Machines-I Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	0	0	2	1	
Course Objectives	The objectives of this course are • To understand the working of DC machines and transformers. • To perform key tests to analyze machine performance. • To develop practical skills in handling electrical equipment.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand the principles of DC machines and transformers.	Level 2: Understand
CO2	Apply testing methods to assess machine performance.	Level 3: Apply
CO3	Analyze machine behavior under different conditions.	Level 4: Analyze
CO4	Evaluate speed control and transformer operation methods.	Level 5: Evaluate

List of Experiments

Sr. No.	**Content**
1	To perform an open-circuit test of a single-phase transformer.
2	To perform short-circuit test of a single-phase transformer.
3	To perform a load test on the single-phase transformer
4	To study the conversion of 3 phase to six phase using 3 single phase transformers.
5	To study the parallel operation of two single-phase transformers.
6	To perform polarity test on the single-phase transformer.
7	To study the Load Characteristics of DC shunt generator.
8	To study the Load Characteristics of DC series motor.
9	To perform the speed control of a DC Motor by field resistance Control and Armature control method.
10	To perform speed control of a DC motor by using Ward-Leonard Method. Draw the graph between armature voltage and speed of motor.
11	To study Hopkinson's test of DC Shunt machine.
12	To study the magnetisation characteristics of DC Shunt Generator. Draw the graph between the armature voltage and field current.

Virtual Lab Links

Experiment Name	Virtual Lab Link
To study the Load Characteristics of DC shunt generator	https://ems-iitr.vlabs.ac.in/exp/load-characteristics-dc-shunt/
To study the speed control of DC Motor by field resistance Control.	https://ems-iitr.vlabs.ac.in/exp/dcmotor-field-resistance-control/simulation.html
To study the speed control of D.C. Shunt motor by armature control method.	https://ems-iitr.vlabs.ac.in/exp/dcshunt-motor-armature-control/
To perform speed control of DC motor by using Ward-Leonard Method. Draw the graph between armature voltage and speed of motor.	https://ems-iitr.vlabs.ac.in/exp/dcmotor-ward-leonard/simulation.html
To study the magnetisation characteristics of DC Shunt Generator. Draw the graph between the armature voltage and field current.	https://ems-iitr.vlabs.ac.in/exp/magnetization-characteristics-dcshunt/

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course code	**PCC-EE-209A**				
Category	Professional Core Courses				
Course title	**Electrical Engineering Materials**				
Scheme and Credits	L	T	P	**Credits**	**Semester- III**
	3	0	0	**3**	
Course Objectives:	The objectives of this course are • To develop a comprehensive understanding of the electrical and thermal conductivity properties of materials, including metals and semiconductors. • To explore and evaluate the magnetic and dielectric properties of materials, including their applications and behavior under different conditions. • To analyze magnetic materials and their practical utilization. • To develop an understanding of semiconductor physics for electrical and electronic applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skill demonstrated	RBT Level
CO1	Describe the factors influencing resistivity and electron motion in an electric field for electrical conductivity in metals.	Level 1: Remember
CO2	Explain dielectric polarisation, dielectric constant, and their effects on capacitors and monatomic gases.	Level 2: Understand
CO3	Illustrate the types of magnetism in magnetic materials.	Level 3: Apply
CO4	Analyze dielectric losses, loss tangent, and their frequency and temperature dependence on dielectric materials.	Level 4: Analyse

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Conductivity of Metal: Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, thermionic emission, photoelectric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials, thermal properties, thermal conductivity of metals, thermoelectric effects.

Unit-II

Dielectric Materials: Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, dielectric losses, significance of the loss tangent, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferroelectricity, piezoelectricity.

Unit-III

Magnetic Materials: Introduction, Classification of magnetic materials, diamagnetism, Paramagnetism, ferromagnetism, magnetization curve, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials, magnetic resonance.

Unit-IV

Semiconductors: Energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, the Einstein relation, hall effect, thermal conductivity of semiconductors, electrical conductivity of doped materials.

Suggested Readings

- An Introduction to Electrical Engineering by C. S. Indulkar and S. Thiruvengadam, S. Chand Publications.
- Engineering Materials by Kenneth G. Budinski, Prentice Hall of India, New Delhi.
- Electrical Engineering Materials by A. J. Dekker, Pearson Publications.
- A Text Book of Electrical and Electronics Engineering Materials by P. L. Kapoor, Khanna Publishers.
- A Textbook of Electrical Engineering Materials by R. K. Rajput, Laxmi Publications.

Useful Video Links:

Unit No.	Topic	Link
Unit-I	Expression for electrical conductivity in metals	https://www.youtube.com/watch?v=wzWJwjjvu9I
Unit-II	Insulating Materials	https://www.youtube.com/watch?v=-fAphSvtVKA
Unit-III	Magnetic Materials	https://www.youtube.com/watch?v=-fAphSvtVKA
Unit-IV	Semiconductor materials	https://www.youtube.com/watch?v=-5iR1H2nxvo

Course Code	**MC-201A**				
Category	Mandatory Courses				
Course Title	**Environmental Science**				
Scheme and Credits	L	T	P	**Credits**	**Semester-III**
	2	0	1	-	
Course Objectives	The objectives of this course are to • Create awareness of the multidisciplinary nature and importance of environmental studies, including the sustainable management and conservation of natural resources. • Develop an understanding of ecosystem dynamics, biodiversity, pollution types, and their impacts on environmental and human health. • Foster critical thinking on social, ethical, and legislative aspects of environmental protection, emphasizing the role of individuals and society. • Engage students in practical learning through fieldwork and case studies to apply environmental concepts for sustainable development and responsible citizenship.				
Practical/Field Visits	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				
Remarks	The subject of Environmental Studies will be included as a qualifying paper in all UG Courses and the students will be required to qualify the same otherwise the final result will not be declared and degree will not be awarded. The duration of the course will be 40 lectures. The examination will be conducted along with the semester examinations. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of degree. However, these marks will be shown in the detailed marks certificate of the students.				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe key concepts of environmental studies, types of natural resources, ecosystem structures, pollution types, major environmental laws, and human-environment interactions.	Level 1: Remember
CO2	Explain the interrelationships among ecosystems, biodiversity, pollution, social issues, environmental ethics, and related legislation for sustainable development.	Level 2: Understand
CO3	Apply principles of environmental management, pollution control, disaster preparedness, and sustainable practices in real-world and field-based environmental contexts.	Level 3: Apply
CO4	Analyze environmental problems, population growth impacts, climate change, welfare programs, and the role of information technology in promoting public health and environmental sustainability.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I.

