M.D. UNIVERSITY, ROHTAK

SCHEME OF STUDIES AND EXAMINATION

(Under NEP-2020)

BACHELOR of TECHNOLOGY

(ELECTRICAL ENGINEERING)

common with

(Electrical and Electronics Engineering)

SEMESTER 3rd & 4th

Scheme effective from academic session 2026-27

'H' Scheme (Under NEP-2020)

1. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits
2 Hours Practical (Lab) per week	1 credit

2. Structure of the Undergraduate Engineering program:

Sr. No.	Category
1	Humanities and Social Sciences including Management courses
2	Basic Science Courses
3	Engineering Science courses
4	Program Core Courses (Branch specific)
5	Professional Elective courses relevant to chosen specialization/branch
6	Open Elective Courses (from Humanities, Technical Emerging or other Subjects)
7	Project work, Seminar and Internship in Industry or elsewhere
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition] etc. (non-credit)

3. Course code and definition:

Course Code	**Definitions**
L	Lecture
T	Tutorial
P	Practical
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional Core Courses
LC	Laboratory Courses
MC	Mandatory Courses
PT	Practical Training
PEC	Professional Elective courses
OEC	Open Elective courses
PRROJ/SEM	Seminar Employment Enhancement Courses (Project/Summer Internship/ Seminar)

PROGRAM OUTCOMES (PO)

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6. Analyse and evaluate societal and environmental aspects while solving complex engineering problems, considering their impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment.

PO7. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO8. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO10. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO11. Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (Electrical Engineering)

PSO 1: Analysis, Design, and Development: An ability to understand complex problem solutions by analysis and design with appropriate development of the problem as per the requirement by applying knowledge of electrical engineering.

PSO 2: knowledge of Electrical Engineering Tools and Equipment: An ability to analyse and apply the adaptive tools and electrical equipment needed to solve challenging problems in the engineering world, as well as contribute to different fields such as defence, healthcare, society, transportation, and industrialisation.

PSO3: Acquisition of Skill: An ability to work in a team in different areas of science and technology by having social, environmental, and sustainability skills. To make the project optimal for management, which is economical and becomes a long-lasting learning experience by incorporating recent tools and techniques.

Semester 3

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-EE-201-H	Electrical Machines-1	3	1	0	4	**4**	30	70		100	3
2	26PCC-EE-203-H	Electrical Circuit Analysis	3	1	0	4	**4**	30	70		100	3
3	26PCC-EE-205H	Measurement And Instrumentation	3	0	0	3	**3**	25	50		75	3
4	26ESC-EE-201-H	Analog Electronics	3	0	0	3	**3**	25	50		75	3
5	26BSC-MATHEE-203-H	Math-III	3	1	0	4	**4**	30	70		100	3
6	26LC-EE-201-H	Electrical Machines-1lab	0	0	2	2	**1**	5		20	25	3
7	26LC-EE-203-H	Electrical Circuit Analysis Lab	0	0	2	2	**1**	5		20	25	3
8	26LC-EE-205-H	Measurement And Instrumentation Lab	0	0	2	2	**1**	5		20	25	3
9	26LC-EE-207-H	Analog Electronics lab	0	0	2	2	**1**	5		20	25	3
		Total				26	**22**				550	

For Honors Courses

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-EE-207-H	Electrical Safety and Standards	2	0	0	2	**2**	15	35	0	50	3
2	26LC-EE-209-H	Electrical Safety and Standards lab	0	0	2	2	**1**	5		20	25	3
Total							**3**	20	35	20	75	

Semester-4

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-EE-202-H	Digital Electronics	3	0	0	3	**3**	25	50		75	3
2	26PCC-EE-204-H	Electrical Machines-II	3	1	0	4	**4**	30	70		100	3
3	26PCC-EE-206-H	Power Systems-1	3	1	0	4	**4**	30	70		100	3
4	26PCC-EE-208-H	Signal & Systems	3	1	0	4	**4**	30	70		100	3
5	**PEC**	Refer to Table 1	3	1	0	4	**4**	30	70		100	3
6	26PCC-EE-210-H	Electrical power Generation	2	0	0	2	**2**	15	35		50	3
7	26LC-202-H	Digital Electronics lab	0	0	2	2	**1**	5		20	25	3
8	26LC-204-H	Electrical Machines-II lab	0	0	2	2	**1**	5		20	25	3
9	26LC-206-H	Power Systems-1 Lab	0	0	2	2	**1**	5		20	25	3
10	26AU-ENV-202-H	Environmental Science	2	0	1	3	**0**	Refer Note 1				
					Total	30	24				600	
		For Honors course										
1	26PCC-EE-212-H	Power Plant Engineering	3		0	3	**3**	25	50		75	3
2	27LC-210-H	Project Stage-1	0		2	2	**1**	5		20	25	3
					Total	**5**	4				100	

Note-1: AU is a mandatory non–credit course in which students will be required to obtain passing marks in theory. 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 detailed marks certificate of student.

Marks Distribution:

- Internal Assessment: 30 marks
- Theory Examination: 70 marks

The institute will conduct the theory examination at its own level.

Note-2: At the end of the 4th semester, each student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional organization/ Research Laboratory/ training centre, etc., and submit a typed report along with a certificate from the organization& its evaluation shall be carried out in the 5th Semester.

The students of B.Tech working Professionals course have to submit training/project report of their respective company/organization for the period of summer training/ industrial training for the evaluation purpose.

List of Program Electives-I (Table 1)

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PEC-EE-202-H	Electromagnetic field theory	3	1	0	4	**4**	30	70		100	3
2	26PEC-EE-204-H	Electrical Engineering Materials and Devices	3	1	0	4	**4**	30	70		100	3
3	26PEC-EE-206-H	Soft Computing	3	1	0	4	**4**	30	70		100	3

Course code	26PCC-EE-201-H				
Category	Professional Core Courses				
Course title	**Electrical Machines-1(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	3	**1**	**0**	**4**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To acquaint the students with the basic phenomenon/concepts of Electrical Machines.
- To understand and explain scientifically the various electrical machines (DC machines and transformres) problems in the industry/engineering field.
- To understanding of construction, principle of operation of DC Machines and transformers.
- To understand the performance, and control of various electrical machines used in the industry.
- **COURSE OUTCOMES (CO):**

By the end of the Course, Students will be able to:

CO1: Understand the concepts of magneticcircuits, Operation of dc machines, Single phase and three phase transformers.

CO2: Analyse the differences in operation of different dc machineconfigurations and Transformers.

CO3: Evaluate the electrical parameters of DC machines and Transformers for differentworking conditions.

CO4: improve the design of DC machines and Transformers considering the electrical parameters like losses, Loading, Testing and cooling.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3		
CO2		3										3		
CO3	2	3											2	
CO4			3										3	2
WT. AVG	2.5	2.67	3									3	2.5	2
									Overall Mapping of Subject					2.61

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

General introduction to electrical machines: Magnetic circuits, Concepts of reluctance and permeance, Faraday's law of electromagnetic induction, Lenz's Law and Fleming's rules. Electromechanical energy conversion principle, Principle of operation of generators and motors. Magnetic curves and their relevance. (06)

UNIT-II

D.C Machines: Constructional features, armature windings - simple lap and wave winding; armature voltage and torque equations. D.C generators: Classifications, performance characteristics; Losses, efficiency and power flow diagram.

D.C. motors: Classifications, torque/speed characteristics of different types; Losses, efficiency and power flow diagram. Starting, speed control and braking. Testing and efficiency. BLDC motor (10)

UNIT-III

Transformers: Constructional features; Ideal transformer and practical transformer, name plate rating, phasor diagrams, equivalent circuit and determination of its parameters from O.C and S.C tests, sunneber test and other test; referred values of Input and out put side; Regulation, efficiency and all day efficiency expressions and calculations. Parallel operation. (10)

UNIT-IV

Autotransformer: Basic constructional features; Comparative study with two winding transformer. 3-phase Transformer: As a single unit with name plate rating and as a bank of three single phase transformers; Parallel operation conditions and load sharing (10)

Alternative NPTEL/SWAYAM Course:

SNo	**NEPTEL course name**	**Instructor**	**Host Institute**
1.	Electrical Machines-Ihttps://nptel.ac.in/courses/108105155	By Prof. Tapas Kumar Bhattacharya	IIT Kharagpur
2.	ElectricalMachineshttps://nptel.ac.in/courses/108102146	Prof.G Bhuvaneshwari	IIT Delhi

Suggested Text Books / Reference Books:

1. B. L. Theraja, Electrical Technology- Vol-II, S Chand
2. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
3. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
4. M. G. Say, "Performance and design of AC machines", CBS Publishers,2002.
5. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers,2011.
6. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education,2010.

Course code	26PCC-EE-203-H				
Category	Professional Core Courses				
Course title	Electrical Circuit Analysis				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	3	**1**	**0**	**4**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To create awareness about the circuit basics and analysis.
- To understand how to solve the different circuit topologies with a different approach.
- Able to learn about the two-port network and network synthesis.
- To understand how to deal with first-order and second-order networks in DC and AC circuits.

COURSE OUTCOMES (CO):

At the end of this course, students will demonstrate the ability to;

CO1: Apply network basic laws, super node and super mesh to analyze electrical circuits.

CO2: Able to solve the various network topologies using any one of the theorems.

CO3: Identify the different circuit interconnections and solve them using two-port network interconnections.

CO4: Analyze the circuit response in the transient and steady-state regimes for both AC/ DC circuits.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2							3		
CO2		3	2	1								3		
CO3	2	3	1	1									2	
CO4		1	3	2									3	2
WT. AVG	2.5	2.5	2		2							3	2.5	2

									Overall Mapping of Subject	2.35

Note: The Examiner will set a total of nine questions. The students have to attempt five questions in total, the first being compulsory, and the remaining four questions must be attempted, one question from each unit. The remaining eight questions must be set by taking two questions from each unit.

Section-A

DC circuit analysis:

Node and Super node analysis, Mesh and Super mesh analysis, concept of duality and dual networks, Star-Delta transformation, Circuit analysis with Dependent Current and Voltage Sources. DC theorem (Superposition theorem, Thevenin theorem, Norton theorem) with dependent sources.

Network Theorems (AC Circuit):

Complex power and power factor in AC circuits, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem.

Section-B

Two-Port Network: Two-port parameters:

Impedance parameters, admittance parameters, transmission parameters, and hybrid parameters, relationship of two-port parameters, interconnections of two-port networks, Network Tropology and Graph Theory: Incident matrix, fundamental tie-set matrix and fundamental cut-set matrix.

Electrical Circuit Analysis using Laplace Transforms:

Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions, Poles and Zeros plot, Transfer function representation.

Section-C

Network synthesis:

Hurwitz polynomials, positive real functions. Properties of real immittance functions, Synthesis of LC driving point immittances, Synthesis of RC driving point impedances, Synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances. Three-phase circuits, Synthesis of Y21 and Z21 with R ohm terminations.

