



**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA
(JHAJJAR)**

An Autonomous Institute

‘A’ GRADE ACCREDITED BY NAAC

**Scheme of Studies & Examinations & Syllabus For
Bachelor of Technology (Electrical Engineering)
(Effective from the Session: 2025-26)**



**APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU,
ROHTAK**

1. DEFINITION OF CREDIT

1	1 Lecture (L) per week	1 Credit
2	1 Tutorial (T) per week	1 Credit
3	1 Practical (P) per week	0.5 Credit
4	2 Practical (Lab) per week	1 Credit

2. RANGE OF CREDIT

A range of credits from 160 to 170 for a student to be eligible to get Under Graduate degree in Electrical Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18-20 credits. These could be acquired through MOOCs.

3. STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM (B. TECH)

Sr. No.	Category	Breakup of Credits
1	Basic Science Courses	21
2	Engineering Science Courses	22
3	Professional Core Courses	71
4	Professional Elective Courses	12
5	Humanities and Social Courses including Management Courses	12
6	Multidisciplinary Open Electives Courses	9
7	Value Added Courses	3
8	Project	4
9	Industrial Training	16
10	Mandatory Non-Credit Courses – Audit Course	(Non-Credit)
	Total Credits	170

4. COURSE CODE AND DEFINITIONS

Sr. No.	Category	Course Code
1	Basic Science Courses	BSC
2	Engineering Science Courses	ESC
3	Professional Core Courses	PCC
4	Professional Elective Courses	PEC
5	Humanities and Social Sciences including Management courses	HSMC
6	Multidisciplinary Open Electives Courses	OEC
7	Value Added Courses	VAT
8	Laboratory Courses	LC
9	Mandatory Non-Credit Courses (Audit Course)	MC
10	Project	PR
11	Practical Training	PT
12	Internship	INT

Scheme of Studies and Examination
B.Tech (Electrical Engineering) – 5th Semester
w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal Assessment	External Examination	Practical	Total	
1	Professional Core Courses	PCC-EE-301A	Power Systems-I	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-EE-303A	Control Systems	3	0	0	3	3	40	60		100	3
3	Professional Core Courses	PCC-EE-305A	Microprocessor and Microcontroller	3	0	0	3	3	40	60		100	3
4	Professional Core Courses	PCC-EE-307A	Signals and Systems	3	0	0	3	3	40	60		100	3
5	Professional Electives Courses	-----	Refer Table-II	3	0	0	3	3	40	60		100	3
6	Humanities and Social Science including Management Courses	HSMC-01A	Fundamentals of Management & Organisational Behaviour	3	0	0	3	3	40	60		100	3
7	Professional Core Courses / (Lab Course)	LC-EE-309A	Power Systems-I Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses (Lab Course)	LC-EE-311A	Control Systems Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses (Lab Course)	LC-EE-313A	Microprocessor and Microcontroller Lab	0	0	2	2	1	25		25	50	3
10	Practical Training	PT-EE-315A	Evaluation of Summer Internship	0	0	2	2	1	25		25	50	3
		TOTAL CREDIT						23				800	

Notes:

I. Students must choose one course from the Professional Elective Courses category (Table-II). They may also opt for Massive Open Online Courses (MOOCs) offered through the SWAYAM, SWAYAM Plus, or NPTEL platforms, subject to the approval of the concerned Chairperson, Board of Studies/Head of the Department.

Table II (Professional Elective Courses)

S.No.	Course Code	Course
1	PEC-EE-317A	Digital Signal Processing
2	PEC-EE-319A	Power System Protection
3	PEC-EE-321A	Power System Stability
4	PEC-EE-323A	Power System Planning and Reliability

Note: Students have to select any one course from the above list, provided that the course has not been studied earlier.

Scheme of Studies and Examination
B.Tech (Electrical Engineering) – 6th Semester
w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Contact Hrs. per week	Credit	Examination Schedule (Marks)				Duration of Exam (Hours)
				L	T	P			Internal Assessment	External Examination	Practical	Total	
1	Professional Core Courses	PCC-EE-302A	Power System-II	3	1	0	4	4	40	60		100	3
2	Professional Core Courses	PCC-EE-304A	Power Electronics	3	1	0	4	4	40	60		100	3
3	Professional Core Courses	PCC-EE-306A	Electric Power Generation	3	0	0	3	3	40	60		100	3
4	Professional Core Courses	PCC-EE-308A	Computer Aided Electrical Machine Design	3	0	0	3	3	40	60		100	3
5	Professional Electives Courses	-----	Refer Table-III	3	0	0	3	3	40	60		100	3
6	Open Elective Courses	-----	Refer Table-IV	3	0	0	3	3	40	60		100	3
7	Professional Core Courses (Lab Courses)	LC-EE-310A	Power System-II Lab	0	0	2	2	1	25		25	50	3
8	Professional Core Courses (Lab Courses)	LC-EE-312A	Power Electronics Lab	0	0	2	2	1	25		25	50	3
9	Professional Core Courses (Lab Courses)	LC-EE-314A	Computer Aided Electrical Machine Design Lab	0	0	2	2	1	25		25	50	3
10	Mandatory Courses	MC-301A	Essence of Indian Traditional Knowledge	2	0	0	-	0	40		60		3
		TOTAL CREDIT						23				750	

Notes:

I. MC-301A is a mandatory non –credit course in which the students will be required passing marks in theory. However, these marks will not be added in the total marks.