Natural Resources: Renewable and non-renewable resources, Natural resources and associated problems.

a) Forest resources: Use and over-exploitation: deforestation, case studies. Timber extraction, mining dams and their effects on forests and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes, caused by agriculture and overgrazing, effects of modern agriculture, fertilizer pesticide problems, Water logging, salinity, case studies. e) Energy resources: Growing energy needs; renewable and non- renewable energy sources, use of alternate energy sources, case studies.

f) **Land resources:** Land as are source, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources, equitable use of resources for sustainable life styles

Unit-II

Ecosystems: Producers, Consumers and Decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food web sand ecological pyramids**,** Introduction, types, characteristic features, structure and function of Forest ecosystem, Grass land ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Bio diversity and its conservation: Introduction, Definition, Genetic, Species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity. Threats to biodiversity, habitat loss, poaching of wild life, man-wild life conflicts, Endangered and endemic species of India, In-situ and ex-situ conservation of biodiversity.

Unit-III

Environmental Pollution: Definition, Causes, Effects and Control Measures of Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution, Nuclear Hazards.

Solids Waste Management: Causes, Effects and Control Measures of Urban and Industrial Wastes, Role of an Individual in Prevention of Pollution, Pollution Case Studies.

Disaster Management: Floods, Earthquake, Cyclone and Landslides.

Social issues and the Environment: From unsustainable to sustainable development, Urban problems related to energy, Water conservation, Rain Water Harvesting, Watershed Management, Resettlement and Rehabilitation of People, its problems and concerns case studies.

Environmental Ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies, Waste land reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of pollution) Act, Water (Prevention and Control of pollution) Act, Wild life Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit-IV

Human population and the Environment: Population growth, Variation among Nations, Population explosion-Family Welfare Programme, Environment and human health, Human Rights. Value Education, HIV/AIDS, Woman and Child Welfare Role of Information Technology in Environment and human health. Case Studies.

Field Work (Field work equal to10 lecture hours)- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-urban/Rural/Industrial/ Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hills, slopes, etc.

Suggested Readings:

- Environmental Biology by K.C. Agarwal, Nidi Pub. Ltd., Bikaner.

- The Biodiversity of India by Bharucha, MA Pin Publishing Pvt. Ltd., Ahmedabad.
- Hazardous Waste Incineration by R.C. Brunner, McGraw Hill.
- Environmental Chemistry by A.K. De, Wiley Eastern Ltd.
- Global Biodiversity Assessment by V.H. Heywood & R.T. Watson, Cambridge University Press.
- Environmental Protection and Laws by H. Jadhav & V.M. Bhosale, Himalaya Pub. House.
- Matter Hazardous by A.K. Mhaskar, Techno-Science Publications.
- Waste Water Treatment by M.N. Rao & A.K. Datta, Oxford & IBH Publication.
- Environmental Chemistry by B.K. Sharma, Goel Publication. House, Meerut.
- Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II by R.K. Trivedi, Enviro Media.
- Introduction to Air Pollution by R.K. Trivedi & P.K. Goel, Techno-Science Publications.
- Environmental Management by K.D. Wagner, W.B. Saunders Co., Philadelphia, USA.
- A Textbook of Environmental Education by Dr. J.P. Yadav, G.V.S. Publishers.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Environment Science: Introduction	https://www.youtube.com/watch?v=5QxxaVfgQ3k
	Natural Resources	https://www.youtube.com/watch?v=CXCT2R1K6Ts
	Ecosystem	https://www.youtube.com/watch?v=1dBU6HB8G6s
Unit-II	Biodiversity and its conservation	https://archive.nptel.ac.in/courses/102/104/102104068/
Unit-III	Sustainable Water Management In Urban Areas	http://digimat.in/nptel/courses/video/127106004/L29.ht
	Environmental Pollution	https://archive.nptel.ac.in/courses/123/105/123105001/
Unit-IV	Population and population growth	https://archive.nptel.ac.in/courses/102/104/102104068/
	National Family Welfare Programme	https://www.youtube.com/watch?v=X5F99L8ZEtc

Course Code	**BSC-MEE-202A**				
Category	Basic Science Courses				
Course Title	**Engineering Mathematics-III**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	1	0	**4**	
Course Objectives	The objectives of this course are to • Understand and classify first and second-order linear partial differential equations, and apply appropriate solution techniques including complementary function and particular integral methods. • Solve and analyze physical models such as wave and diffusion equations using methods like separation of variables.				
Course Pre-requisite	Mathematics up to 12th Standard and Engineering Mathematics-I& II				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100Marks				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define partial differential equations and probability distributions, including their properties and physical relevance.	Level 1: Remember
CO2	Classify second-order PDEs using complementary functions and particular integrals.	Level 2: Understand
CO3	Apply probability concepts, including conditional probability and Bayes' Theorem, for real-world problems using discrete and continuous distributions.	Level 3: Apply
CO4	Analyze numerical methods (Bisection, Newton-Raphson, Euler, Runge-Kutta) for solving equations and ODEs with a focus on accuracy and efficiency.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Definition of Partial Differential Equations, First order linear partial differential equations, Partial Differential Equations of higher order: Second-order linear partial differential equations and their classification, Solution to homogenous and non-homogenous linear partial differential equations of second order by complimentary function and particular integral method, Initial and boundary conditions, Separation of variables method to simple problems in Cartesian coordinates.

Unit-II

Solution of polynomial and transcendental equations – Bisection method, Regula-Falsi method and Newton-Raphson method, Finite differences, Interpolation using Newton’s forward and backward difference formulae, Newton’s

divided difference and Lagrange's formulae, Numerical integration, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules, Taylor's series, Euler and modified Euler's methods, Runge-Kutta method of fourth order for solving first and second order ordinary differential equations. Matrix inversion.

Unit-III

Measures of central tendency, Moments, Skewness and Kurtosis Basic concept of Probability, Conditional probability, Bayes' theorem, Discrete random variables, Binomial distribution, Poisson distribution, Expectation of discrete random variables, Variance of a sum, Correlation coefficient, Continuous random variables and their properties, Distribution functions, Normal Distribution.

Unit-IV

Testing of hypothesis, Test of significance, Large sample test for single proportion, Difference of proportions, Tests for single mean, Difference of means and Difference of standard deviations, Test for ratio of variances, Chi-square test for goodness of fit and Independence of attributes.