Section-D

Solution of First and Second order networks (AC and DC circuits):

Steady state and transient state response, initial and final conditions in network elements, Solution of first and second order differential equations for series and parallel R-L, R-C, R-L-C circuits, forced and free response, time constants.

Text / Reference Books:

1. C. K. Alexander and M. N. O. Sadiku, “Electric Circuits”, McGraw-Hill Education, 2004.
2. M. E. Van Valkenburg, “Network Analysis”, Prentice Hall, 2006.
3. W. H. Hayt and J. E. Kemmerly, “Engineering Circuit Analysis”, McGraw-Hill Education, 2013.
4. D. Roy Choudhury, “Networks and Systems”, New Age International Publications, 1998.
5. K. V. V. Murthy and M. S. Kamath, “Basic Circuit Analysis”, Jaico Publishers, 1999.

course code	26PCC-EE-205H				
Category	Professional Core Courses				
Course title	**Measurement And Instrumentation (Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	3	**0**	**0**	**3**	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

1. To understand the principles, construction, and applications of various analog and digital measuring instruments used in electrical engineering.
2. To apply methods for measuring electrical parameters such as current, voltage, power, and energy in single-phase and three-phase systems, with a focus on accuracy and error analysis
3. To gain proficiency in the use and analysis of DC and AC electrical bridges for the measurement of resistance, inductance, and capacitance.
4. To explore the working principles, construction, and applications of transducers and sensors used in industrial and automation systems.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1. Define and explain key measurement concepts like accuracy, sensitivity, and reproducibility, and their impact on electrical measurements.

CO2. Competence in analyzing and using analog instruments, such as ammeters, voltmeters, and wattmeterfor accurate current, voltage, and power measurements.

CO3. Proficiency in using electrical bridges (DC and AC) for resistance, inductance, and capacitance measurement, with understanding of each method's limitations.

CO4. Skill in operating digital and electronic measurement instruments, including CRO, DSO

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2									2	-	-	-
CO2	3	3	2									2	-	-
CO3	3	3	2									3	-	-
CO4	3	2	2								3	-	2	2

WT. AVG	3	2.5	2								2.5	2.5	2	2
									Overall Mapping of Subject					2.28

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-1

Introduction: Introduction to measurement, Methods of measurement, Classification of instruments, Types of errors in measurement. Accuracy, tolerance, sensitivity, reproducibility, absolute and secondary measuring instruments, recording instruments.CRO

UNIT-2

Analog Instruments: Classifications of analog instruments, Introduction to operating, controlling and damping torque, Electrodynamometer type wattmeter, Electro-dynamometer type Power factor meter. Moving Coil (PMMC) & Moving Iron (MI) instruments: construction, torque equation range extension, effect of temperature, classification, errors, advantages, and disadvantages.

UNIT-3

AC-DC Bridges and Potentiometer AC, DC Bridges: Measurement of resistance: Wheatstone, Kelvins Double, and Megger, earth resistance measurement by earth tester Measurement of inductance and capacitance: Maxwell’s bridge, Schering bridge, Potentiometer, Numerical problem.

UNIT-4

Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Instrument Transformer: Current Transformer (CT), Types of CT (measuring and protection), Potential Transformer (PT). Introduction to Transducers and their Application.

Text Books:

1. A.K. Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation," DhanpatRai Publications.

2. J.B. Gupta, "A Course in Electrical and Electronic Measurements & Instrumentation," Katson Publications.

3. H. S. Kalsi, “Electronic Instrumentation”, Third Edition, Tata McGraw Hill

4. R. K. Rajput, "Electrical and Electronic Measurement and Instrumentation," S. Chand Publications. References:

5. Sabrie Soloman, “Sensors Handbook”, Second Edition, McGraw Hill

6. Ramon Pallaá S-Areny and J. G. Webster, “Sensors And Signal Conditioning”, Second Edition, John Wiley & Sons, Inc.

7. Introduction to Measurements and Instrumentation, Arun K. Ghosh, Fourth Edition, Eastern Economy Edition, PHI Learning, 2012.

Course code	26ESC-EE-201-H				
Category	Engineering Science Courses				
Course title	**Analog Electronics(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	3	**0**	**0**	**3**	
Classwork	25Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

Objectives:

- To introduce the basic concepts and characteristics of diodes, transistors, and MOSFETs.
- To explain the working of rectifier and amplifier circuits.
- To describe the operation of operational amplifiers and their applications.
- To enable students to design simple active filters and oscillator circuits.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand the characteristics and operating principles of diodes, transistors, and MOSFETs.
CO2: Analyse the performance of rectifier and amplifier circuits under different operating conditions.
CO3: Apply operational amplifiers to realize linear and nonlinear analog circuits.
CO4: Design active filters and oscillator circuits for practical analog applications.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3			2									3	
CO2		2	3									3		
CO3	3												2	
CO4					3							3		2
WT. AVG	3	2	3	2	3							3	2.5	2
									Overall Mapping of Subject					2.56

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least 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. Structure and I-V characteristics of a BJT; BJT as a switch. BJT as an amplifier: small-signal model, biasing circuits, current mirror; common-emitter, common-base and common-collector amplifiers; Small signal equivalent circuits, high-frequency equivalent circuits. (10)

UNIT-II

MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, commonsource, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit. (06)

UNIT-III

Operational Amplifier: Inverting and non-inverting configurations, difference amplifier, Effect of finite open loop gain and bandwidth on circuit performance, Large signal operation of op-amp. Differential Amplifier:MOS differential pair, small signal operation of the MOS differential pair, BJT differential pair, other non-ideal characteristic of the Differential amplifier (DA), DA with active load.

Feedback: The general feedback structure, properties of negative feedback, the fourbasic feedback topologies, the series-shunt feedback amplifier, the series-seriesfeedback amplifier, the shunt-shunt and shunt series feedback amplifier.(10)

UNIT-IV

Linear applications of op-amp: Idealized analysis of op-amp circuits. Inverting and non- inverting amplifier, differential amplifier, instrumentation amplifier, integrator, single stage active filters, Active Filters: Sallen Key, Butterwoth, VCOs, voltage regulator, oscillators (Wein bridge and phase shift),

Nonlinear applications of op-amp:Hysteretic Comparator, Zero Crossing Detector, Square- wave and triangular-wave generators. Precision rectifier, Peak detector. Monoshot. (10)

Alternative NPTEL/SWAYAM Course:

Sno	NEPTEL course name	Instructor	Host Institute
1.	Analog Electronicshttps://nptel.ac.in/courses/108106188	ByProf. Radhakrishnan Rao	IIT Madras
2.	Analog Electronicshttps://onlinecourses.nptel.ac.in/noc20_ee27/preview	Prof. Pradip Mandal	IIT Kharagpur

3.	Analog Electronicshttp://https://nptel.ac.in/courses/108102112	Prof. Shouribratachatterjee	IIT Delhi

Suggested Text Books / Reference Books:

1. A. S. Sedra and K. C. Smith, “Microelectronic Circuits”, New York, Oxford University Press, 1998.
2. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, McGraw Hill U. S., 1992.
3. J. Millman and A. Grabel, “Microelectronics”, McGraw Hill Education, 1988.
4. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1989.
5. P.R. Gray, R.G. Meyer and S. Lewis, “Analysis and Design of Analog Integrated Circuits”, John Wiley & Sons, 2001.

Course Code	26BSC-MATHEE-203-H				
Category	Basic Science Course				
Course Title	**Mathematics-III (PDE, Probability and Statistics)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-III
	3	**1**	**0**	**4**	
Branch	Electrical Engineering				
Class Work	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

1.Formulation, Classification and solution methodologies for first (linear and non-linear, both) and second order PDE with applications in engineering.

2. Understand the concept of Methods of Separation of variables with applications in real world problems.

3. To understand and apply the concept of various statistical measures like mean, variance, skewness and kurtosis.

4.To establish a foundational understanding of probability theory, including the classification of random variables and probability distributions (both discrete and continuous), their properties, and applications across various engineering disciplines

COURSE OUTCOMES:

By the end of the course, students will be able to:

CO1: **To define** the concepts and terminology of Partial differential equation (PDE) including formulation, classification and solution methodologies for first and second order PDE with applications in engineering.

CO2: **Understand** the concepts and related terminology of probability andstatistics including conditional probability, Baye's rule, random variables, expectation, probability distributions.

CO3: **Apply** the knowledge & ideas of probability distributions (Binomial, Poisson, Normal, Exponential) in modelling and analysis of real-world problems.

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CO4: **Classify** random variables, probability distributions and **justify** their selection for solving engineering and real-world problems based on their properties, assumptions, and applicability.

CO5: **Analyze** experimental and numerical data using statistical measures for correlation coefficient and line of regression to interpret results for decision-making.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									1
CO2	3	2	1	1								1
CO3	3	3	2	2								1
CO4	3	3	2	2								1
CO5	3	3	3	3								1

Note: Examiner will set 9 questions in all with two questions from each unit and question Q.1 covering all units. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Partial Differential Equations: Formulation of PDE, Lagrange's linear PDEs; First order non-linear PDEs, Charpit's Method. Second-order linear PDEs and their classification. Solution to homogeneous linear partial differential equations with constant coefficients by complementary function and particular integral method.

UNIT-II

Initial and boundary conditions, Separation of variables method to simple problems in Cartesian coordinates. Methods of Separation of variable's applications to one dimensional Heat and Wave Equations, Two-dimensional Heat flow and Laplace equation.

UNIT-III

Statistics: Measures of Central Tendency: Mean, Median, Mode, Measure of Dispersion: Range, Standard Deviation, Mean Deviation, Quartile-Deviation, Moments, Measure of Skewness and Kurtosis, Co-efficient of Correlation and Rank Correlation, Lines of Regression.

UNIT-IV

Probability: Probability spaces, Conditional probability, Bayes' theorem, Discrete random variables, Bernoulli distribution, Binomial distribution, Poisson distribution, Expectation of discrete random variables, Moments, Variance of a sum, Correlation Coefficient, Lines of Regression. Continuous random variables and their properties, Normal, Exponential and Gamma distributions.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
2. B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers.
3. P. G. Hoel, S. C. Port, C. J. Stone, Introduction to Probability Theory, Universal Book Stall.
4. S. Ross, A First Course in Probability, Pearson Education India.
5. W. Feller, An Introduction to Probability Theory and its Applications, Wiley India.

6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications.

Course code	26LC-EE-201-H				
Category	Professional Core Courses				
Course title	**Electrical Machines-1 lab (Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS:-

1.To determine the polarity of primary and secondary windings.
2. To determine core loss, no-load current, and no-load power factor.
3.To determine copper losses and equivalent circuit parameters.
4.To determine efficiency and voltage regulation at different loads.
5.To determine efficiency under full-load conditions without actual loading.
6. Determine the Load characteristic of a DC Shunt Generator.
7. Determination the Load characteristic of a DC compound Generator.
8. Determination of the Magnetising characteristic of a DC Shunt Generator.
9. Determination of efficiency of DC machine through Hopkinson s Test
10. Speed control of DC machines by Ward-Leonard test
11. Bracking of DC motors.