II. They may also opt for Massive Open Online Courses (MOOCs) offered through SWAYAM, SWAYAM Plus, or NPTEL platforms subject to approval by the concerned Chairperson, Board of Studies (BoS)/Head of the Department.

III. At the end of 6th semester, each student has to undergo Practical Training of 4/6 weeks in the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc. and its evaluation shall be carried out in the 7th Semester.

IV. Students must choose one course from the Professional Elective Courses category (Table III) and one course from the Multidisciplinary Open Elective Courses category (Table IV). They may also opt for Massive Open Online Courses (MOOCs) offered through the SWAYAM, SWAYAM Plus, or NPTEL platforms, subject to the approval of the concerned Chairperson, Board of Studies/Head of the Department.

Table III (Professional Elective Courses)

S.No.	Course Code	Course
1	PEC-EE-316A	Power Management
2	PEC-EE-318A	Renewable Energy Converters
3	PEC-EE-320A	Advanced Control Systems
4	PEC-EE-322A	Power Quality and FACTS

Note: Students have to select any one course from the above list, provided that the course has not been studied earlier.

Table IV (Multidisciplinary Open Elective Courses)

Sr. No.	Code	Subject	Offered by	Departments Eligible to Choose the Course
1	OEC-01A	Engineering Ethics	Department of Electronics and Communication Engineering	All Engineering Departments
2	OEC-02A	Waste Management	Department of Civil Engineering	All Engineering Departments except the Department of Civil Engineering
3	OEC-03A	Internet of Things and Edge Computing	Department of Computer Science and Engineering	All Engineering Departments
4	OEC-04A	Project Management	Department of Mechanical Engineering	All Engineering Departments
5	OEC-05A	Renewable Energy Resources	Department of Electrical Engineering	All Engineering Departments
6	OEC-06A	United Nation's Sustainable Development Goals	Department of Electronics and Communication Engineering	All Engineering Departments
7	OEC-07A	Computer Aided Risk Analytics	Department of Fire Technology and Safety	All Engineering Departments
8	OEC-08A	Health, Safety and Environment	Department of Fire Technology and Safety	All Engineering Departments except the Department of Fire Technology and Safety
9	OEC-09A	Fundamentals of Additive Manufacturing	Department of Mechanical Engineering	All Engineering Departments except the Department of Mechanical Engineering
10	-----	MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms	Online Platforms	All Engineering Departments

Course Code	PCC-EE-301A				
Category	Professional Core Courses				
Course Title	Power System-I				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	1	0	4	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental concepts of power systems including three-phase networks, per unit system, and power representation. • To develop the understanding of students in fault analysis using symmetrical components and grounding practices in power systems. • To familiarize the students with switchgear, protection schemes, and their applications in ensuring system reliability and safety. • To make the students learn about modern power system aspects including DC transmission, solar PV systems, and wind energy conversion systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, components, and representations used in power systems including three-phase networks, fault analysis, protection schemes, and renewable energy systems.	Level 1: Remember
CO2	Explain the principles of power system analysis, fault behavior, protection mechanisms, and operation of DC transmission and renewable energy systems.	Level 2: Understand
CO3	Apply methods to determine fault currents, and demonstrate the use of protection schemes and renewable energy interfaces.	Level 3: Apply
CO4	Classify power system conditions, faults, protection schemes, and transmission methods to analyze their performance and interrelationships.	Level 4: Analyze

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

Unit-I

Basic Concepts: Introduction, Review of Three-phase systems. Analysis of simple three phase circuits. Single-phase representation of balance three-phase network, The one-line diagram and the impedance or reactance diagram, Per unit (PU) system, Complex power, The steady state model of synchronous machine, Transmission of electric power, Representation of loads.

Unit-II

Fault Analysis: Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.

Unit-III

Switchgear and protection: Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

Unit-IV

Introduction to DC Transmission & Solar PV systems: DC Transmission Systems: Line Commutated Converters (LCC) and Voltage Source Converters (VSC). LCC and VSC based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Permanent Magnetic Synchronous Generators and Induction Generators.

Suggested Readings:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012
6. EHV-AC/DC Transmission System; S. Rao: Khanna Pub.
7. C.L Wadhwa, "Electrical Power system" new age publication.
8. Power System Protection & Switchgear by B. Ram, McGraw Hill

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to Power System Analysis	https://nptel.ac.in/courses/108105067
	Single line diagram, PU system	https://www.youtube.com/watch?v=dmNIW2q-tbI
UNIT-II	Balanced fault analysis,	https://www.youtube.com/watch?v=24X4znh4nl0&list=PL36A60B630E8C7B56&index=26
UNIT-III	Attributes of Protection schemes	https://www.youtube.com/watch?v=WPmOB31UTkI&list=PLbRMhDVUMngef3WZI2VcPeBUALq989427
UNIT- IV	DC Transmission Systems	https://www.youtube.com/watch?v=yP7OACmLP48