Suggested Readings:

- Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers.
- Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publishing Company Limited.
- A text book of Engineering Mathematics by N. P. Bali and Manish Goyal, Laxmi Publications.
- Numerical Methods by P. Kandasamy, K. Thilagavathy, & K. Gunavathi, S. Chand and Company.
- Introductory Methods of Numerical Analysis by S. S. Sastry, PHI learning publication.
- Business Statistics by T.R. Jain, S.C. Aggarwal, VK Global Publications Pvt. Ltd.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Definition of Partial Differential Equations.	https://www.youtube.com/watch?v=KlZqe4UC1jk
	Solution to homogenous and non-homogenous linear partial differential equations	https://www.youtube.com/watch?v=5eZbgxmpK3Q&t=520s
	Initial and boundary conditions of partial differential equations of second order	https://www.youtube.com/watch?v=PVUfuiuWaZQ
Unit-II	Bisection method, Regula-Falsi method and Newton-Raphson method	https://www.youtube.com/watch?v=3j0c_FhOt5U&list=PLU6SqdYcYsfIk1VhXxIYNPFU67ym6gae8
	Interpolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae	https://www.youtube.com/watch?v=Y-yMQvYpltU https://www.youtube.com/watch?v=zdyUwzOm1zw https://www.youtube.com/watch?v=2h0R0Uka1HI
	Numerical integration, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules	https://www.youtube.com/watch?v=EA76ONWBgK4&list=PLhSp9OSVmeyJBkLSO51JFPSEIIoeRiaJy
Unit-III	Basic concept of Probability, Conditional probability, Bays' theorem	https://youtu.be/60vHy2lA4o4 https://www.youtube.com/watch?v=ZFMcWe_SNyI https://www.youtube.com/watch?v=-ELHOnLwE9U
Unit-IV	Testing of Hypothesis & Levels of significance, Large Sample Test	https://auece.digimat.in/nptel/courses/video/111105090/L72.html
	Chi-Square Test	https://youtu.be/SlCsNb-VXds?feature=shared
	Miscellaneous	https://onlinecourses.nptel.ac.in/noc22_ma81/preview

Course Code	**PCC-EE-204A**				
Category	Professional Core Courses				
Course Title	**Electrical Machines-II**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are ● To understand the construction, working principles, and performance of induction machines. ● To learn the operation, characteristics, and control of synchronous machines. ● To gain basic knowledge of special machines and their industrial applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the construction, working principles and types of single-phase induction machines and synchronous machines.	Level 1: Remember
CO2	Explain the operation, characteristics, and applications of synchronous machines and induction machines.	Level 2: Understand
CO3	Apply the starting methods, speed control and applications of induction machines, synchronous machines and special machines like stepper, reluctance, and hysteresis motors.	Level 3: Apply
CO4	Analyze the construction, emf & torque equation, and regulation methods, speed control methods of synchronous and induction machines.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and the remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Poly-Phase Induction Motor: Basic concepts of rotating electrical machines, Constructional features, Principal of operation, production of rotating magnetic field, speed and slip, frequency of rotor voltage and current, induction motor action, torque production, testing, development of equivalent circuit, performance characteristics, winding emfs, circle diagram, starting methods, double cage and deep bar motors. Methods of speed control - stator voltage control, stator resistance control, frequency control, rotor resistance control, slip power recovery control, efficiency, cogging or magnetic locking, limitations and applications of I.M.

Unit-II

Single-Phase Induction Motors: Introduction, Principle of operation, double revolving field theory, cross-field theory, starting methods, different types of single-phase induction motors, and equivalent circuit of a single-phase induction motor. Induction Generator: Principle of operation, types and applications.

Special Machines: Reluctance motors, Hysteresis motors, servomotors, linear induction motors, stepper motors, step angle and their applications.

Unit-III

Synchronous Generator: Principle, construction of cylindrical rotor and salient pole machines, winding, EMF equation, Armature reaction, testing, model of the machine, regulation – synchronous reactance method, Potier triangle method. Output power equation, power angle curve, Transient and sub-transient reactance, synchronization, parallel operation.

Unit-IV

Synchronous Motor: Principles of synchronous motor, power angle curve, V-curve, starting, hunting, cause and effect of hunting, damper winding, synchronous condenser, Applications: Industrial applications, speed control applications and power factor correction.

Suggested Readings

- Principle of Electrical Machines by V K Mehta, Rohit Mehta, S Chand.
- Electric Machines by Ashfaq Hussain, Dhanpat Rai.
- Electric Machines by I.J. Nagrath, & D.P. Kothari, TMH, New Delhi.
- Generalized theory of Electrical Machines by P.S. Bhimbra, Khanna Publication.
- Electric Machinery by Fitzgerald and Kingsley, MGH.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Poly-phase Induction Motor	https://youtu.be/leXNHZM-CZE
	Speed and Slip	https://youtu.be/DANGZvHOgj0
Unit-II	Single Phase Induction motors	https://youtu.be/KPMy_L7oyOk
	Equivalent circuit of 1 phase I.M	https://youtu.be/h8386o98deY
Unit-III	Construction of synchronous machine	https://youtu.be/D-uPPjFBKDI
	Armature reaction and synchronous reactance	https://youtu.be/FCKx-1xR4To
Unit-IV	Synchronous motor operation, phasor diagram	https://youtu.be/edJFTap0zYw
	Phasor diagram of salient pole synchronous motor under various conditions	https://youtu.be/hx_QAyjgrNM

Course code	**LC-EE-210A**				
Category	Professional Core Courses				
Course title	**Electrical Machines-II Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	**1**	
Course Objectives	The objectives of this course are • To study performance and circuits of induction and synchronous motors. • To explore speed control and voltage effects on motor performance. • To understand voltage regulation and load-sharing in generators. • To learn alternator synchronization and fault analysis techniques.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	To Study performance and circuits of induction and synchronous machines.	Level 2: Understand
CO2	Apply and demonstrate different load test and speed control methods for induction machines and synchronous machines.	Level 3: Apply
CO3	Analyze the different performance curves like torque-speed and V-curves to optimize machine performance.	Level 4: Analyze
CO4	Assess the operation of synchronous generators in parallel, perform synchronization, and determine key parameters like voltage regulation.	Level 5: Evaluate

List of Experiments

Sr. No.	**Contents**
1	To perform the open circuit test and block rotor test on 3 phase induction motor and draw the circle diagram
2	To perform the speed control of an induction motor by rotor resistance control.
3	To conduct the load test to determine the performance characteristics of the I.M.
4	To compute the torque v/s speed characteristics for 3-phase induction motor.
5	To perform the open circuit test and blocked rotor test on a single-phase induction motor and determine equivalent circuit parameters
6	To perform O.C. test on synchronous generator and determine the full load regulation of a three phase synchronous generator by impedance method.
7	To perform and Measure Synchronous Impedance and Short Circuit Ratio of Synchronous Generator.
8	Study of Power (Load) sharing between two Three Phase alternators in parallel operation Condition.
9	To plot V- Curve of synchronous motor.