Course Outcomes:

The students will be able to:

CO1: Students will be able to **identify, connect, and operate single-phase transformers and DC machines** in accordance with standard laboratory safety procedures and equipment ratings.

CO2: Students will be able to **conduct and analyze standard performance tests** on transformers (such as open-circuit and short-circuit tests) and DC machines (including no-load and load tests) to determine efficiency, losses, and voltage regulation.

CO3: Students will be able to **interpret experimental data and characteristic curves** of transformers and DC machines, and correlate the observed results with theoretical principles of electromagnetic energy conversion.

CO4: Students will be able to **document experimental observations and results effectively**, evaluate sources of experimental error, and demonstrate teamwork and professional laboratory practices while performing electrical machine experiments.

Note: At least 10 experiments are to be performed by the students.

1).Each laboratory class/section shall not be more than about 20 students.

2).To allow fair opportunity of practical hands on experience to each student,each experiment may either done by each student individually or in groupofnotmore than 3-4 students. Larger groups are strictly discouraged/disallowed.

3).Pre-experimental &post experimentalquiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	Familiarization of the electrical machine laboratory apparatus.	https://ems-iitr.vlabs.ac.in/exp/lab-equipment-familiarization/
2.	To study the Load Characteristics of DC shunt generator	https://ems-iitr.vlabs.ac.in/exp/load-characteristics-dc-shunt/
3.	Speed Control of DC motor by field resistance control	https://ems-iitr.vlabs.ac.in/exp/dcmotor-field-resistance-control/
4.	Speed Control of DC motor by armature resistance control	https://ems-iitr.vlabs.ac.in/exp/dcshunt-motor-armature-control/
5.	To perform speed control of DC motor by using Ward- Leonard Method of speed control	https://ems-iitr.vlabs.ac.in/exp/dcmotor-ward-leonard/
6.	Determination of Transformer equivalent circuit from Open Circuit and Short Circuit Test.	https://ems-iitr.vlabs.ac.in/exp/circuit-parameters-oc-test/

Course code	26LC-EE-203-H				
Category	Professional Core Courses				
Course title	Electrical Circuit Analysis Lab (Practical)				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS: -

1. To study the basics of MATLAB software.
2. Write a programme to calculate and verify two-portparametersina T-network using MATLAB:
   i. Impedance (Z)-parameter
   ii. Addmittance (Y-parameter
   iii. Hybrid (h)-parameter
   iv. Inverse hybrid (g)-parameter
   v. Transmission line (ABCD-parameter
   vi. Inverse transmission line (abcd)-parameter
3. Write a programme to calculate and verify the equivalent interconnection of a two-port network using MATLABconnected in
   i. Series-series
   ii. Parallel-parallel
   iii. Cascading
4. Write a program to calculate and verify the various matrices of graph theory using MATLAB:
   i. Fundamental incident matrix
   ii. Fundamental loop matrix
   iii. Fundamental cut-set matrix
5. To simulate the Thevenin theorem in a DC circuit using MATLAB.
6. To simulate the Superposition theorem in a DC circuit using MATLAB.
7. To simulate the Maximum power transfer theorem in a DC circuitusing MATLAB.
8. To verify the source-free response of the RC and RL series circuit using MATLAB.

9. To verify the step response of the RC and RL series circuit using MATLAB.
10. To study and synthesize the two-port network using the Cauer form and the Foster form.

Course Outcomes:

The students will be able to:

CO1:Students will be able to identify, connect, and operate the basics of various matrix operations and the syntax of various loop functions in MATLAB.

CO2:Students will be able to apply the DC circuit theorem to analyze the load-side response and implement it in MATLAB simulation.

CO3:Students will be able to evaluate AC and DC transients and implement them in MATLAB.

CO4: Students will be able to estimate the two-port parameters, their interconnections, and their relationships. Also, the student will be able to implement these on MATLAB.

Note: Students must perform at least 10 experiments.

1).Each laboratory class/section shall not be more than about 20 students.

2) To allow a fair opportunity for practical hands-on experience to each student, each experiment may be either done by each student individually or in a group of not more than 3-4 students. Larger groups are strictly discouraged/disallowed.

3).Pre-experimental & post-experimental quiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

Course code	26LC-EE-205-H				
Category	Professional Core Courses				
Course title	Measurement and Instrumentation (Practical)				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS: -

1. To perform the study of PMMC and Moving Iron instruments.
2. To perform the measurement of unknown resistance using Wheatstone Bridge.
3. To perform the measurement of low resistance using Kelvin's Double Bridge.
4. To perform the measurement of inductance using Maxwell's Bridge.
5. To perform the measurement of capacitance using Schering Bridge.
6. To perform the measurement of inductance using Anderson Bridge.
7. To perform three-phase power measurement using:
    - To perform the single wattmeter method.
    - To perform the two wattmeter method.
8. To perform calibration and testing of a single-phase energy meter.
9. To perform the study of CRO.
10. To perform the study of frequency meter.
11. To perform the study of different types of digital meters.

PART B: VIRTUAL LAB EXPERIMENTS

1. To perform familiarization with measuring instruments using Virtual Lab simulation.
2. To perform measurement of unknown resistance using Wheatstone Bridge (Virtual Simulation).
3. To perform measurement of low resistance using Kelvin's Double Bridge (Virtual Lab).
4. To perform measurement of inductance using Maxwell's Bridge (Virtual Lab module).
5. To perform capacitance measurement using Schering Bridge (Virtual Simulation).
6. To perform measurement of three-phase power using two wattmeter method (Virtual Lab).
7. To perform calibration of single-phase energy meter (Virtual Lab simulation).
8. To perform study of dynamic characteristics of first and second order instruments (Virtual Lab module).

9. To perform signal conditioning experiment for RTD and strain gauge using Virtual Instrumentation module.
10. To perform A/D and D/A conversion experiment using Virtual Lab.

Course Outcomes

After completion of the laboratory, the student shall be able:

CO1 – To perform measurement of resistance, inductance, capacitance, power and energy using standard methods.

CO2 – To calibrate electrical instruments and evaluate accuracy and error.

CO3 – To analyze dynamic characteristics of instruments.

CO4 – To use Virtual Labs platforms for remote experimentation and simulation.

CO5 – To interpret experimental data and prepare structured laboratory reports.

Note: Students must perform at least 10 experiments.

1).Each laboratory class/section shall not be more than about 20 students.

2) To allow a fair opportunity for practical hands-on experience to each student, each experiment may be either done by each student individually or in a group of not more than 3-4 students. Larger groups are strictly discouraged/disallowed.

3).Pre-experimental & post-experimental quiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

Course code	26LC-EE-207-H				
Category	Engineering Science Course				
Course title	**Analog Electronics Lab (Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS:-

1. To study the following laboratory instruments:
(a) Analog and digital multimeters
(b) Function / signal generators
(c) Regulated DC power supplies (constant voltage and constant current modes)
(d) Analog CRO and measurement of time period, amplitude, frequency, and phase difference using Lissajous figures.
2. To plot the V–I characteristics of a P–N junction diode and determine cut-in voltage, reverse saturation current, and static and dynamic resistances.
3. To plot the V–I characteristics of a Zener diode and study its application as a voltage regulator. Observe the effect of load variation and determine load regulation limits.
4.To plot the frequency response of a single-stage amplifier and determine the gain–bandwidth product.
5. To plot drain current–drain voltage and drain current–gate voltage characteristics of a field-effect transistor and determine $I_{DSS}$and pinch-off voltage.
6. To plot the gain–frequency characteristics of an emitter follower and determine its input and output resistances.
7. To plot the input and output characteristics of a BJT in CB, CE, and CC configurations and determine the corresponding h-parameters.
8. To study a half-wave rectifier and observe the effect of filters on the output waveform. Calculate theoretical and practical ripple factor.
9. To study a bridge rectifier and observe the effect of filter circuits on DC output voltage and ripple factor.
10. To plot the output characteristics of a MOSFET.
11. To determine the following parameters of an operational amplifier:
(a) Input bias current
(b) Input offset current
(c) Input offset voltage
(d) Common-mode rejection ratio (CMRR)

Course Outcomes:

The students will be able to:

CO1: Identify, connect, and operate basic analog electronic instruments and devices following standard laboratory safety practices.

CO2: Perform experiments on diodes, transistors, MOSFETs, rectifiers, and amplifiers to obtain their characteristics and performance parameters.

CO3: Analyse experimental results and correlate observed characteristics with theoretical concepts of analog electronics.

CO4: Record experimental observations systematically, evaluate sources of error, and demonstrate effective teamwork and professional laboratory practices.

Note: At least 10 experiments are to be performed by the students.

1).Each laboratory class/section shall not be more than about 20 students.

2).To allow fair opportunity of practical hands on experience to each student,each experiment may either done by each student individually or in groupofnotmore than 3-4 students. Larger groups are strictly discouraged/disallowed.

3).Pre-experimental &post experimentalquiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	V–I characteristics of a diode	https://be-iitkgp.vlabs.ac.in/exp/characteristics-diode/simulation.html
2.	Zener diode and voltage regulator	https://be-iitkgp.vlabs.ac.in/exp/voltage-regulator/simulation.html
3.	Rectifier circuits (half/full)	https://be-iitkgp.vlabs.ac.in/exp/full-wave-rectification/
4.	MOSFET output characteristics	https://mevlsi-iitkgp.vlabs.ac.in/exp/mosfet/
5.	Op-amp differentiator and integrator	https://be-iitkgp.vlabs.ac.in/exp/operational-amplifier/
6.	Analog electronics circuits overview	https://vlabs.iitkgp.ac.in/aec/

Course code	26PCC-EE-207-H				
Category	Professional Core Courses				
Course title	Electrical Safety and Standards (Theory)				
Scheme and Credits	L	T	P	Credits	Semester-3
	3	0	0	3	
Classwork	25Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

The objectives of this course are to:

- To make students aware of electrical hazards and safety practices in electrical engineering systems.
- To understand national and international electrical safety standards and codes.
- To impart knowledge of earthing, insulation, protective devices, and safe operation of electrical installations.
- To develop the ability to apply safety regulations and standards in design, operation, and maintenance of electrical systems.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to

CO1: Identify electrical hazards and explain safety requirements in electrical systems.
CO2: Interpret national and international electrical standards and codes relevant to electrical installations.
CO3: Analyze earthing systems, insulation coordination, and protective devices for electrical safety.
CO4: Apply electrical safety standards and practices in the design, operation, and maintenance of electrical installations

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2					1					3		
CO2	2	3					1					3		
CO3	2	3	3										2	

CO4	3	2	3	1									3	2
WT. AVG	2.5	2.5	3	1								3	2.5	2
									Overall Mapping of Subject					2.35

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Introduction to Electrical Safety (08 Hours)

Importance of electrical safety, statistics of electrical accidents, effects of electric shock on human body, factors affecting severity of shock, electrical hazards (shock, burns, arc flash, arc blast), safe limits of current and voltage, safety precautions in electrical work, personal protective equipment (PPE).