Course Code	PCC-EE- 303A				
Category	Professional Core Courses				
Course Title	CONTROL SYSTEMS				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental concepts of control systems including modelling, transfer functions, and system representations. • To develop the understanding of students in analyzing time response, stability, and performance of control systems. • To familiarize the students with frequency response techniques and stability assessment methods in control systems. • To make the students learn about controller design, compensation techniques, and state space analysis of control systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, models, and techniques used in control systems including system representation, stability, frequency response, and controller design.	Level 1: Remember
CO2	Discuss the behavior of control systems in time and frequency domains, including stability, response characteristics, and control strategies.	Level 2: Understand
CO3	Determine system response, stability, and performance using time domain, frequency domain, and state space techniques.	Level 3: Apply
CO4	Analyze control system performance, stability, and design approaches based on system parameters, compensators, and controller configurations.	Level 4: Analyze

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

Unit-I

Introduction to Control Systems: Mathematical modelling of electrical and mechanical systems, Feedback Control, Open-Loop and Closed-loop systems, Significance of feedback system, Transfer function models of linear time-invariant systems, Block diagram reduction technique and signal flow graphs.

Unit-II

Transient State and Steady State Analysis: Standard test signals, time response of first-order systems, characteristic equation of feedback control systems, transient response of second-order systems, time domain specifications, steady-state response, steady-state errors and error constants.

Stability analysis: Stability, Routh-Hurwitz stability criterion, relative stability, Concept of root locus, development of root loci, rules for construction of root locus, root movements under closed-loop operation, effects of poles and zeros on root locus, stability analysis using root locus.

Unit-III

Frequency Response: Relationship between time and frequency response, Closed-loop Frequency response, Frequency-domain specifications analysis using Bode plots, Gain margin and phase margin, Nyquist plot (Polar Plot), Use of Nyquist stability criterion for stability analysis.

Unit-IV

Compensator and Controller Design: Feedback compensation –Lead, Lag and Lead –Lag compensation, design of P, I, D, PD, PI, PID error control strategies, impact on transient response and steady-state response.

State variable Analysis: Concepts of state variables, State space model, Solution of state equations, Eigen values and Stability Analysis, Concept of controllability and Observability.

Suggested Readings:

1. N.S. Nise, “Control System Engineering”, 7th Edition, 2015, Wiley Publications.
2. K. Ogata, “Modern control engineering”, 5th Edition, 2010, Prentice Hall.
3. F. Golnaraghi, and B.C Kuo, “Automatic control systems” 9th Edition, 2008, Prentice Hall.
4. I.J. Nagrath and M.Gopal, “Control Systems Engineering”, 5th Edition, 2009, New Age Publishers.
5. D’ Azzo and Houpis, “Linear Control Systems Analysis and Design”, 5th Edition, 2003, McGraw Hill.
6. R.C. Dorf, and R.H. Bishop, “Modern Control systems”, 12th Edition, 2011, Addison-Wesley.
7. S. Hasan Saeed, “Automatic Control System”, Katson Publications, 2008.
8. B. S. Manke, “Linear Control Systems with MATLAB Applications”, Khanna Publications.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Open & Closed Loop Systems	https://www.youtube.com/watch?v=xQKcBugAlv4&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=5
UNIT-II	Time Response (1st & 2nd Order)	https://www.youtube.com/watch?v=kbjCGGTxqUo&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=9
UNIT-III	Routh-Hurwitz Criterion.	https://www.youtube.com/watch?v=cez4InLZ7Pw&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=17
UNIT-IV	Lead & Lag Compensation.	https://www.youtube.com/watch?v=pTTTOuUps7I&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=25
	PID Controller Design.	https://www.youtube.com/watch?v=bUYzLCwAoCQ&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ&index=31

Course Code	PCC-EE-305A				
Category	Professional Core Course				
Course Title	Microprocessor and Microcontroller				
Scheme and Credits	L	T	P	Credits	Semester- V
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamentals of microprocessors, their architecture, instruction sets, and programming concepts. • To develop the understanding of students in peripheral devices, memory organization, and interfacing techniques in microprocessor systems. • To familiarize the students with microcontroller architectures, features, and processor design approaches. • To make the students learn about 8051 microcontroller programming and its real-time interfacing applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, architectures, instruction sets, peripheral devices, and features of microprocessors and microcontrollers.	Level 1: Remember
CO2	Explain the working of microprocessor and microcontroller systems, including memory organization, interfacing, and architectural differences.	Level 2: Understand
CO3	Demonstrate programming and interfacing techniques using microprocessors and microcontrollers for solving real-time problems.	Level 3: Apply
CO4	Classify microprocessor and microcontroller systems, architectures, memory schemes, and interfacing methods based on performance and application requirements.	Level 4: Analyze

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

Unit-I

Fundamentals of Microprocessors and Programming: Introduction to Microprocessors: Evolution, 8-bit/16-bit (8085/8086), Architecture, Pin configuration, addressing modes and Register organization of 8085.

8086 Architecture: Pin configuration, register organization, Addressing Modes, Memory Segmentation, Instruction Set of 8086, Minimum/Maximum Mode, Assembly language programming of 8086.