10	Synchronization of two Three Phase Alternators by a) Synchro scope Method b) Three dark lamp Method c) Two bright one dark lamp Method.
11	Determination of sequence impedances of synchronous machine for various stator voltages.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To Study No Load Test on Three Phase Induction Motor.	https://em-coep.vlabs.ac.in/exp/no-load-test-induction-motor/
To Study blocked rotor test on 3 Phase Induction Motor.	https://em-coep.vlabs.ac.in/exp/blocked-rotor-test-induction-motor/
To study the torque speed characteristics of a three phase induction motor.	https://bes-iitr.vlabs.ac.in/exp/three-phase-induction-motor/
To Study Open Circuit Test on Three Phase Alternator.	https://em-coep.vlabs.ac.in/exp/open-circuit-phase-alternator/index.html
To Study Short Circuit Test on Three Phase Alternator.	https://em-coep.vlabs.ac.in/exp/short-circuit-phase-alternator/index.html
To plot V Curves and Inverted V curves of Three Phase Synchronous Motor	https://em-coep.vlabs.ac.in/exp/synchronous-motor/
To Study Load Test on Three Phase Alternator	https://em-coep.vlabs.ac.in/exp/load-test-phase-alternator/index.html

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-EE-206A**				
Category	Professional Core Courses				
Course Title	**Digital Electronics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To learn the fundamentals of logic simplification using logic gates, Boolean algebra, De Morgan's theorem, and canonical forms (SOP & POS) • To understand mastering number systems, complements, and operations on complement numbers, along with techniques like Karnaugh Maps (up to 6 variables) and the Quine-McCluskey (QM) method for systematic logic reduction • To Design and Analyze Combinational Logic Circuits and Implement Sequential Logic Systems • To Explore Data Conversion Techniques and Programmable Logic Devices				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall the knowledge of Boolean algebra, K-MAP, ASM, FSM and QM methods for simplification and optimization of digital circuits.	Level 1: Remember
CO2	Understand the combinational logic circuits using logic gates for arithmetic operations, code conversion, and control applications.	Level 2: Understand
CO3	Apply the knowledge of latches, flip-flops and counters in synchronous and asynchronous modules for memory storing applications.	Level 3: Apply
CO4	Analyse the memories and programmable logic devices for understanding the architectural blocks of FPGA and CPLD.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all Units and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Logic Simplification: Logic Gates (AND, OR, NAND, NOR etc.), Review of Boolean Algebra and De Morgan's Theorem, Digital codes, Realization Using Gates, Number system, SOP & POS forms, Canonical forms complements of a number, addition and subtractions of a complements numbers,. Karnaugh maps up to 6 variables, Q M Method, Error detection and correction code.

Unit-II

Combinational Logic Design: Half and Full Adders, Half and Full Subtractors, Multiplexers, Demultiplexers, Encoder, Decoder, Magnitude Comparators, Priority encoder , Parallel Adders, Adder with Look Ahead Carry, BCD Adder.

Unit-III

Sequential Logic Design: Latches, building blocks like S-R, JK and Master-Slave JK FF, D FF, T FF Edge triggered FF, conversions of FF, Ripple and Synchronous counters, Ring and Johnson counter, UP & DOWN counter, Sequence Generator, Shift registers.

Unit-IV

A/D and D/A Converter: Sample and hold circuit, weighted resistor and R -2 R ladder D/A Converters, specifications for D/A converters. A/D converters: Quantization, parallel - comparator, successive approximation, counting type, dual-slope ADC, specifications of ADCs.

Programmable Logic Devices: ROM, PLA, PAL, SRAM, DRAM. FPGA and CPLDs.

Suggested Readings

- Modern Digital Electronics by R.P. Jain, Tata McGraw Hill, 4th edition.
- Switching Theory & Logic Design by A. Anand Kumar, PHI.
- Digital Electronics Circuit and System by V K Puri, TMH.
- Digital Circuits and Systems by D.V. Hall, Tata McGraw Hill.
- Principle of Digital Electronics by K Meena, PHI learning.
- Logic & Computer Fundamentals by Morris Mano,4th Edition, Pearson Education.

Useful Video Links

Unit No.	Topics	Links
Unit-I	Boolean Algebra	https://www.youtube.com/shorts/xtAYbY_Pz7I
Unit-II	Multiplexer	Introduction to Multiplexer | What are Multiplexers | Digital Electronics
	Combinational Circuits	https://www.youtube.com/watch?v=fXrbYMDevDU
Unit-III	Sequential Circuits	https://www.youtube.com/watch?v=S0mKCNLmCh4&list=PLgwJf8NK-2e4mEQv0ttgW-am4wiqrpdcX
	Counter	https://www.youtube.com/watch?v=NTCrCYPoA5A&list=PLgwJf8NK-2e6lcDg0NxW-_yO6Bl5dPBp8
Unit-IV	Finite state machines	https://www.youtube.com/watch?v=LOZxYBOKRLg

Course code	**LC-EE-212A**				
Category	Professional Core Courses				
Course title	**Digital Electronics Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	1	
Course Objectives	The objectives of this course are to • Understand digital logic fundamentals by studying basic and universal gates and minimising Boolean functions using K-map. • Analyse and design combinational circuits such as adders, subtractors, multiplexers, and demultiplexers. • Design and verify sequential circuits including flip-flops, counters, and sequence detectors. • Gain practical knowledge of data conversion through the design and verification of ADC and DAC.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Understand the working of basic logic gates and realize logic functions using universal gates.	Level 2: Understand
CO2	Analyze logic expressions up to five and six variables using the Karnaugh Map (K-Map) method for optimal circuit design.	Level 4: Analyse
CO3	Implement and validate the truth tables of S-R, J-K, T, and D type flip-flops to understand sequential circuit fundamentals.	Level 4: Analyse
CO4	Design and test data conversion circuits, such as ADC and DAC for digital-analogue interfacing and 3-bit synchronous counters, synchronous UP/DOWN decade counters using JK flip-flops, and asynchronous counters.	Level 6: Create

List of Experiments

Sr. No.	**Content**
1	To study & design basic gates.
2	To study and realize logic functions with the help of universal gates.
3	To realize and minimize five & six variables using K-Map method.
4	To verify the operation of Multiplexer & De-multiplexer.
5	To perform Half adder and Full adder
6	To perform Half Subtractor and Full Subtractor.
7	To verify the truth table of S-R, J-K, T & D Type flip-flop.
8	To design & verify the operation of 3 bit synchronous counter.
9	To design & verify the operation of synchronous UP/DOWN decade counter using JK flip
10	To design & verify operation of Asynchronous counter.
11	To design and implement a circuit to detect a count sequence.
12	To design & verify operation of ADC & DAC.