UNIT-II

Earthing and Insulation Practices (10 Hours)

Need and objectives of earthing, types of earthing (equipment earthing and system earthing), earthing methods, earthing resistance and its measurement, grounding of substations and industrial installations. Insulation materials, classes of insulation, insulation resistance measurement, dielectric strength, insulation coordination.

UNIT-III

Protective Devices and Safety in Electrical Installations (10 Hours)

Protective devices: fuses, MCB, MCCB, ELCB, RCCB, RCBO, relays and circuit breakers. Protection against overcurrent, short circuit, earth fault, overvoltage and lightning. Safety in low voltage and high voltage installations, safe clearance, interlocking, lock-out and tag-out (LOTO) procedures.

UNIT-IV

Electrical Standards, Codes, and Regulations (10 Hours)

Overview of electrical standards and codes: Indian Electricity Rules, IS standards, IEC standards, IEEE standards. National Electrical Code (NEC – India). Safety standards for electrical machines, transformers, cables, switchgear, and substations. Testing, inspection, and certification of electrical installations. Electrical safety audits.

Alternative NPTEL/SWAYAM Course:

SNo	NEPTEL course name	Instructor	Host Institute
1.	Electrical Safety	Prof. S. Chandrasekaran	IIT Madras
2.	High Voltage Engineering	Prof. Ravindra Arora	IIT Roorkee

Suggested Text Books / Reference Books:

1. C. L. Wadhwa, *Electrical Power Systems*, New Age International Publishers.
2 B. R. Gupta, *Electrical Safety and Protection*, S. Chand Publications.
3 S. Rao, *Electrical Safety: Principles and Practices*, Khanna Publishers.

4 IEEE Standards on Electrical Safety and Grounding.
5 National Electrical Code (India), Bureau of Indian Standards.

Course code	26LC-EE-209-H				
Category	Professional Core Courses				
Course title	**Electrical Safety and Standards lab (Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS:-

1. **Study of Electrical Safety Practices**
   - Identification of electrical hazards.
   - Use of personal protective equipment (PPE).
   - Safe working procedures in electrical laboratories.
2. **Study of Earthing Systems**
   - Measurement of earth resistance using earth tester.
   - Comparison of plate, pipe, and rod earthing systems.
3. **Insulation Resistance Measurement**
   - Measurement of insulation resistance of cables, transformers, and motors using Megger.
4. **Study of Electrical Shock Protection Methods**
   - Demonstration of protective grounding, double insulation, and residual current devices (RCDs/ELCBs).
5. **Testing and Operation of Protective Devices**
   - Study of MCB, MCCB, RCCB, RCBO, HRC fuse, and their characteristics.
6. **Electrical Wiring Standards and Testing**
   - Continuity test, polarity test, and insulation test of domestic wiring circuits.
7. **Study of Safety Standards and Electrical Codes**
   - Familiarization with relevant Indian Standards (IS), IEC standards, National Electrical Code (NEC), and Central Electricity Authority (CEA) safety regulations.
8. **Measurement of Touch Voltage and Step Voltage**
   - Understanding safe limits and mitigation techniques.
9. **Energy Meter and Electrical Installation Inspection**
   - Verification of meter connections and safety compliance checks.
10. **Electrical Fire Safety**
    - Identification of fire hazards.
    - Use of suitable fire extinguishers for electrical installations.

11. **Safety Audit of Electrical Laboratory**

- Preparation of safety checklist.
- Identification and reporting of unsafe conditions.

12. **Testing of Surge Protection Devices (SPD)**
- Study of protection against lightning and switching surges.

13. **First Aid for Electrical Accidents**
- Demonstration of CPR awareness and emergency response procedures.

14. **Case Studies on Electrical Accidents**
- Analysis of accident causes, preventive measures, and lessons learned.

Course Outcomes:

The students will be able to:

CO1: Identify electrical hazards and apply safe working practices in electrical installations and laboratories.
CO2: Perform testing and inspection of earthing systems, insulation, wiring, and protective devices according to applicable standards.
CO3: Interpret and apply national and international electrical safety standards and codes for safe operation and maintenance.
CO4: Conduct safety audits, prepare technical reports, and demonstrate professional responsibility toward electrical safety and accident prevention.

Note: At least 10 experiments are to be performed by the students.

1).Each laboratory class/section shall not be more than about 20 students.

2).To allow fair opportunity of practical hands on experience to each student,each experiment may either done by each student individually or in groupofnotmore than 3-4 students. Larger groups are strictly discouraged/disallowed.

3).Pre-experimental &post experimentalquiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S. N	Experiment Name	Experiment Link(s)
1.	Earthing System Analysis	Virtual Labs / ETAP Simulator
2.	Insulation Resistance Testing	Electrical Safety Simulators
3.	Protective Relay and Circuit Breaker Operation	MATLAB/Simulink, ETAP
4.	Electrical Installation Safety Audit	Virtual Safety Training Modules
5.	Ground Fault and Leakage Current Protection	ETAP / PowerWorld

6.	Electrical Fire Hazard Assement	Safety Training Simulators

Semester-4

r. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PCC-EE-202-H	Digital Electronics	3	0	0	3	**3**	25	50		75	3
2	26PCC-EE-204-H	Electrical Machines-II	3	1	0	4	**4**	30	70		100	3
3	26PCC-EE-206-H	Power Systems-1	3	1	0	4	**4**	30	70		100	3
4	26PCC-EE-208-H	Signal & Systems	3	1	0	4	**4**	30	70		100	3
5	**PEC**	Refer to Table 1	3	1	0	4	**4**	30	70		100	3
6	26PCC-EE-210-H	Electrical power Generation	2	0	0	2	**2**	15	35		50	3
7	26LC-202-H	Digital Electronics lab	0	0	2	2	**1**	5		20	25	3
8	26LC-204-H	Electrical Machines-II lab	0	0	2	2	**1**	5		20	25	3
9	26LC-206-H	Power Systems-1 Lab	0	0	2	2	**1**	5		20	25	3
10	26AU-ENV-202-H	Environmental Science	2	0	1	3	**0**	Refer Note 1				
					Total	30	24				600	
		For Honors course										
1	26PCC-EE-212-H	Power Plant Engineering	3		0	3	**3**	25	50		75	3
2	27LC-210-H	Project Stage-1	0		2	2	**1**	5		20	25	3
					Total	**5**	4				100	

Note-1: AU is a mandatory non–credit course in which students will be required to obtain passing marks in theory. 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 detailed marks certificate of student.

Marks Distribution:

- Internal Assessment: 30 marks
- Theory Examination: 70 marks

The institute will conduct the theory examination at its own level.

Note-2: At the end of the 4th semester, each student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional organization/ Research Laboratory/ training centre, etc., and submit a typed report along with a certificate from the organization& its evaluation shall be carried out in the 5th Semester.

The students of B.Tech working Professenols course have to submit training/project report of their respective company/organization for the period of summer training/ industrial training for the evaluation purpose.

List of Program Electives-I (Table 1)

Sr. No.	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Scheme (Marks)				Duration of Exam (Hours)
			L	T	P			Internal awards	Theory	Practical	Total	
1	26PEC-EE-202-H	Electromagnetic field theory	3	1	0	4	**4**	30	70		100	3
2	26PEC-EE-204-H	Electrical Engineering Materials and Devices	3	1	0	4	**4**	30	70		100	3
3	26PEC-EE-206-H	Soft Computing	3	1	0	4	**4**	30	70		100	3

Course code	26PCC-EE-202-H				
Category	Programme Core Course				
Course title	**Digital Electronics(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	3	1	**0**	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

Objectives:

To understand the fundamentals of digital logic and develop an ability to design basic digital circuits.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand binary number system and logic families which is the basics of computing system.

CO2: Understand working and implementation of logic gates.

CO3: Design and analyzecombinational and sequentiallogiccircuits.

CO4: Understand the operation of digital to analog and analog to digital converters.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2					2								
CO2	2				3	2						2		
CO3			3		3	2						3	3	2
CO4			3		3							3	3	2
WT. AVG	2		3		3	2						2.6	3	2
									Overall Mapping of Subject					2.51

Note:

Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinee has to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Digital Systems and Binary numbers: Digital signals, digital systems, advantages of digital systems, logic levels, signed binary numbers, complement binary arithmetic, binary codes, BCD arithmetic, error detecting and correcting codes.

Digital Logic Families: Types of logic families, voltage levels, noise margin, power dissipation, fan-in and fan-out, CMOS logic. (10)

UNIT-II

Gate Level Minimization: Canonical and standard forms, POS and SOP simplifications, K-Map method, Q-M method, don't care conditions, NAND and NOR implementations, integrated circuits. (10)

UNIT-III

Combinational Logic: Design and analysis of combinational circuits – adders, carry look ahead adder, subtractors, multiplier, magnitude comparators, encoders, demultiplexersand multiplexers. (10)

UNIT-IV

Sequential Logic: Design and analysis of sequential circuits – latches, flip-flops, registers and counters.

A/D and D/A converter: Introduction to Digital to analog converters: weighted resistor/resistor divider converter, R-2R Ladder D/A converter, specifications for D/A converters, Introduction to analog to digital converters: sample and hold circuit, quantization and encoding, parallel comparator A/D converter, counter type A/D converter, successive approximation A/D converter, dual slope A/D converter. **(10)**

Alternative NPTEL/SWAYAM Course:

S.No.	NEPTEL course name	Instructor	Host Institute
1.	Digital Systems Design, Department of Electrical Communication Engineering, Indian Institute of Technology Kharagpur https://nptel.ac.in/courses/117/105/117105080/	By Prof. Roychoudhury, D.	IIT Kharagpur

2.	Digital Circuits & Systems, Department of Electrical Engineering, Indian Institute of Technology Madras https://nptel.ac.in/courses/117106086	By Prof. S. Srinivan	IIT Madras

Suggested Text Books / Reference Books:

1. Ciletti, Michael D., and M. Morris Mano. Digital design. Hoboken: Prentice-Hall, 2007.
2. Floyd, Thomas L. Digital fundamentals, 10/e. Pearson Education India, 2011.
3. Jain, R. P. Modern digital electronics. Vol. 1. No. 10. Tata McGraw-Hill Education, New Delhi, 2003
4. A. Kumar, Fundamentals of Digital Circuits, Prentice Hall India, 2016.
5. M. M. Mano, Digital logic and Computer design, Pearson Education India, 2016.