Unit-II

Peripheral Devices: Parallel Peripheral Interface (8255), Timer / Counter (8254), Programmable Interrupt Controller (8259), USART (8251), DMA Controller (8237) **Memory Concepts:** Cache Memory, Virtual Memory–Mapping and Access Mechanisms.

Unit-III

Introduction of Microcontroller: Different types of microcontrollers: Embedded microcontrollers, External memory microcontrollers, Processor Architectures: Harvard V/S Princeton, CISC V/S RISC Architecture and Microcontrollers memory types. **Microcontroller's features:** Clocking, I/O pins, Interrupts, Timers, Peripherals.

Unit-IV

Microcontroller 8051- Architecture, Pin Diagram, I/O Ports, Internal RAM and Registers, Interrupts, Addressing Modes, Memory Organization and External Addressing, Instruction Set, Assembly Language Programming, Real Time Applications of Microcontroller- Interfacing with LCD, ADC, DAC, Stepper Motor, Key Board and Sensors.

Suggested Readings:

1. Microprocessors and interfacing by D. V. Hall, TMH, 2nd Edition.
2. Microprocessor 8086: Architecture, Programming and Interfacing by Sunil Mathur, PHI Publisher
3. Microprocessors and Microcontrollers by Sunil Mathur, Jeebananda Panda, PHI Publisher
4. Advanced Microprocessors and Peripherals Architectures, Programming and Interfacing by Ray A. K. and Burchandi, TMH.
5. The Intel Microprocessors 8086- Pentium Processor by Brey, 8th Edition, Pearson Education.
6. The X86 PC: Assembly Language, Design and interfacing by M. A. Mazidi, J. P. Maizidi and Danny Causey, 5th Edition, Pearson Education.
7. Microcontrollers: Architectures, Programming, Interfacing and System Design by Raj Kamal, Pearson Education

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Microprocessors and Interfacing –	https://www.youtube.com/playlist?list=PLdlPA9pGVVtaUwRP-2Eaux10vo_USuDy1
Unit-II	8255 Programmable Peripheral Interface: Block Diagram and Working Explained	https://www.youtube.com/watch?v=JCAjbuuvXbA
Unit-III	Von Neumann vs. Harvard Architecture: Understanding the Key Differences	https://www.youtube.com/watch?v=YiZy6vfgtHU
Unit-IV	8051 Microcontroller and Interfacing, The 8051 Microcontroller and Embedded Systems	https://www.youtube.com/playlist?list=PLEPI1RnS5drMCNuIVPDwdrRO_U0awwTxJ

Course Code	PCC-EE-307A				
Category	Professional Core Courses				
Course Title	Signals and Systems				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental concepts of signals, systems, and their mathematical representations. • To develop the understanding of students in Fourier transforms and their applications in signal analysis. • To familiarize the students with time domain and frequency domain analysis of continuous-time and discrete-time systems. • To make the students learn about Laplace and Z-transform techniques for analysis and solution of system equations.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, types of signals, system properties, and transform techniques used in signal and system analysis.	Level 1: Remember
CO2	Discuss the representation and analysis of signals and systems in time and frequency domains using Fourier, Laplace, and Z-transform techniques.	Level 2: Understand
CO3	Apply transform methods to analyze signals, determine system responses, and solve differential and difference equations.	Level 3: Apply
CO4	Analyze signals and systems based on their properties, transform domains, and system characteristics to interpret their behavior.	Level 4: Analyze

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

Unit-I

Signals: Definition, types of signals and their representations: continuous-time, discrete-time, periodic, non-periodic, even, odd, energy, power, deterministic, random, one-dimensional, multidimensional, 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).

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.

Unit-III

Time and frequency domain analysis of systems: Analysis of first order and second order systems, continuous-time (CT) system analysis using LT, system functions of CT systems, poles and zeros, block diagram representations; discrete-time system functions, block diagram representation, illustration of the concepts of system bandwidth and rise time through the analysis of a first order CT low pass filter.

Unit-IV

Laplace-Transform (LT) and Z-transform (ZT): (i) 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) (ii) One sided and Bilateral Z-transforms, ZT of some common signals, ROC, Properties and theorems, solution of difference equations using one-sided ZT, s- to z-plane mapping.

Suggested Readings:

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

Useful Video links

Unit No.	Topic	Link
UNIT-I	Power of Signals	https://youtu.be/gr1VqIYiMqQ?list=PLUQpHm_JtukKp93SX0nKToqHPsumsD-cP
UNIT-II	Fourier Transform	https://youtu.be/xBVsp1aoga4?list=PLUQpHm_JtukKp93SX0nKToqHPsumsD-cP
UNIT-III	Properties of Discrete Time LTI System	https://youtu.be/IDTSXFc9AeE?list=PLuv3GM6-gsE0WgB_q3tI2Gat_PEjQhF8o
UNIT- IV	Laplace Transform	https://youtu.be/TSkHT5solVM?list=PLuv3GM6-gsE0WgB_q3tI2Gat_PEjQhF8o