Virtual Lab Links

Experiment Name	Virtual Lab Link
To study & design basic gates.	https://de-iitr.vlabs.ac.in/exp/truth-table-gates/
To verify the truth table of S-R, J-K, T & D Type flip-flop.	https://de-iitg.vlabs.ac.in/exp/truth-tables-flip-flops/
To perform Half adder and Full adder	https://de-iitg.vlabs.ac.in/exp/half-adder-full-adder/
To perform Half Subtractor and Full Subtractor.	https://de-iitr.vlabs.ac.in/exp/half-full-subtractor/

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-EE-208A**				
Category	Professional Core Courses				
Course Title	**Transmission and Distribution**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To provide knowledge of the evolution, structure, and components of modern power systems, including substations, bulk grids, micro-grids, and AC/DC distribution systems. • To develop the ability to calculate line parameters, analyze transmission line models, voltage regulation, reactive power compensation, and evaluate distribution system performance. • To understand sag and stress analysis, effects of environmental conditions, and insulation design for reliable and safe power transmission. • To study cable types, corona effects, and HVDC transmission technology for efficient and advanced power delivery.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall the Distribution system, Transmission line with skin effect, Ferranti and proximity effect and Cables	Level 1: Remember
CO2	Understand performance of transmission lines & insulators.	Level 2: Understand
CO3	Apply Grading of cables and HVDC links.	Level 3: Apply
CO4	Analyze line parameter, sag & stress, corona in transmission lines.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Introduction: Evolution of Power Systems and Present-Day Scenario. Structure of a power system, Bulk Power Grids and Micro-grids, indoor and outdoor substations, equipment for substations, layout, auxiliary supply.
Distribution Systems: Radial, ring mains and network distribution system, comparison of various types of ac and dc systems.

Unit-II

Transmission Lines and their performance: Calculation of line parameters, Ferranti effect, proximity effect. Short, medium and long transmission lines, performance of transmission lines, circle diagram, capacity of synchronous condenser, tuned lines, voltage control.

Unit-III

Mechanical Design and Insulators: Sag and stress calculations, effect of ice and wind, dampers. Types of insulators, insulating materials, voltage distribution over insulator string, equalizer ring.

Unit-IV

Cables: Types of LV and HV cables, grading of cables, capacitance, ratings. CORONA: Phenomenon, critical voltage, power loss, reduction in losses, radio-interference, and HVDC transmission – types of links, advantages and limitations.

Suggested Readings

- Power System Analysis & Design by J. D. Glover, M.S. Sarma and T. J. Overbye, Cengage Learning India Pvt. Ltd.
- Power Systems Analysis by A.R. Bergen, & V. Vittal, Pearson Education.
- Power System Stability & Control by P. Kundur, Tata McGraw Hill, 2006.
- Electric Power Systems by B.M. Weedy, & B.J. Cory, Wiley India.
- Elements of Power System Analysis by J. J. Grainger, & W.D. Stevenson., Tata McGraw-Hill Publishing Company Limited.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Structure of Power systems	https://youtu.be/Yg6XsepGCKY?list=PLD4ED2FAF3C155625
Unit-II	Transmission line parameters	https://youtu.be/lr1jgbR5ca8?list=PLD4ED2FAF3C155625
Unit-III	Sag and Tension Analysis	https://youtu.be/Gz10k08xdDk
Unit-IV	Grading of cables	https://youtu.be/Csw1OTdWu_8?list=PLD4ED2FAF3C155625

Course code	**LC-EE-214A**				
Category	Professional Core Courses				
Course title	**Transmission and Distribution Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester- IV**
	0	0	2	1	
Course Objectives	The objectives of this course are • To enable the design and performance evaluation of transmission and distribution systems. • To enhance understanding of power transmission line phenomena and operational characteristics. • To develop proficiency in modeling and analyzing power system components using MATLAB. • To analyze and compare the performance of distribution systems under various configurations.				
Course Pre-requisite	Physics of 12th Standard				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Apply Power system blocks in MATLAB, corona loss in transmission line, mechanical design of transmission line.	Level 3: Apply
CO2	Analyse the proximity and skin effect.	Level 4: Analyze
CO3	Assess Line Parameters, ABCD Parameters, performance of transmission line, Ferranti effect.	Level 5: Evaluate
CO4	Design long and short transmission lines using MATLAB.	Level 6: Create

List of Experiments

Sr. No.	Content
1	To synthesise the Power System blocks in MATLAB.
2	To design short and long transmission line using MATLAB.
3	To study and calculate the transmission line parameters.
4	To study the Corona loss in the power distribution system.
5	To study the proximity and skin effect.
6	To find ABCD parameters of a model of transmission line.
7	To study performance of a transmission line under no load condition & load at different power factors.
8	To observe the Ferranti effect in a model of transmission line.
9	To study performance characteristics of a typical DC distribution system in radial & ring main configurations.

10	To study mechanical design of the transmission line.

Virtual Lab Links

Experiment Name	**Virtual Lab Link**
To study the Power System blocks in MATLAB.	https://in.mathworks.com/help/sps/ref/powersystemssimulationonramp.html?utm
To design short and long transmission line using MATLAB.	https://support.mathworks.com/matlabcentral/fileexchange/43340-long-transmission-line-matlab-simulation-by-rohit-kanojia?utm
To study the corona loss in power distribution system.	https://vm-dei.vlabs.ac.in/index_home.php
To study the proximity and skin effect.	https://sa-nitk.vlabs.ac.in/exp/plc-normal-load-operation/theory.html?utm_
To find ABCD parameters of a model of transmission line.	https://asnm-iitkgp.vlabs.ac.in/exp/two-port-network/procedure.html
To study performance of a transmission line under no load condition & under load at different power factors.	https://www.academia.edu/31466035/A_Virtual_Electric_Power_Transmission_Line_Lab
To study performance characteristics of typical DC distribution system in radial & ring main configuration.	https://sa-nitk.vlabs.ac.in/exp/monitoring-feeder-parameter/theory.html
To study mechanical design of transmission line.	https://lntedutech.com/power-transmission-line-engineering/?utm

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiment if they feel useful to add.