Course code	26PCC-EE-204-H				
Category	**Professional Core Course**				
Course title	**Electrical Machines-II(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 4
	3	**1**	**0**	**4**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To understand the construction, principle of operation and applications of Induction machines and Synchronous Machines.
- To develop equivalent circuit and phasor model for electrical machine and use them for performance evaluation.
- To analyze performance characteristics of three phase Induction machine and synchronous machines.
- To understand the performance, applications and selection criteria of AC machines for industrial and utility systems.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Explain the basic principle of operation and industrial applications of Induction machines and Synchronous Machines

CO2: Develop and use equivalent circuit model to analyze the steady state performance of AC machines

CO3: Evaluate the performance parameters of rotating machines with different operating conditions

CO4: Access machine behavior under various operating conditions and Illustrate the starting, controlling and various advanced approach for rotating electrical machines

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	3	2										3		
CO2		3										2		
CO3	2	3											3	
CO4			3										2	2
WT. AVG	2.5	2.67	3									2.5	2.5	2
									Overall Mapping of Subject					2.53

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Three-Phase Induction Motor: Principal of operation, Constructional features and types of induction motor, Revision of the concept of rotating magnetic field, induction motor action, equivalent circuit, no load and block rotor test, parameter determination, torque production, starting and maximum torque, performance characteristics, torque-sip characteristics, effect of parameter variation on torque speed characteristics, circle diagram, cogging and crawling double cage and deep bar motors.

UNIT-II

Starting and Speed control of Three Phase Induction Motor: Methods of speed control - stator voltage control, stator resistance control, frequency control, rotor resistance control, slip power recovery control, starting method-Need for starting, types of starters, direct online (DOL) starter, rotor resistance, autotransformer and star-delta starters**.**

Induction Generator: Principle of operation, types and applications.

Single Phase Induction motors: Double revolving field theory, cross field theory, equivalent circuit, no load and block rotor test, parameter determination, performance analysis, different types and starting methods of single phase induction motors, universal motor, shaded pole induction motor.

UNIT-III

Three-Phase Synchronous Generator: Principle of operation, constructional features and types of rotor, winding factor, EMF equation, armature winding, armature reaction, equivalent circuit, phasor diagram, voltage regulation, methods to find the voltage regulation, synchronous reactance method, synchronous impedance method, Potier triangle method, output power equation, power angle curve.

UNIT-IV

Three-Phase Synchronous Generators: Transient and sub-transient reactance, synchronization, parallel operation of alternator synchronization and load division

Synchronous Motor: Construction,Principles of operation, starting methods, damper winding, equivalent circuit, power angle curve, V-curve, comparison between induction motor and synchronous motor, synchronous condenser applications.

Alternative NPTEL/SWAYAM Course:

Sr No	NEPTEL course name	Instructor	Host Institute
1	Electrical Machines-II https://nptel.ac.in/courses/108105131	By Prof. Tapas Kumar Bhattacharya	IIT Kharagpur
2	Electrical Machines https://nptel.ac.in/courses/108102146	Prof. G Bhuvaneshwari	IIT Delhi

TEXT/ REFERENCE BOOKS:

1. Principle of Electrical Machines, V K Mehta, Rohit Mehta, S Chand
2. Electric Machines ,Ashfaq Hussain, Dhanpat Rai
3. Electric Machines: I.J.Nagrath and D.P. Kothari, TMH, New Delhi.
4. Generalized theory of Electrical Machines: P.S. Bhimbra (Khanna Pub.)
5.Electric Machinery, Fitzgerald and Kingsley, MGH

Course code	26PCC-EE-206-H				
Category	Professional Core Courses				
Course title	Power Systems-1**(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	3	1	**0**	4	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To create awareness about the structure and present-day Scenario of a power system.
- To understand how to designthe mechanical design of a transmission line with skin effect and proximity effect.
- Able to learn about the HVDC transmission system and the topology of the distribution system.
- To understand how to deal with the various cable and insulator gradings and ratings. To know the performance of the transmission line

COURSE OUTCOMES (CO): By the end of the Course, Students will be able to:

CO1: Understand the basic laws of Transmission and Distribution. Knowledge about the structure and present-day Scenario of a power system.

CO2: Analyses of transmission and distribution line parameters.Understand the mechanical design of a transmission line that accounts for skin and proximity effects.

CO3: Understand the various cable and insulator gradings and ratings. To know the performance of the transmission line

CO4: Planning and design of HVDC transmission systems, including monopolar, bipolar, and homopolar. Also understand the topology of power system as: Radial, Ring and Interconnected distribution system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	3	2	2	1	2							3		
CO2		3	2	1								3		
CO3	2	3	1	1									2	
CO4		1	3	2									3	2
WT. AVG	2.5	2.5	2		2							3	2.5	2
									Overall Mapping of Subject					2.35

Note: The Examiner will set a total of nine questions. The students have to attempt five questions in total, the first being compulsory, and the remaining four questions must be attempted, one question from each unit. The remaining eight questions must be set by taking two questions from each unit.

Section-A

INTRODUCTION:

Evolution and Growth of Power Systems in India. Deregulation in power, Environmental aspects of energy generation, Structure of a power system, Distributed generation, Bulk Power Grids and Micro-grids, indoor and outdoor substations, equipment for substations, layout, auxiliary supply.

BASIC TERMINOLOGY IN POWER SYSTEMS:

Reserve generating capacity, maximum load, annual load factor, capacity factor, diversity factor, and tariffs.

DISTRIBUTION SYSTEMS:

Radial, ring mains, and network distribution systems, comparison of various types of AC and DC systems.

Section-B

CALCULATION OF TRANSMISSION LINE PARAMETER:

Inductance of line: Definition, Inductance of 1-Ø two-wire line, Inductance of composite conductor line, Inductance of 3-Ø single line, Inductance of 3-Ø double line, and Proximity effect.
Resistance of line: Resistance of line and Skin effect.
Capacitance of line: Definition, Capacitance of 1-Ø two-wire line, Capacitance of 3-Ø line with symmetrical and unsymmetrical spacing, Effect of earth on transmission line capacitance, Ferranti effect.

PERFORMANCE OF POWER TRANSMISSION LINE:

Classification of transmission line: Short, Medium, and Long transmission lines, Equivalent circuit, Interpretation of long line, tuned power line, power flow through a transmission line, method of voltage control, and Circle diagram.

Section-C

MECHANICAL DESIGN:

Catenary curve, Sag-tension calculation, effect of ice and wind, Sag at different support levels, stringing chart, dampers.

INSULATORS:

Types, insulating materials, voltage distribution over the insulator string, and the method of equalizing the potential over the insulator in a string.

INSULATED CABLES:

Insulating material and its requirement, EHV cables, grading of cables, insulation resistance of cable, capacitance of single core cable, and Current rating of cable. Types of cable, Comparison of overhead and underground cable.

Section-D

CORONA:

Phenomenon of corona, derivation for critical disruptive voltage and visual critical disruptive voltage, power loss, factor affecting corona loss, advantages and disadvantages, radio interference, method of reduction in corona losses,

HVDC TRANSMISSION:

Need for HVDC transmission; types of links (monopolar, Bipolar, and homopolar),advantages and limitations of HVDC transmission.

Text / Reference Books:

1. Power System Analysis: Hadi Saadat, McGraw-Hill, Inc., US, 1998.
2. Power System Engineering 3rd edition: D.P.Kothari and I.J.Nagrath, McGraw-Hill, 219.
3. Electrical Power Systems: C. L. Wadhwa,7th edition, New Age International Publisher, 2016

Course code	26PCC-EE-208-H				
Category	Professional Core Courses				
Course title	**Signals and Systems(Theory)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	3	**1**	**0**	**4**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To acquaint the students with the basic concepts of signals and systems in continuous-time and discrete-time domains.
- To understand and explain signal representations, transformations, and properties of linear time-invariant systems.
- To develop an understanding of Fourier, Laplace, and Z-transform techniques for time and frequency domain analysis.
- To analyse continuous-time and discrete-time systems using transform methods for engineering applications.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Understand and classify continuous-time and discrete-time signals and analyse basic properties of LTI and causal systems.

CO2: Analyse signals in the frequency domain using Fourier Transform and DTFT, including magnitude–phase spectra and sampling concepts.

CO3: Apply Laplace Transform techniques for analysis of continuous-time systems, including solution of differential equations and pole–zero plots.

CO4: Use Z-transform methods for discrete-time system analysis, including solution of difference equations and stability assessment.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3											3		

CO2		3		2								3	2	
CO3	2	3											2	
CO4	3				2							3		2
WT. AVG	2.67	3		2	2							3	2	2
									Overall Mapping of Subject					2.38

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Signals: Definition, types of signals and their representations: continuous-time, discrete-time, periodic, non-periodic, even, odd, energy, power, deterministic, random, one-dimensional, multi-dimensional, Shifting and scaling operations, Linear Time Invariant and Causal systems; commonly used signals (in continuous-time as well as in discrete-time): unit impulse, unit step, unit ramp (and their inter-relationships), exponential, rectangular pulse, sinusoidal; operations on continuous-time and discrete-time signals (including transformations of independent variables). 10

UNIT-II

Fourier Transforms (FT):(i) Definition, conditions of existence of FT, properties, magnitude and phase spectra, Some important FT theorems, Parseval's theorem, Inverse FT, relation between LT and FT(ii) Discrete time Fourier transform (DTFT), inverse DTFT, convergence, properties and theorems, Comparison between continuous time FT and DTFT, Sampling theorem, Applications of Fourier Transform.(10)

UNIT-III

Time and frequency domain analysis of systems, Analysis of first order and second order systems, continuous-time (CT) system analysis using Laplace-Transform (LT), One-sided LT of some common signals, important theorems and properties of LT, inverse LT, solutions of differential equations using LT, Bilateral LT, Regions of convergence (ROC), pole-zero (s-plane) plots.(10)

UNIT-IV

Z-transform (ZT):One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Pole-zero plots (z-plane), properties and theorems, solution of difference equations using one-sided ZT, s- to z-plane mapping (06)

Alternative NPTEL/SWAYAM Course:

Sno	NEPTEL course name	Instructor	Host Institute
1.	Signals and Systemshttps://nptel.ac.in/courses/108104100	By Prof. Aditya K. Jagannatham	IIT Kanpur

Suggested Text Books / Reference Books:

1. `Signal and Systems' I J NAGRATH, R. RANJAN & Sharan, 2009 Edn., TMH, New Delhi
2. V. Oppenheim, A.S. Willsky and S. Hamid Nawab, 'Signals &System',PEARSON Education, Second Edition, 2003.
3. Signals & System by A Anand Kumar, Third edition PHI.
4. Schaume Series on Signals & Systems, HSU & RANJAN, TMH,India

Course code	26PEC-EE-202-H				
Category	Program Elective Course				
Course title	**Electromagnetic Fields Theory** (Theory)				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	3	**1**	**0**	**4**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- To introduce the student to the coordinate system and its implementation to electromagnetics.
- Understand basic concepts and principles of electromagnetic fields.
- Appreciate the relation between electric and magnetic fields.
- Understand the applications of EM waves in different Medias.