Course Code	HSMC-01A				
Category	Humanities and Social Science including Management Courses				
Course Title	Fundamental of Management and Organizational Behaviour				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are to • Introduce students to foundational management theories, functions, and organizational concepts to build a strong conceptual framework. • Develop understanding of individual and group behavior, motivation, communication, and leadership in organizational settings. • Equip students with practical skills to manage interpersonal processes, conflicts, and team dynamics effectively. • Foster critical analysis of organizational structures, cultures, and change mechanisms to enhance adaptability and effectiveness in organizations.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define fundamental management concepts, functions, organizational processes, and organizational behavior elements.	Level 1: Remember
CO2	Explain the roles, skills, and interrelationships in management, individual behaviors, group dynamics, and communication processes within organizations.	Level 2: Understand
CO3	Apply principles of management, motivation techniques, leadership styles, and conflict management strategies to solve organizational behavior challenges.	Level 3: Apply
CO4	Analyze organizational structure, culture, change processes, and behavioral dynamics to support effective decision-making and organizational development.	Level 4: Analyze

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

Unit-I

Introduction of Management: Meaning, Definitions, Nature of Management; Managerial Levels, Skills and Roles in an Organization.

Functions of Management: Planning, Organizing, Staffing, Directing & Controlling, Interrelationship of Managerial Functions, Scope of Management, Importance of Management, Difference between Management and Administration.

Unit-II

Introduction of Organization: Meaning and Process of Organization, Management v/s Organization.

Fundamentals of Organizational Behavior: Concepts, Evolution, Importance and Relationship with other Fields, Contemporary Challenges and Opportunities of OB.

Individual Processes and Behavior: Personality, Concept, Determinants and Applications.

Perception: Concept, Process and Applications

Learning: Brief Introduction

Motivation: Concept, Techniques and Importance

Unit-III

Interpersonal Processes: Teams and Groups, Definition of Group, Stages of Group Development, Types of Groups, Meaning of Team, Merits and Demerits of Team, Difference between Team and Group, Conflict-Concept, Sources, Types, Management of Conflict.

Leadership: Concept, Function, Styles, Qualities of Leadership.

Communication: Meaning, Process, Channels of Communication, Importance and Barriers of Communication.

Unit-IV

Organizational Processes: Organizational Structure, Meaning and Types of Organizational Structure and their effect on Human Behavior.

Organizational Culture: Elements, Types and Factors affecting Organizational Culture.

Organizational Change: Concept, Types and Factors affecting Organizational Change, Resistance to Change.

Suggested Readings:

1. Fundamentals of Management by Robbins, S.P. and Decenzo, Pearson Education, New Delhi.
2. Organizational Behaviour by Robbins, S.P. & Judge, T.A., Prentice Hall of India, New Delhi.
3. Management concept practice and cases by Ghuman Karminder, Aswathappa K., Tata McGraw Hill, New Delhi
4. Fundamental of Management by Chhabra T. N., Sun India Publications, New Delhi.
5. Organizational Behaviour by Stephen P Robin, Pearson Education.
6. Organizational Behaviour by McShane, Steven L, Tata McGraw Hill, New Delhi.
7. Organizational Behaviour by FC Sharma, Shree Mahavir Publications.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Nature and Scope of Management	https://nptel.ac.in/courses/110105146
UNIT-II	Perception and Personality	https://nptel.ac.in/courses/110103433
UNIT-III	Group Dynamics	https://archive.nptel.ac.in/courses/110/106/110106145/
UNIT- IV	Organizational Change, Resistance to Change.	https://nptel.ac.in/courses/110105146

Course code	LC-EE-309A				
Category	Professional Core Courses (Lab Course)				
Course title	Power System-I Lab				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Course Objectives	The objectives of this course are to • Provide practical understanding of sequence reactance, fault analysis, and protective relays used in power system protection. • Study transmission line behavior including Ferranti effect and voltage distribution in high-voltage long transmission lines. • Develop understanding of photovoltaic module characteristics and wind energy conversion system.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Explain the operating principles and characteristics of protective relays, transmission line phenomena, insulating oil testing equipment.	Level 2: Understand
CO2	Determine sequence reactances, fault currents, relay characteristics, and short-circuit currents of power system components using hardware setups and simulation tools.	Level 3: Apply
CO3	Analyze the behavior of power systems under symmetrical and unsymmetrical fault conditions by interpreting fault current patterns and system responses using simulation studies.	Level 4: Analyze
CO4	Assess the operating characteristics of photovoltaic and wind energy conversion systems.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
	Hardware Based
1	To determine negative and zero sequence reactance of an alternator.
2	To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
3	To study the IDMT over current relay and determine the time current characteristics.
4	To study percentage differential relay.
5	To study Impedance, MHO and Reactance type distance relays.

6	To study Ferranti effect and voltage distribution in H.V. long transmission line using transmission line model.
7	To study operation of oil testing set.
8	To assess PV modules and their characteristics like open circuit voltage, short circuit current, Fill factor, Efficiency.
9	To assess I-V and P-V characteristics of PV module with varying radiation and temperature level.
10	To assess the I-V and P-V characteristics of series and parallel combination of PV modules.
11	To assess wind energy generation concepts like tip speed, torque and power relationship, wind speed versus power generation.
Simulation software Based	
12	To obtain steady state, transient and sub-transient short circuit currents in an alternator.
13	To perform symmetrical fault analysis in a power system.
14	To perform unsymmetrical fault analysis in a power system.