Course Code	**PCC-CSE-207A**				
Category	Engineering Science Courses				
Course Title	**Python Programming (Common with CSE 3rd Sem)**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce Python programming basics, including syntax, data types, and control structures. • To develop skills in Python data structures, functions, and recursion. • To explore Python's graphical programming, image processing, and GUI development. • To explain object-oriented programming, exception handling, and multithreading concepts.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skill Demonstrated**	**RBT Level**
CO1	Recall fundamental Python programming concepts including syntax, data types, control structures, functions, object-oriented principles, and multithreading.	Level 1: Remember
CO2	Explain the use of Python data structures, file operations, graphical libraries, and GUI components for developing structured programs.	Level 2: Understand
CO3	Develop Python programs using logic, functions, graphics, OOP, and multithreading to solve real-world problems.	Level 3: Apply
CO4	Analyze and compare programming constructs and design techniques for efficient Python applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Introduction: Installing Python; basic syntax, interactive shell, editing, saving, and running a script; data types; variables, assignments; numerical types; arithmetic operators and expressions; Loops and selection statements, Control statements String manipulations: subscript operator, indexing, slicing a string; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file.

Unit-II

Lists, Tuple, dictionary and Design with functions: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; Tuple: creating tuples, accessing elements, tuple immutability, operations, tuple methods, tuples vs. lists; dictionary literals, adding, and removing keys, accessing and replacing values; traversing dictionaries. Hiding redundancy, complexity; arguments and return values; Program structure and design. Recursive functions.

Unit-III

Simple graphics and image processing: Simple graphics, Turtle operations, Manipulating turtle screen, Drawing two dimensional shapes, examining an object attributes, Taking a random walk, Color and RGB scheme, Image processing: Image manipulation operations, properties of images, image module, copying, blurring and reducing image.
Graphical User Interfaces using Tkinter: Terminal based and GUI based programs, Introduction to Tkinter, Simple GUI-Based Programs, Windows and Window Components, Input and Output with Entry Fields, Defining and Using Instance Variables, Other Useful GUI Resources.

Unit-IV

Object Oriented concepts: Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modelling; persistent storage of objects, Inheritance, polymorphism, operator overloading; abstract classes; exception handling, try block.
Multithreading: Threads and Processes, Sleeping Threads, Producer, Consumer, and Synchronization, The Readers and Writers Problem, Shared Cell Class, Thread-Safe Class.

Suggested Readings

- Fundamentals of Python: First Programs by Kenneth Lambert, Course Technology, Cengage Learning, 2012.
- Introduction to Computer Science Using Python: A Computational Problem-Solving by Dierbach, C. Focus, John Wiley & Sons, (2012).
- Let Us Python by A. Kanetkar, & Y. Kanetkar, BPB Publications.
- Python – The Complete Reference by M. C. Brown, McGraw Hill Education.
- Core Python Programming by R. N. Rao, Dream Tech Press.
- Python Programming: Using Problem Solving Approach by R. Thareja, Oxford University Press.
- Python Programming by S. Sridhar, J. Indumathi, & V. M. Hariharan, Pearson Education.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Variables and Input Statement	https://youtu.be/ruQb8jzkGyQ
Unit-II	List operators	https://youtu.be/jMShssechMI
Unit-III	Graphical User Interfaces using Tkinter	https://youtu.be/-GhzpvvIXlM?list=PLS1QulWo1RIY6fmY_iTjEhCMsdtAjgbZM
Unit-IV	Fundamentals of Object Oriented Programming	https://youtu.be/K3g4srbkUNM?list=PLLy_2iUCG87Ah844iZW3w3nzWSTA8KSZA

Course code	**LC-CSE-215A**				
Category	Lab Course				
Course title	**Python Programming Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-IV**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To introduce students to the basic syntax, data types, control structures, and functions in Python programming. ● To enable students to implement mathematical, searching, and sorting algorithms using Python programming constructs. ● To provide hands-on experience with file handling, object-oriented programming, and Python libraries such as Turtle, OpenCV, and Tkinter. ● To develop students' ability to analyze algorithmic logic, debug programs, and optimize solutions using Python.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skill Demonstrated**	**RBT Level**
CO1	Understand fundamental Python programming constructs such as input/output, operators, control flow, and functions.	Level 2: Understand
CO2	Write Python programming techniques to implement algorithms for mathematical operations, searching, and sorting.	Level 3: Apply
CO3	Apply file handling, libraries (Turtle, OpenCV, Tkinter) and OOP concepts in Python to solve practical problems.	Level 3: Apply
CO4	Analyze the logic, performance, and correctness of Python solutions for problems involving algorithms and data.	Level 4: Analyze

List of Experiments

Sr. No.	**Content**
1	Write a Program to compute the G.C.D of two numbers.
2	Write a Program to find the square root of a number.
3	Write a Program to find the power of a number.
4	Write a Program to find the maximum in a list of numbers.
5	Write a Program to implement linear search in a list.
6	Write a Program to implement binary search in a list.
7	Write a Program to sort the element using selection sort.
8	Write a Program to sort the element using insertion sort.
9	Write a Program to sort the element using merge sort.
10	Write a Program to first "n" prime numbers.
11	Write a Program to find the most frequent word in a text file.
12	Write a Program in Python for a random walk using turtle.
13	Write a Program in Python using Tkinter/OpenCV to rotate an image.
14	Create a GUI based login page in Python language.

15	Write a program to implement inheritance in Python.

Note: At least 10 experiments are to be performed by the students. Faculty members can add 2-3 extra experiments under topics beyond the syllabus.

Course Code	**PEC-EE-216A**				
Category	Professional Elective Courses				
Course Title	**Wind and Solar Energy Systems**				
Scheme and Credits	L	T	P	**Credits**	**Semester- IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of wind energy, including wind characteristics, energy conversion principles, turbine classification, and system components. • To understand modern wind turbine technologies and the characteristics of various electrical generators used in wind energy systems, such as induction and synchronous generators. • To provide knowledge of solar thermal energy systems, including solar radiation measurement, collector types, orientation, and thermal performance analysis for practical applications. • To familiarise students with solar photovoltaic technology, covering solar cell fundamentals, types, performance evaluation, and Maximum Power Point Tracking (MPPT) for efficient PV system design.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe the basics terminology of wind energy, wind turbines, solar energy.	Level 1: Remember
CO2	Explain wind turbines, instruments for measuring solar radiation, solar collectors, solar cells and solar MPPT techniques.	Level 2: Understand
CO3	Apply the concept of wind turbines, solar MPPT techniques to extract maximum power.	Level 3: Apply
CO4	Analyse generator characteristics, V-I characteristics of PV panel.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Wind Energy: Basic History of wind power, Indian and Global statistics, Characteristics of Wind, principles of wind energy conversion, components of wind energy conversion system, classification of wind turbines- horizontal axis and vertical axis, Betz limit ratio, advantages and disadvantages of wind energy system.