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: To understand the various operations of vector calculus.
CO2: To understand the basic laws of electromagnetism.
CO3: To obtain the electric and magnetic fields for simple configurations under static conditions.
CO4: To understant Maxwell's equation in different forms and different media.

CO - PO mapping

CO PO MAPPING															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		

CO2		3											3		
CO3	2	3												2	
CO4			2											3	2
WT. AVG	2.5	2.67	2										3	2.5	2
										Overall Mapping of Subject					2.44

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

SECTION - A

Review of Vector Calculus

Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation ,integration, vector operator del, gradient ,divergence and Curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another.

SECTION - B

Static Electric Field

Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density.

Conductors, Dielectrics and Capacitance

Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

SECTION – C

Static Magnetic Fields

Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Magnetic Forces, Materials and Inductance

Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

SECTION – D

Time Varying Fields and Maxwell's Equations

Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions. **Electromagnetic Waves**

Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

Text / References Books:

1. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Publication, 2014.
2. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
3. A. Pramanik, "Electromagnetism-Problems with solution", Prentice Hall India, 2012.
4. G. W. Carter, "The electromagnetic field in its engineering aspects", Longmans, 1954.
5. W. J. Duffin, "Electricity and Magnetism", McGraw Hill Publication, 1980.
6. W. J. Duffin, "Advanced Electricity and Magnetism", McGraw Hill, 1968.
7. G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge UniversityPress, 1966.
8. B. D. Popovic, "Introductory Engineering Electromagnetics", Addison-Wesley Educational Publishers, International Edition, 1971.
9. W. Hayt, "Engineering Electromagnetics", McGraw Hill Education, 2012.

Course code	26PEC-EE-204-H				
Category	Programme Elective Course				
Course title	Electrical Engineering Materials and Devices (Theory)				
Scheme and Credits	L	T	P	Credits	Semester-4
	3	1	0	4	
Classwork	30Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

The objectives of this course are to:

- Introduce the fundamental concepts of electrical, magnetic and dielectric materials used in electrical and electronic devices.
- Provide understanding of the physical, electrical and thermal properties of engineering materials.
- Develop knowledge of semiconductor materials and devices used in power and electronic applications.
- Enable students to analyze the selection and performance of materials and devices in practical electrical engineering systems.

COURSE OUTCOMES (CO):

By the end of this course, the students will be able to:

CO1: Understand the structure, properties and applications of conducting, insulating and magnetic materials.

CO2: Analyze the electrical, thermal and mechanical behavior of dielectric and magnetic materials.

CO3: Evaluate the characteristics and performance of semiconductor materials and basic electronic devices.

CO4: Apply the knowledge of materials and devices for appropriate selection in electrical and electronic engineering applications.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	3	2										3		
CO2		3										3		
CO3	2												2	
CO4			3		1								3	2
WT. AVG	2.5	2.5	3		1							3	2.5	2
									Overall Mapping of Subject					2.45

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks. Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Electrical Conducting and Insulating Materials

Atomic structure, energy bands in solids, classification of materials. Conducting materials – resistivity, temperature coefficient, alloys, superconductors. Insulating materials – classification, thermal and electrical properties, breakdown strength, ageing of insulation, applications in electrical equipment. *(06 Hours)*

UNIT-II

Dielectric and Magnetic Materials

Dielectric materials – polarization, dielectric constant, dielectric loss, ferroelectric, piezoelectric and pyroelectric materials. Magnetic materials – classification, hysteresis, soft and hard magnetic materials, magnetic losses, ferrites, applications in electrical machines and transformers. (10 Hours)

UNIT-III

Semiconductor Materials and Devices

Semiconductor materials – intrinsic and extrinsic semiconductors, carrier transport, PN junction, V–I characteristics. Diodes – rectifier, Zener, LED and photodiode. Bipolar Junction Transistor (BJT) – operation and characteristics. MOSFET – structure, working and applications.(10 Hours)

UNIT-IV

Special Materials and Power Devices

Thermal, optical and insulating materials used in power equipment. Smart and nano materials. Power semiconductor devices – SCR, DIAC, TRIAC, IGBT, UJT – construction, characteristics and applications in power electronics and electrical drives. *(10 Hours)*

Alternative NPTEL/SWAYAM Course:

SNo	NEPTEL course name	Instructor	Host Institute
1.	Electronic Materials, Devices and Fabrication	Prof. K. S. Ramesh	IIT Madras
2.	Semiconductor Devices	Prof. S. Dasgupta	IIT Roorkee

Suggested Text Books / Reference Books:

1. C. S. Indulkar & S. Thiruvengadam, *Electrical Engineering Materials*, S. Chand.
2. A. J. Dekker, *Electrical Engineering Materials*, Prentice Hall.
3. S. O. Kasap, *Principles of Electronic Materials and Devices*, McGraw Hill.
4. B. G. Streetman & S. Banerjee, *Solid State Electronic Devices*, Pearson.
5. P. K. Palanisamy, *Electrical Engineering Materials*, Scitech Publications.

Course code	26PEC-EE-206-H				
Category	Programme Elective Course				
Course title	Soft Computing (Theory)				
Scheme and Credits	L	T	P	Credits	Semester-4
	3	1	0	4	
Classwork	30Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

To understand the concepts of soft computing.

- To introduce the ideas of fuzzy logic, Artificial Neural networks, genetic algorithm.
- To introduce the concepts of hybrid intelligent systems.
- To introduce application areas of soft computing and the criteria to select appropriate soft computing

Course Outcomes: At the end of this course, students will demonstrate the ability to

CO1: Understand the concepts and basics of soft computing.

CO2: Know about the basic soft computing techniques like of fuzzy logic, Artificial Neural networks, genetic algorithm etc..

CO3: Understand the basic concepts, advantages and disadvantages of hybrid intelligent systems.

CO4: Various areas where soft computing and related techniques can be practically implemented.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2									2	2		
CO2	2	3	2	2	2						2	3	2	

CO3	2	3	2	2	2						2	3	2	2
CO4	2	3	3	2	2						2	3	2	2
WT. AVG	2	2.75	2.5	2	2						2	3	2	2
Overall Mapping of Subject														2.5

Section A

Soft Computing: Introduction, requirement, different soft computing techniques and their characteristics, comparison with hard computing, applications.

Section B

Fuzzy sets and Fuzzy logic: Introduction, Fuzzy sets versus crisp sets, properties of fuzzy sets, operations on fuzzy sets, Extension principle, Fuzzy relations, Linguistic variables, linguistic terms, Linguistic hedges, Fuzzy reasoning, Mamdani and TSK fuzzy inference systems, Applications, fuzzy controllers, Theoretical and implementation issues.

Section C

Artificial Neural Network: Introduction, comparison with biological neural network, basic models of artificial neuron, different architectures of ANN, Learning techniques, ANN based system modeling, ANN based controller design, theoretical and implementation issues, Applications.

Section D

Evolutionary algorithms and hybrid systems: Genetic Algorithm (GA), different operators of GA, convergence of Genetic Algorithm, Particle swarm optimization algorithm, Neural-Network-Based Fuzzy Systems, Fuzzy Logic-Based Neural Networks, Genetic Algorithm for Neural Network Design, Fuzzy Logic design, other Applications of GA.

References :

1. Neuro Fuzzy & Soft Computing - J.-S.R.Jang, C.-T.Sun, E.mizutani, Pearson Education

2. Neural Networks and Fuzzy Systems: Dynamical Systems Application to Machine Intelligence - Bart Kosko, Prentice Hall

3. T.J. Ross, "Fuzzy Logic Control", TMH Publications.

4. S. Hekins, "Comprehensive Neural Networks", Pearson Publications.

5. S. Rajsekharan, VijayalaxmiPai, "Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and applications", Prentice Hall

6. V. Kecman, "Learning and Soft Computing", MIT Press. B.Tech. (Electrical Engineering) BOS 24-05-2017

7. D. Ruan, "Intelligent Hybrid Systems", Kluwer Academic Publisher.

Course code	26PCCEE205H				
Category	Professional Core Courses				
Course title	Electrical Power Generation (Theory)				
Scheme and Credits	L	T	P	Credits	Semester-4
	2	0	0	2	
Classwork	15Marks				
Examination	23 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

The objectives of this course are to:

- Provide basic understanding of power generation methods using conventional and non-conventional energy sources.
- Familiarize students with construction, working and performance of different power plants.
- Introduce concepts of load curves, tariffs and economics of power generation.
- Enable students to analyze the selection and operation of power plants for reliable and economical power supply.

COURSE OUTCOMES (CO):
By the end of the Course, Students will be able to:

CO1: Understand different sources of energy and basic principles of electric power generation.
CO2: Analyze the working and performance of thermal, hydro, nuclear and diesel power plants.
CO3: Evaluate load characteristics, plant factors and economics of power generation.
CO4: Apply the concepts of power generation for selecting suitable power plants under different conditions.
CO - PO mapping

CO PO MAPPING															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	2											3		
CO2		3											3		
CO3	2		3											2	
CO4			3		1									3	2
WT. AVG	2.5	2.5	3		1								3	2.5	2
										Overall Mapping of Subject					2.42

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

UNIT-I

Power Generation Fundamentals

Energy resources, conventional and non-conventional sources. Layout of a power system. Load curve, load duration curve, base load and peak load power plants. Connected load, maximum demand, demand factor, diversity factor, load factor, plant factor and capacity factor.*(06 Hours)*

UNIT-II

Thermal and Diesel Power Plants

Selection of site, layout and working of thermal power station. Boilers, turbines, condensers and cooling towers. Coal handling and ash handling.

Diesel power plants – layout, working, advantages and limitations. *(10 Hours)*

UNIT-III

Hydro and Nuclear Power Plants

Hydro electric power plant – selection of site, classification, layout, components and working. Nuclear power plant – basic principles, nuclear fission, layout and working of nuclear power station, advantages and safety aspects. *(10 Hours)*

UNIT-IV

Non-Conventional Power Generation & Economics

Solar, wind, tidal, geothermal and fuel cell power generation – principles and applications.

Economics of power generation: cost of generation, depreciation, tariff methods and selection of power plant. *(10 Hours)*

Alternative NPTEL/SWAYAM Course:

SNo	NEPTEL course name	Instructor	Host Institute
1.	Power Generation, Operation and Control	Prof. D. P. Kothari	IIT Delhi
2.	Energy Resources and Technology	Prof. S. K. Singh	IIT BHU

Suggested Text Books / Reference Books:

1. B. R. Gupta, *Power Plant Engineering*, S. Chand.

2. I. J. Nagrath & D. P. Kothari, *Power System Engineering*, McGraw Hill.
3. P. K. Nag, *Power Plant Engineering*, Tata McGraw Hill.
4. M. M. El-Wakil, *Power Plant Technology*, McGraw Hill.
5. G. D. Rai, *Non-Conventional Energy Sources*, Khanna Publishers.