Virtual Lab Links

Experiment Name	Virtual Lab Link
To determine negative and zero sequence reactance of an alternator.	https://vp-dei.vlabs.ac.in/Dreamweaver/exp3.html
To study percentage differential relay	https://vp-dei.vlabs.ac.in/Dreamweaver/exp10.html
To study Ferranti effect and voltage distribution in H.V. long transmission line using transmission line model	https://vp-dei.vlabs.ac.in/Dreamweaver/exp9.html
To study operation of oil testing set.	https://vp-dei.vlabs.ac.in/Dreamweaver/exp4.html
To understand PV modules and their characteristics like open circuit voltage, short circuit current, Fill factor, Efficiency,	https://ep-iitb.vlabs.ac.in/exp/characteristics-solar-cell/theory.html
To obtain steady state, transient and sub-transient short circuit currents in an alternator	https://vp-dei.vlabs.ac.in/Dreamweaver/exp8.html
Symmetrical short circuit analysis	https://vlabsdev.in/labs/vpl/sym-3phase/
Unsymmetrical short circuit analysis	https://vlabsdev.in/labs/vpl/unsym-3lg/

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

Course code	LC-EE-311A				
Category	Professional Core Courses (Lab Course)				
Course title	CONTROL SYSTEMS LAB				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Course Objectives	The objectives of this course are - Analyze behavior of control systems using response and frequency plots. - Understand sensors and actuators used in control applications. - Apply control techniques (P, I, D, compensators) to improve performance. - Study and implement feedback and closed-loop control systems				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the operating principles and characteristics of servo motors, stepper motors, and control devices in closed-loop system.	Level 2: Understand
CO2	Demonstrate Bode plots, root locus diagrams, and compensator for given control system.	Level 3: Apply
CO3	Analyze the effect of addition of poles and zeros on the transfer function and closed-loop stability of a control system.	Level 4: Analyze
CO4	Evaluate the performance of PID controllers and closed-loop systems.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	To study speed Torque characteristics of A.C servo motor.
2	To study speed Torque characteristics of D.C servo motor.
3	To demonstrate simple motor driven closed loop DC position control system.
4	To study the lead, lag, lead-lag compensators and to draw their magnitude and phase plots.
5	To study and demonstrate simple closed loop speed control system.
6	To obtain the Operational Characteristics for the Control Application of the following devices. (i) Stepper Motor, (ii) Temperature Detectors.
7	To study control action of light control device.
8	To implement a PID controller for temperature control of a pilot plant.
9	Determination of the Incremental Transfer Function of an AC Servomotor.
10	Study the effect of addition of zeros to the forward path transfer function of a closed loop system.

11	Study the effect of addition of poles to the forward path transfer function of a control system.
12	To obtain bode plot for a given transfer function of the system.
13	To obtain root locus for a given transfer function of the system.

Virtual Lab Links

Experiment Name	Virtual Lab Link
To obtain bode plot for a given transfer function of the system.	https://ce-dei.vlabs.ac.in/exp/to-obtain-bode-plot-for-a-given-transfer-function-of-the-system/
To obtain root locus for a given transfer function of the system.	https://ce-dei.vlabs.ac.in/exp/to-obtain-root-locus-for-a-given-transfer-function-of-the-system.
Study the effect of addition of poles to the forward path transfer function of a control system.	https://ce-dei.vlabs.ac.in/exp/study-the-effect-of-addition-of-poles-to-the-forward-path-transfer-function-of-a-control-system/
To study the lead, lag, lead-lag compensators and to draw their magnitude and phase plots.	https://ce-dei.vlabs.ac.in/exp/pole-zero-plot/
To obtain the Position Control performance of DC Servo Motor.	https://vlabs.iitkgp.ac.in/ctrl/Exp4/index.html
Study the effect of addition of zeros to the forward path transfer function of a closed loop system.	https://ce-dei.vlabs.ac.in/exp/study-the-effect-of-addition-of-zeros-to-the-forward-path-transfer-function-of-a-closed-loop-system/

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

Course Code	LC-EE-313A				
Category	Professional Core Courses (Lab Course)				
Course Title	Microprocessor and Microcontroller Lab				
Scheme and Credits	L	T	P	Credits	Semester- V
	0	0	2	1	
Course Objectives	The objectives of this course are • To understand architecture and working of Microprocessor and Microcontroller. • To learn assembly programming for arithmetic and data operations. • To provide hands-on experience in interfacing various peripherals with processor based systems.				
Assessment	25 Marks				
End Semester Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Explain the architecture and functioning of microprocessors and microcontroller using model kits and instruction sets.	Level 2: Understand
CO2	Apply interfacing techniques to connect peripherals with computing devices for practical applications.	Level 3: Apply
CO3	Analyze embedded control algorithms for hardware interfacing and timing operations using microcontroller kit.	Level 4: Analyze
CO4	Develop and debug assembly language programs for arithmetic, logical, and data manipulation tasks using instruction sets.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	To study the architecture and functional blocks of the 8085 and 8086 microprocessors using trainer kit.
2	Write and execute program to perform arithmetic operations such as addition, subtraction, multiplication and division using 8085 instruction set.
3	Write a program to add the content of the memory location to the content of other memory location and store the result in 3 rd memory location using 8086 instruction set.
4	Write a program to add 16 bit number using 8086 instruction set.
5	Write a program for multiplication of two 16 bit numbers using 8086 instruction set.
6	Write a program for division of two 16 bit numbers using 8086 instruction set.
7	Write a program to calculate the factorial of a given number using the 8086 instruction set.
8	Write a program to find the average of two given numbers using the 8086 instruction set.
9	Write a program to find the largest number in a data array using 8086 Instruction set.
10	Write and execute an 8086 assembly language program to interface and control a stepper motor using the 8255 (PPI).