Unit-II

Wind Turbine Technologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Squirrel-cage Induction generator, Wound rotor induction generators, Doubly Fed Induction Generator, Synchronous Generators, Permanent Magnet Synchronous Generators and their characteristics.

Unit-III

Solar Thermal: Physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

Unit-IV

Solar Photovoltaic: Photovoltaic energy conversion, solar cell fundamentals, solar cell classification- Amorphous, mono-crystalline, polycrystalline, performance of solar cell, V-I characteristics of a PV panel, Maximum Power point Tracking (MPPT) algorithm.

Suggestions Redding

- Non-Conventional Energy Sources by G.D. Rai, Khanna publishers, 2014.
- Wind Energy Theory and Practice by Siraj Ahmed publisher PHI learning Pvt Ltd.
- Renewable Energy Sources and Emerging Technologies by D.P Kothari, K.C Singal, Rakesh Ranjan , PHI learning Pvt Ltd.
- Renewable Energy resources by Tiwari, & Ghosal, Narosa.
- Solar Photo Voltaics Fundamentals, Technology and application by Chetan Singh Solanki, PHI learning Pvt Ltd.
- Renewable Energy Resources by John Twidell and Tony Weir, Taylor and Francis.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Power Generation from Wind Energy	https://youtu.be/k7LX0a67V8A
Unit-II	Turbine Terms	https://youtu.be/z7HV-ixAjs4
Unit-III	Solar Radiation	https://youtu.be/Og4LEc7SpdQ
Unit-IV	Solar Collectors	https://youtu.be/ co3m8nVUg

Course Code	**PEC-EE-218A**				
Category	Professional Elective Courses				
Course Title	**Electromagnetic Fields**				
Scheme and Credits	L	T	P	**Credits**	**Semester- IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are to • Familiarise yourself with various coordinate systems and electromagnetic vector fields. • Impart knowledge on the concepts of electrostatic, magneto static and electrodynamic Fields. • Disseminate concepts related to electromagnetic waves, Waveguides and applications of electromagnetic fields. • Understand transmission line equation and wave propagation in different medium.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Describe Vector algebra, line, area, volume Integral.	Level 1: Remember
CO2	Understand vector theorems, different coordinate systems and transformation.	Level 2: Understand
CO3	Apply concept of electrostatic, magneto static laws, and boundary conditions.	Level 3: Apply
CO4	Analyze Transmission line equations and wave propagation in different medium.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Vector Analysis: Review of scalars, vectors, vector multiplication- dot and vector products, component of a vector, Co-ordinate system- Cartesian, cylindrical and spherical co-ordinate system. Transformation of different co-ordinate system. Gradient, Curl and Divergence. Divergence theorem, Stroke's theorem. Line integrals, Surface integrals, Volume integrals, Differential length, area and Volume in Cartesian, cylindrical and spherical co-ordinate system. Dirac- Delta function.

Unit-II

Electrostatic Fields: Overview of electrostatic field, Coulomb's Law and field intensity. Electric fields due to point charge, continuous charge distributions like line charge, surface charge and volume charge distributions. Electric flux density, Gauss's Law and its Application. Electric potential, Relationship between E and V - Maxwell's equation. Scalar potential. Electric Dipole, Electric field intensity due to electric dipole. Electric flux lines. Properties of Electric flux lines due to point charge and dipole. Energy density in Electrostatic field.
Convection and Conduction currents and current densities. Conductors, Point form of Ohm's law. Polarization in Dielectric. Continuity equation of current and Relaxation time. Electrostatic Boundary conditions, Poisson's and

Laplace's equations, General procedure for solving Poisson's and Laplace's equations. Resistance and capacitance, Capacitance of parallel plate capacitor, coaxial cable, Spherical capacitor.

Unit-III

Magneto Static Fields: Introduction to magneto static fields, Biot-Savart's law. Ampere's circuit law and its application- Maxwell's equation. Magnetic flux density, Maxwell's equation for static EM fields. Magnetic scalar and vector potentials, Forces due to magnetic fields - Force on a charged particle, Force on a current element and Force between two current elements, Magnetic Torque and Moment, Magnetic Dipole, Magnetisation in materials- Classification of magnetic materials, Magnetic boundary conditions. Inductance for simple geometry. Magnetic energy, magnetic circuits. Statement and Interpretation of Maxwell's equation.

Unit-IV

Time Dependent Fields: General introduction, Faraday's Law .Transformer and motional emf stationary loop in time varying B field (Transformer emf), Moving loop in static B field (Motional emf). Moving loop in time varying fields, Displacement current. Maxwell's equation in Final forms, Time varying Potentials. Time harmonic fields. Introduction of Electromagnetic wave propagation, waves in general, wave propagation in lossy dielectric. Plane waves in loss less Dielectric, Plane waves in free space, Plane waves in good conductors. Power and Poynting vector. Reflection of Plane wave at normal incidence. Reflection of Plane wave at Oblique incidence - Parallel Polarization and Perpendicular Polarization.

Suggestions Redding

- Engineering Electromagnetics by W H Hayt Jr, J A Buck, & M Jaleel Akhtar, McGraw Hill Education.
- Outline of Electromagnetics by Mahmood Nahvi, A. Joseph, & Edminister, Schaum's, McGraw Hill Education.
- Fundamental of Electromagnetic by Karl E. Lonngren, Sava Savov, & Randy J. Jost, Scitech Publishing Inc.
- Electromagnetics by J. Edminister, & Vishnu Priye, Schaum's Series.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Review of scalar and vector fields	https://www.youtube.com/watch?v=gEa38ldV_a0&pp=0gcJCdgAo7VqN5tD
	Stoke's theorem.	https://www.youtube.com/watch?v=MZILJp2iKUs
Unit-II	Electric flux density,	https://www.youtube.com/watch?v=gJtxcGEg5R0
	Gauss's Law. Application of Gauss's law	https://www.youtube.com/watch?v=whv_d-fBCg0
Unit-III	Biot-Savart's law, Ampere's law	https://www.youtube.com/watch?v=4YEQ98NUWOY
	Forces due to magnetic fields; Vector potential	https://www.youtube.com/watch?v=Nwnj1JSvfnk
Unit-IV	Faraday's Law	https://www.youtube.com/watch?v=deI8cJiCKEo
	Maxwell's equation	https://www.youtube.com/watch?v=ibF0L6X53tg