Course code	26LC-202-H				
Category	Basic Science Course				
Course title	**Digital Electronics(Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS:-

1. Realization of logic gates using universal gates.
2. To design & realize a given function using K-maps and verify its performance.
3. To verify the operation of multiplexer & demultiplexer.
4. To verify the operation of adder & subtractor.
5. To verify the operation of comparator.
6. To verify the truth tables of S-R, J-K, T &D type flip flops.
7. To verify truth table of encoder /decoder.
8. To verify the operation of bi-directional shift register.
9. To design a 4-bit shift register and verify its operation.
10. To design & verify the operation of 4-bit synchronous counter.
11. To design and verify the operation of synchronous UP/DOWN decade counter using J K flip-flops.
12. To verify the operation of analog to digital converter.
13. To verify the operation of digital to analog converter.

Course Outcomes:

The students will be able to:

CO1: Understand the basic digital circuits and to verify their operation.

CO2: Illustrate realization of Boolean expression in SOP and POS form.

CO3: Construct basic combinational circuits and verify their functionalities.

CO4: To understand the concepts of flipflops, registers and counters**.**

Note: At least 10 experiments are to be performed by the students.

1). Each laboratory class/section shall not be more than about 20 students.
2).To allow fair opportunity of practical hands on experience to each student,each experiment may either done by each student individually or in groupofnotmore than 3-4 students. Larger groups are strictly discouraged/disallowed.
3).Pre-experimental &post experimentalquiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

EXPERIMENTS THAT MAY BE PERFORMED THROUGH VIRTUAL LABS:

S.N0.	Experiment Name	Experiment Link(s)
1.	To study the logic gates – AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.	https://de-iitr.vlabs.ac.in/exp/truth-table-gates/
2.	Realization of logic gates using universal gates.	https://de-iitr.vlabs.ac.in/exp/realization-of-logic-functions/
3.	To verify the operation of multiplexer & demultiplexer.	https://de-iitr.vlabs.ac.in/exp/multiplexer-demultiplexer/
4.	To verify the operation of adder.	https://de-iitr.vlabs.ac.in/exp/half-full-adder/
5.	To verify the operation of subtractor.	https://de-iitr.vlabs.ac.in/exp/half-full-subtractor/
6.	To verify the operation of comparator.	https://de-iitr.vlabs.ac.in/exp/comparator-using-logic-gates/
7.	To verify the truth tables of S-R, J-K, T & D type flip flops.	https://de-iitr.vlabs.ac.in/exp/truth-tables-flip-flops/
8.	To design & verify the operation of 4-bit synchronous counter.	https://de-iitr.vlabs.ac.in/exp/4bit-synchronous-asynchronous-counter/

Course code	26LC-204-H				
Category	Professional Core Course				
Course title	**Electrical Machines-II Lab(Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

Notes:

(i) At least 10 experiments are to be performed by students in the semester.

(ii) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus

LIST OF EXPERIMENTS:

1. To perform the open circuit test and block rotor test on 3 phase induction motor to obtain the parameters of equivalent circuit.
2. To study the speed control of 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 various stator voltages.
5. To perform the open circuit test and block rotor test on 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 synchronous impedance method.
7. To Study 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) Synchroscope 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.

Course Outcomes:
The students will be able to:

CO1: Students will be able to **identify, connect, and operate single phase and three phase induction machines and synchronous machines** in accordance with standard laboratory safety procedures and equipment ratings.

CO2: Students will be able to **conduct and analyze standard performance avaluationtests**such as open-circuit and short-circuit tests on **induction machines and synchronous machines** to determine the equivalent circuit parameters, efficiency, losses, and voltage regulation.

CO3: Students will be able to **interpret experimental data and characteristic curves** of **induction machines and synchronous machines** and correlate the observed results with theoretical principles of electromagnetic energy conversion and various mode of operation.

CO4: Students will be able to **document experimental observations and results effectively,** evaluate sources of experimental error, and demonstrate teamwork and professional laboratory practices while performing electrical machine experiments.

Note:

1 Each laboratory group shall not be more than about 20 students.

2 Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & setup by the concerned institution.

3 To allow fair opportunity of practical hands on experience to each student, each experiment may either done by each student individually or in group of not more than 3-4 students. Larger groups be strictly discouraged/disallowed.

4 Pre-experimental &post experimental quiz/questions may be offered for each lab experiment to reinforce & aid comprehension of the experiment.

Course code	26LC-206-H				
Category	Professional Core Course				
Course title	Power Systems-1 lab (Practical)				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	0	**0**	**2**	**1**	
Internal Lab	05 Marks				
External lab	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

LIST OF EXPERIMENTS:-

A-Software based

1. To study the Power System blocks in MATLAB.
2. To design short and medium transmission line using MATLAB.
3. To study and calculate the transmission line parameters using MATLAB.

B-Hardware-based.

4. To study the corona loss in the power distribution system.
5. To study the proximity and skin effect in a transmission line.
6. To find the ABCD parameters of a model of a transmission line
   i. Nominal T-network
   ii. Nominal π-network.
7. To study the performance of a transmission line under no load conditions& under load at different power factors.
8. To observe the Ferranti effect in a model of a transmission line.
9. To study the performance characteristics of a typical distribution system on the transmission panel of:
   i. Radial topology
   ii. Ring main configurations
   iii. Interconnected
10. To observe the improvement in voltage at the load side using compensation of reactive power on the transmission kit panel.
11. To observe the power flow on the HVDC transmission panel in the link as:
    i. Homopolar link
    ii. Monopolar link
    iii. Bipolar link

Course Outcomes:

The students will be able to:

CO1: Students will be able to identify, connect, and operate the basics of various power system blocks and loop functions in MATLAB.

CO2: Students will be able to estimate the transmission line parameters and implement them in MATLAB.

CO3: Students will be able to evaluate the performance of the line: parameter, improvement in load voltage by compensation, efficiency, and voltage regulation using a transmission panel with different inputs by a 3-Ø Variac.

CO4: Students will be able to understand HVDC transmission in three modes.

Note: Students must perform at least 10 experiments.

1). Each laboratory class/section shall not be more than about 20 students.

2) To allow a fair opportunity for practical hands-on experience to each student, each experiment may be either done by each student individually or in a group of not more than 3-4 students. Larger groups are strictly discouraged/disallowed.

3). Pre-experimental & post-experimental quiz/questions may be offered for each lab experiment to reinforce &aid comprehension of the experiment.

Course code	26LC-EE-208-H				
Category	Professional Core Courses				
Course title	**Electrical Workshop (Practical)**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	0	**0**	**2**	**1**	
Classwork	05 Marks				
Examination	20 Marks				
Total	25 Marks				
Duration of Exam	02 Hours				

Notes**:**

(iii) At least 10 experiments are to be performed by students in the semester.

(iv) At least 7 experiments should be performed from the list, remaining three experiments may either be performed from the above list or designed and set by the concerned institution as per the scope of the syllabus

LIST OF EXPERIMENTS:

1. Introduction of tools, electrical materials, symbols and abbreviations.
2. To study stair case wiring.
3. To study house wiring i.e., batten, cleat, casing-caping and conduit wirings.
4. To study fluorescent tube light.
5. To study Circuit of a SMPS.
6. To study circuit & working of a U.P.S.
7. To study Circuit & working of a Home Inverter.
8. To study construction of moving iron, moving coil, electrodynamic & induction type meters.
9. To design & fabricate single phase transformer.
10. To study fuses MCBs and importance of earthing.
11. To fabricate a simple PCB using screen printing or any other technique.

Course Outcomes:

The students will be able to:

CO1: Students will be able to **identify, connect and operate electrical tools, materials, symbols and components used in electrical installations, house wiring, SMPS, UPS, MCB, Inverter** in accordance with standard laboratory safety procedures and equipment ratings.

CO2: Students will be able to **perform basic electrical wiring such as house wiring, conduit wiring and industrial wiring as per standards** and learn electrical safety rules and safe working practice in workshop environments.

CO3: Students will be able to **interpret experimental data and analyze simple electrical circuits and control panels**.

CO4: Students will be able to **identify, test and troubleshoot common faults in electrical wiring, machines and appliances**.

Note:

1. Each laboratory group shall not be more than about 20 students.
2. Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining experiments may either be performed from the above list or designed & setup by the concerned institution.
3. To allow fair opportunity of practical hands on experience to each student, each experiment may either done by each student individually or in group of not more than 3-4 students. Larger groups be strictly discouraged/disallowed.
4. Pre-experimental & post experimental quiz/questions may be offered for each lab experiment to reinforce & aid comprehension of the experiment.

Course code	26AU-ENV-202-H				
Category	Audit Course (Mandatory)				
Course title	Environmental Science				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester-4
	2	**0**	**1**	**0**	
Classwork	30 Marks				
Examination	70 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished product. It will guide the students living in a historic transitional period of burgeoning awareness of the conflict between human activities and environmental constraints to help and save the fragile and endangered planet with the natural resources already overexploited

COURSE OUTCOMES (CO):

By the end of the Course, Students will be able to:

CO1: Solve various engineering problems applying environmentally sustainable approach to produce eco-friendly products.
CO2: Use relevant pollution control methods to solve domestic and industrial problems.
CO3: To recognize eco-friendly and sustainable energy resources for combating global problems like climate change, acid rain and resource depletion etc.
CO4: To solve local solid hazardous and e-waste problems.

CO - PO mapping

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

Unit-1 TheMultidisciplinarynatureofenvironmentalstudies.Definition, scopeandimportance. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Interaction between earth, man and environment.
(2lectures)

Unit-2 NaturalResources:

Renewableandnon-renewableresources:
Naturalresourcesandassociatedproblems.

a) Forest resources:Useandover-exploitation;deforestation, casestudies.Timberextraction,miningdamsandtheireffectsonforestsandtribalpeople.

b) Waterresources:Useandover-utilizationofsurfaceandgroundwater,floods,drought,conflictsoverwater,dams-benefitsandproblems.

c) Mineralresources:Useandexploitation,environmentaleffectsofextractingandusingmineralresources,casestudies.

d) Foodresources: World foodproblems,changes,causedbyagricultureandovergrazing,effectsofmodernagriculture, fertilizer-pesticideproblems,Waterlogging,salinity,casestudies.

e) Energyresources:Growingenergyneeds;renewableandnon-renewableenergysource,useofalternatesources,casestudies.

f) Landresources:Landasaresource,landdegradation,maninducedlandslides,soilerosionanddesertification.

* Roleofanindividualinconservationofnaturalresources.

* Equitableuseofresourcesforsustainablelifestyles.

(5lectures)

Unit-3 Ecosystem and biodiversity conservation
* Structure of ecosystem, Biotic and Abiotic components

* Energyflowintheecosystem.