11	To study the architecture and functioning of the 8051 microcontroller using trainer kit.
12	Write and execute a program to generate a square wave using the 8051 microcontroller.
13	Write and execute a program to interface an LED with the 8051 microcontroller and generate a blinking effect using software delay.

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

Virtual Lab Links:

Sr. No.	Topics	Links
1	Introduction of Microprocessor 8086 Trainer Kit	https://www.youtube.com/watch?v=GZibA34SU0c
2	Write a program to find the average of two given numbers using the 8086-instruction set.	https://www.youtube.com/watch?v=nOt9Wa-CIRo&list=PLNdrDld4dxeVrRU4OmzVCR6UUgvRYMquI&index=10
3	Write a program to find the largest number in a data array using 8086 Instruction set.	https://www.youtube.com/watch?v=vNRGKG8ujVc&list=PLNdrDld4dxeVrRU4OmzVCR6UUgvRYMquI&index=12
4	Write a program to calculate the factorial of a given number using the 8086-instruction set.	https://www.youtube.com/watch?v=riliLJP0Q_0&list=PLNdrDld4dxeVrRU4OmzVCR6UUgvRYMquI&index=13
5	To write and execute an 8086-assembly language program to interface a stepper motor using 8255 PPI and control its rotation.	https://www.youtube.com/watch?v=lj5L1nGZAwg
6	To write and execute a program to interface an LED with the 8051 microcontroller and generate a blinking effect using software delay.	https://www.youtube.com/watch?v=aGVn4xGrAfY

Course Code	PT-EE-315A				
Category	Practical Training				
Course Title	Evaluation of Summer Internship				
Scheme and Credits	L	T	P	Credits	Semester-V
	0	0	2	1	
Course Objectives	The objectives of this course are to • To introduce circuit simulation using industry-standard software tools for electronic analysis. • To study technical documentation, engineering processes and industry standards in real-world projects. • To demonstrate professional communication, time management and ethical practices in industrial settings. • to analyze engineering problems and develop solutions using industry-standard tools and methodologies.				
Assessment	25 Marks				
End Semester Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the organizational structure, working environment, and industrial practices of the training organization.	L2: Understand
CO2	Apply engineering knowledge to understand real-time industrial processes, tools, equipment, and systems.	L3: Apply
CO3	Prepare and present a technical training report based on observations, learning, and industrial exposure.	L3: Apply
CO4	Analyze practical problems encountered during training and relate them to theoretical concepts studied in the curriculum.	L4: Analyze

Note:

1. Each student has to undergo practical training of 4/6 weeks during summer vacation and its evaluation shall be carried out in the V semester.
2. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

Course Code	PEC-EE-317A				
Category	Professional Elective Courses				
Course Title	Digital Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental concepts of discrete-time signals, systems, sampling, and z-transform techniques used in digital signal processing. • To develop the understanding of students in frequency domain representation and analysis of discrete-time signals and systems using DFT and FFT techniques. • To familiarize the students with the principles and methods of digital filter design and performance evaluation. • To make the students learn about the implementation of discrete-time systems, spectral analysis, multirate signal processing, and their practical applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, transforms, frequency-domain techniques, filter structures, and multirate processing methods used in digital signal processing.	Level 1: Remember
CO2	Discuss the representation, analysis, filtering, implementation, and sampling rate conversion of discrete-time signals and systems.	Level 2: Understand
CO3	Apply transform-based methods, frequency-domain techniques, and filter design procedures for the analysis and processing of discrete-time signals.	Level 3: Apply
CO4	Analyze discrete-time systems, digital filters, implementation structures, spectral estimation methods, and multirate processing techniques based on their characteristics and performance.	Level 4: Analyze

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

Unit-I

Discrete-Time Signals and Systems: Sequences; representation of signals on orthogonal basis; representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate

Z-Transform: Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transforms, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit-II

Frequency Representation of Signal and Systems: Frequency Domain analysis concept, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Circular convolution, Linear Filtering using DFT, Fast Fourier Transform Algorithm, Decimation in time and Decimation in frequency algorithms, Computations Complexity Calculations, Parseval's Identity.

Unit-III

Design of Digital Filter: Ideal Filter vs Practical Filters, General Specifications and Design Steps, Comparison of FIR & IIR Filters, Design of FIR Filters using Window technique, Park-McClellan's method, Design of IIR Filters using Impulse Invariance technique, Bilinear Transformation, Design of IIR Filters using Butterworth, Chebyshev and Elliptic filter, Digital frequency transformation.