Course Code	**PEC-EE-220A**				
Category	Professional Elective Courses				
Course Title	**Special Electrical Machines**				
Scheme and Credits	L	T	P	**Credits**	**Semester- IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To learn the fundamental principles, constructional features, and performance characteristics of poly-phase and single-phase AC machines, including induction motors, commutator motors, servo motors, and synchronous motors. • To impart knowledge of advanced control techniques for efficient machine operation. • To familiarize students with special-purpose electrical machines and their applications. • To prepare students for industrial and research-oriented applications in modern electrical drives.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Recall the knowledge of advanced control techniques for efficient machine operation.	Level 1: Remember
CO2	Explain the construction, operating principles, and performance characteristics of various poly-phase and single-phase AC machines	Level 2: Understand
CO3	Apply different control techniques (stator voltage control, rotor resistance control, frequency control, slip power recovery, etc.) for achieving constant torque and constant power operation in induction motors.	Level 3: Apply
CO4	Analyse performance and characteristics of special-purpose machines including stepper motors, switched reluctance motors, and permanent magnet machines for specific industrial and automation applications.	Level 4: Analyse

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Poly-Phase AC Machines: Construction and performance of double cage and deep bar three phase induction motors, production of rotating magnetic field, induction motor action, e.m.f. induced in rotor circuit of slip ring induction motor, concept of constant torque and constant power controls, static slip power recovery control schemes (constant torque and constant power), stator voltage control, stator resistance control, frequency control, rotor resistance control, slip power recovery control, induction motor as an induction generator.

Unit-II

Single-Phase Induction Motors: Construction, equivalent circuit, starting characteristics and applications of split phase, capacitor start, capacitor run, capacitor start capacitor-run and shaded pole motors.

Single-Phase Commutator Motors: Construction, principle of operation, characteristics of universal and repulsion motors; Linear Induction Motors. Construction, principle of operation, applications.

Two Phase AC Servo Motors: Construction, torque-speed characteristics, performance and applications.

Unit-III

Stepper Motors: Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications.

Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits.

Unit-IV

Permanent Magnet Machines: Permanent magnet DC motors, sinusoidal PM AC motors, brushless DC motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors.

Suggestions Redding:

- Principle of Electrical Machines by V K Mehta & Rohit Mehta, S Chand.
- Electric Machines by Ashfaq Hussain, Dhanpat Rai.
- Electric Machines by I.J. Nagrath, & D.P. Kothari, TMH, New Delhi.
- Generalized theory of Electrical Machines by P.S. Bhimbra, Khanna Publication
- Electric Machinery by Fitzgerald, & Kingsley, MGH.
- Principles of Electrical Machines and Power Electronics by P.C. Sen, John willey & Sons.
- Fundamentals of Electric Drives by G.K. Dubey, Narosa Publishing House.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Static Slip power Recovery	https://youtu.be/6DctdwlDKhc
Unit-II	Single phase Induction Motor	https://youtu.be/trlmCvmUybk
Unit-III	Variable Reluctance Motor	https://youtu.be/1IiY6YlPHck
Unit-IV	Permanent Magnet Machines	https://youtu.be/dGvSJ25bor4

Course Code	**PEC-EE-222A**				
Category	Professional Elective Courses				
Course Title	**High Voltage Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester- IV**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To develop a fundamental understanding of conduction and breakdown mechanisms in different dielectric media. • To impart knowledge of generation and measurement techniques for high voltages and currents. • To impart knowledge of generation and measurement techniques for high voltages and currents. • To familiarise students with high-voltage testing procedures for various electrical apparatus.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After successful completion of this course, the students will be able to

COs	**Skills Demonstrated**	**RBT Level**
CO1	Remember the conduction and breakdown of dielectrics.	Level 1: Remember
CO2	Understand the generation and measurement of high voltage and current.	Level 2: Understand
CO3	Apply non-destructive testing of materials and electric apparatus and high-voltage testing of electric apparatus	Level 3: Apply
CO4	Analyse the overvoltage phenomenon and insulation coordination in electric power systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each Unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Conduction and Breakdown in Gases: Collision Process, Ionization Processes, Townsend's Current Growth Equation, Current Growth in the Presence of Secondary Processes, Townsend's Criterion for Breakdown, Experimental Determination of Coefficients α and γ, Breakdown in Electronegative Gases, Time Lags for Breakdown, Streamer Theory of Breakdown in Gases, Paschen's Law, Breakdown in Non-Uniform Fields and Corona Discharges.

Conduction and Breakdown in Liquid Dielectrics: Liquids as Insulators, Pure Liquids and Commercial Liquids, Conduction and Breakdown in Pure Liquids, Conduction and Breakdown in Commercial Liquids.

Breakdown in Solid Dielectrics: Introduction, Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown.

Unit-II

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

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

Unit-III

Overvoltage Phenomenon and Insulation Coordination in Electric Power Systems: National Causes for Over-voltages - Lightning Phenomenon, Overvoltage due to Switching Surges, System Faults and Other Abnormal, Principles of Insulation Coordination on High Voltage and Extra High Voltage Power Systems.

Non-Destructive Testing of Materials and Electrical Apparatus: Introduction, Measurement of Dielectric Constant and Loss Factor, Partial Discharge Measurements.

Unit-IV

HV Testing of Electrical Apparatus: Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers, Testing of Surge Arrestors, Radio Interference Measurements, Testing of HVDC Valves and Equipment.

Suggestions Redding

- High Voltage Engineering by M.S. Naidu, & V. Kamaraju, McGraw Hill Latest Edition.
- High Voltage Engineering Fundamentals by E. Kuffel, W.S., & J. Zaengl, Kuffel Newness Latest Edition.
- High Voltage Engineering by C.L. Wadhwa, New Age International Latest Edition.
- High Voltage Engineering by A.M. Farouk, Rizk CRC Press Latest Edition.

Useful Video Links

Unit No.	Topic	Link
Unit-I	Breakdown in dielectrics	https://youtu.be/5S6xQT05Cw4
Unit-II	Introduction to HVDC Transmission	https://youtu.be/yP7OACmLP48
Unit-III	Design and Selection of Insulation	https://youtu.be/ga8moSgeO34
Unit-IV	HV Testing of Equipment	https://youtu.be/sDBstxApMqE