* Ecologicalsuccession.
* Foodchains,foodwebsandecologicalpyramids.
* Aquatic and terrestrial ecosystems
* Different level of biodiversity:Genetic,Speciesandecosystemdiversity.
* Valueofbiodiversity:consumptiveuse,productiveuse, social,ethical,aestheticandoptionvalues.
* Biodiversityatglobal,Nationalandlocallevels.
* Indiaasamega-diversitynation.
* Hot-spotsofbiodiversity.
* Threatstobiodiversity:habitatloss,poachingofwildlife, man-wildlifeconflicts.
* Endangeredandendemicspeciesof India.
* Conservationofbiodiversity:In-situandex-situconservationofbiodiversity.

(5 lecture)

Unit-4 Environmental Assessment and Management:

Aim**s** and objectives of environmental impact assessment (EIA), Environmental Impact Statement (EIS) and environment management plan (EMP).Structure and role of central and state pollution control board, ISO14000: implementation in industries benefit.

* EnvironmentProtectionAct.
* Air(PreventionandControlofpollution)Act.
* Water(PreventionandControlofpollution)Act.
* WildlifeProtectionAct.
* ForestConservationAct.
* Issuesinvolvedinenforcementofenvironmentallegislation.
* *Publicawareness.

(3 lectures)

Unit-5 Environmentalpollution:

Definition,causes,effectsandcontrolmeasuresof:

a) Airpollution.
b) Waterpollutionc) Soilpollution
d) Marinepollutione) Noisepollution
f) Thermalpollutiong) Nuclearhazards
* Bag filters, cyclone separator, electrostatic precipitator, catalytic converter.
* Roleofanindividualinpreventionofpollution.
* Pollutioncasestudies.
* Disastermanagement:floods,earthquake,cycloneandlandslides.

(5lectures)

Unit-6 Contemporary environmental issues:

* Fromunsustainabletosustainabledevelopment.
* Urbanproblemsrelatedtoenergy, National solar mission.
* Waterconservation,rainwaterharvesting, watershed management, Namami Gange and Yamuna action plan.
* Resettlementandrehabilitationofpeople:itsproblemsandconcernscasestudies.
* Environmentalethics:Issuesandpossiblesolutions.
* Climatechange,globalwarming,acidrain,ozonelayerdepletion, sea level rise,nuclearaccidentsandholocaust.Casestudies.
* Wastelandreclamation.
* Carbon sequestration and carbon credits, carbon foot print
* Waste management- Swachha Bharat Abhiyan
* Consumerismandwasteproducts.

(5lectures)

Unit-7 HumanpopulationandtheEnvironment. Populationgrowth,variationamongnations.Populationexplosion-FamilyWelfareProgramme. Environmentandhumanhealth. Epidemiological issues: Fluorosis, Arsenocosis, Goitre, Dengue. HumanRights, ValueEducation, HIV/AIDS. WomanandChildWelfare. RoleofInformationTechnologyinEnvironmentandhumanhealth. CaseStudies. (5 lectures)

Unit-8 FieldWork:

* Visittoalocalareatodocumentenvironmentalassets- river/forest/grassland/hill/mountain.
* Visittoalocalpollutedsite-urban/Rural/Industrial/ Agricultural.
* Study of water polluted site
* Studyofcommonplants,insects,birds.
* Studyofsimpleecosystems-pond,river,hillslopes,etc.

(Fieldworkequalto15lecturehours).

Suggested Text Books / Reference Books:

1. Agarwal,K.C.2001EnvironmentalBiology,NidiPub.Ltd. Bikaner.

2. Bharucha,Frach,TheBiodiversityofIndia,MApinPublishingPvt.Ltd.Ahmedabad-380013,India,E-mail:mapin@icenet.net(R).
3. BrunnerR.C.1989,HazardousWasteIncineration,Mc.Graw HillInc.480p.
4. ClarkR.S.,Marinepollution,SlandersonPressOxford(TB).
5. Cunningham,W.P.Cooper,T.H.Gorhani,E&Hepworth,M.T. 2001,EnvironmentalEncyclopedia,JaicoPub.House,Mumbai 1196p.
6. DeA.K.,EnvironmentalChemistry,WileyEasternLtd.
7. DowntoEarth,CentreforScienceandEnvironment(R).
8. Gleick,H.P.,1993.Waterincrisis,PacificInstituteforStudiesinDev.Environment&SecurityStockholmEnv.Institute, OxfordUniv.Press,473p.
9. HawkinsR.E.EncyclopediaofIndianNaturalHistory,Bombay NaturalHistorySociety,Bombay(R).
10. Heywood,V.H.&Watson,R.T.1995. Global Biodiversity Assessment,CambridgeUni.Press1140p.
11. Jadhav,H&Bhosale,V.M.1995.EnvironmentalProtectionandLaws.HimalayaPub.House,Delhi284p.
12. Mackinney,M.L.&Schoch,RM1996,EnvironmentalSciencesystems&solutions,Webenhancededitiion.639p.
13. MhaskarA.K., MayyerHazardous,Tekchno-Science Publications(TB).
14. MillerT.G.Jr.EnvironmentalScience,WadsworthPublishingCo. TB).
15. Odum,E.P.1971,FundamentalsofEcology.W.B.Saunders Co.USA,574p.
16. RaoM.N.&Datta,A.K.1987WasteWaterTreatment.Oxford &TBHPubl.Co.Pvt.Ltd.345p.
17. Sharma,B.K.2001,EnvironmentalChemistry,GoalPubl. House,Meerut.
18. SurveyoftheEnvironment,TheHindu(M).
19. TownsendC.,HarperJ.andMichaelBegon.Essentialsof Ecology,BlackwellScience(TB).
20. TrivediR.K.,HandbookofEnvironmentalLaws,Rules, Guidelines,ComliancesandStandards,Vol.IandIIEnviroMedia(R).

21. TrideviR.K.andP.K.Goal,Introductiontoairpollution,Techno SciencePublications(TR).
22. WagnerK.D.,1998,EnvironmentalManagement,W.B. Saundersco.Philadelphia,USA499p.
23. AtextbookenvironmentaleducationG.V.S.PublishersbyDr. J.P.Yadav.

(M) Magazine (R) Reference (TB)extbook

Theschemeofthepaperwillbe asunder:

ThesubjectofEnvironmentalSciencewillbeincludedasa qualifyingpaperinallUGCoursesandthestudentswillberequiredtoqualifythesame.Thedurationofthecours ewillbe45lectures.The examinationwillbeconductedalongwiththesemesterexaminations.

Exam.Pattern:Incaseofawardingthemarks,thepaperwillcarry100marks.

Theory:70marks,Practical/ Field visit:30marks.

Thestructureofthequestionpaperwillbe:

Part-A:ShortAnswerPattern	:	10marks
Part-B:EssayTypewithinbuiltchoice	:	60marks
Part-C:		
FieldWork(Practical)	:	30marks

Instructions for Examiners:

Part-A:QuestionNo.1iscompulsoryandwillcontainfiveshort-answertypequestionsof2markseachcoveringtheentiresyllabus.

Part-B:Eightessaytypequestions(withinbuiltchoice)willbesetfromtheentiresyllabusandthecandidatewillber equiredtoansweranyfourofthem.Eachessaytypequestionwillbeof15marks.

The examination of the regular students will be conducted by the concerned college/Institute. Each studentwillberequiredtoscoreminimum40%marksseparatelyin theory and practical/Field visit.Themarksinthisqualifyingpaperwillnotbeincludedindeterminingthepercentageofmarksobtainedfort heawardofdegree.However, these marks will be shown in the detailed marks certificate of the students.

Course code	26PCC-EE-212-H				
Category	Professional Core Course				
Course title	**Power Plant Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 3
	3	**0**	**0**	**3**	
Classwork	25 Marks				
Examination	50 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

- **COURSE OUTCOMES (CO):** To create awareness about various sources of energy, working of thermal power plants and combustion process.
- To understand how power is achieved from renewable sources of energy and functions of hydroelectric power plants.
- Able to learn about Nuclear power plants.
- To understand how Thermal and gas power plants are functioning.

By the end of the Course, Students will be able to:

CO1: Able to get the basics of Power Plants.
CO2: Able to get the idea about the power generation by renewable and non-renewable energy resources.
CO3: Able to know about the different types of cycles and natural resources used in power plants and their applications.
CO4: Able to know about the environmental and safety aspects of power plant operation.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3		

CO2		3										3		
CO3	2	3											2	
CO4			3										3	2
WT. AVG	2.5	2.67	3									3	2.5	2
									Overall Mapping of Subject					2.55

Note: Examiner will set 9 questions in all with two questions from each unit and one question covering all sections which will be Q.1. This Q1 is compulsory and of short answer type. Each question carries equal marks (10 marks). Examinees have to attempt 5 questions in total selecting at least one from each unit.

Section-A

Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

Section-B

Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.

Section-C

Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.

Section-D

Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy, economic and environmental issues, pollution control technologies including waste disposal options for coal and nuclear plants.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.

2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.

3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Course code	27LC-210-H				
Category	Professional Core Course				
Course title	**Project stage-1**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	Semester- 4
	0	**0**	**2**	**1**	
Classwork	05 Marks				
Examination	20 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

COURSE OBJECTIVES:

The objectives of this laboratory are to:

- Introduce students to structured project work.
- Develop problem-solving and analytical skills.
- Encourage teamwork and collaborative learning.
- Provide exposure to engineering tools and software.
- Enhance technical writing and presentation abilities.

COURSE OUTCOMES (CO):

After completing this course, students will be able to:

CO1:	Identify and define electrical engineering problems.
CO2:	Conduct literature surveys using standard resources.
CO3:	Design and simulate basic electrical systems.
CO4:	Implement and test simple hardware/software models and Prepare professional technical reports and presentations.

CO - PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2										3		

CO2		3										3		
CO3	2	3											2	
CO4			3										3	2
WT. AVG	2.5	2.67	3									3	2.5	2
									Overall Mapping of Subject					2.5

The object of Project stage- I is to enable the student to take up investigative study in the broad field of Electrical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic
2. Working out a preliminary Approach to the Problem relating to the assigned topic
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility
4. Preparing a Written Report on the Study conducted for presentation to the Department
5. Final Seminar, as oral Presentation before a departmental committee.

The student will be required to submit two copies of his/her project report to the department for record (one copy eachfor the department and participating teacher). The students may be asked to work individually or in a group normally not more thanfour – six students in a group(If any large/big project occurs then strength of student's increasesas per guide supervision). Viva- voce must be based on the preliminary report submitted bystudents related to the project.

PROJECT REPORT FORMAT

The project report shall be prepared as per MDU guidelines and should include:

1. Title Page
2. Certificate
3. Acknowledgement
4. Abstract
5. Table of Contents
6. List of Figures and Tables
7. Introduction
8. Literature Review
9. Problem Statement & Objectives
10. Methodology
11. Design & Simulation
12. Results and Discussion
13. Conclusion & Future Scope
14. References

15. Appendices (if any)