Unit-IV

Implementation of Discrete Time Systems: Block diagrams and signal flow graphs for FIR and IIR systems, Direct form, Cascade form, Frequency Sampling Structures, and Lattice 42 structures for FIR systems, Direct form, Cascade form, Parallel form, and Lattice and Lattice Ladder Structures for IIR systems, Representation of fixed point and floating-point numbers, Finite word length effects, Parametric and non-parametric spectral estimation. Applications of Digital Signal Processing

Multirate Digital Signal Processing: Introduction to multirate digital signal processing, Multi rate structures for sampling rate conversion, Multistage decimator and interpolators, Polyphase decomposition, Digital Filter Banks.

Suggested Readings:

1. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997.
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. S.K. Mitra, Digital Signal Processing: A computer based approach. TMH
4. Digital Signal Processing: Salivahanan, Vallavaraj and Gnanapriya; TMH
5. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
6. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
7. D.J. DeFatta, J. G. Lucas and W.S. Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to Systems	https://youtu.be/sGu_YhiyE?list=PLUQpHm_JtukLkIO7QB6dp3KITCOM0ChGq
UNIT-II	Discrete time Fourier transform	https://youtu.be/zxFbujk_2f8?list=PLUQpHm_JtukLkIO7QB6dp3KITCOM0ChGq
UNIT-III	IIR Filters	https://youtu.be/Bdw3XcXgHa8?list=PLgMDNELGJ1CYvviJ_ZHrHy5TKLb-Vn7-r
UNIT- IV	Digital Filters Bank	https://youtu.be/ewmZ0qXVXfM

Course code	PEC-EE-319A				
Category	Professional Elective Courses				
Course title	Power System Protection				
Scheme and Credits	L	T	P	Credits	Semester-V
	3	0	0	3	
Course Objectives	The objectives of this course are to • To make the students familiar with the fundamental principles and components of power system protection, including relays, instrument transformers, and circuit breakers. • To develop the understanding of students in fault analysis and protection schemes for power system equipment and networks. • To familiarize the students with protection coordination, modeling, simulation, and testing techniques used in modern protection systems. • To make the students learn about advanced system protection schemes and wide-area monitoring technologies for enhancing power system reliability and security.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, components, protection schemes, and monitoring technologies used in power system protection.	Level 1: Remember
CO2	Discuss the operation of protection systems, fault analysis methods, relay coordination, equipment protection schemes, and wide-area monitoring techniques.	Level 2: Understand
CO3	Determine appropriate protection, coordination, modeling, and testing methods for the analysis and protection of power system components and networks.	Level 3: Apply
CO4	Classify faults, protection schemes, relay characteristics, system disturbances, and monitoring approaches based on their performance and application requirements.	Level 4: Analyze

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

Unit-I

Introduction and Components of a Protection System: Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers, Generator Protection: External and internal faults – differential

protection – biased circulating current protection – self balance system – over-current and earth fault protection – protection against failure of excitation.

Unit-II

Faults and Over-Current Protection: Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination. Transformer protection: Differential protection – self-balance system of protection – over current and earth fault protection – Buchholz’ s relay and its operation..

Unit-III

Equipment Protection Schemes: Directional, Distance, Differential protection. Bus bar Protection, Bus Bar arrangement schemes.

Modeling and Simulation of Protection Schemes: CT/PT modeling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.

Unit-IV

System Protection: Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

Suggested Readings:

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G. Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006. suggested Readings

Useful Video links

Unit No.	Topic	Link
UNIT-I	Fundamentals of Protective Relays	https://youtu.be/QsGn7H_14VY?list=PLLy_2iUCG87BIJ6ZliVIRCx2Cr9_fJMB
UNIT-II	Transformer Protection	https://youtu.be/oC5VmIGxsGA?list=PLLy_2iUCG87BIJ6ZliVIRCx2Cr9_fJMB
UNIT-III	Bus Bars Protection	https://youtu.be/utAoMJrG7vM?list=PLLy_2iUCG87BIJ6ZliVIRCx2Cr9_fJMB
UNIT- IV	Power Swing	https://youtu.be/uRCdfjVdV0w?list=PLbRMhDVUMngef3WZI2VcPeBUALq989427

Course Code	PEC-EE-321A				
Category	Professional Elective Courses				
Course Title	Power Systems Stability				
Scheme and Credits	L	T	P	Credits	Semester- V
	3	0	0	3	
Course Objectives	The objectives of this course are to • To make the students familiar with the fundamental concepts of power system stability and the factors affecting stable system operation. • To develop the understanding of students in the modelling and dynamic behavior of synchronous machines using mathematical and state-space representations. • To familiarize the students with stability assessment techniques and the role of control systems in enhancing power system performance. • To make the students learn about voltage stability, transient phenomena, sub-synchronous oscillations, and their mitigation in power systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, models, stability phenomena, and control techniques associated with power system dynamic behavior and stability.	Level 1: Remember
CO2	Discuss the principles of power system stability, synchronous machine modelling, dynamic response, voltage stability, and sub-synchronous oscillations.	Level 2: Understand
CO3	Apply stability analysis techniques and computational methods to observe the performance of power systems under different operating conditions.	Level 3: Apply
CO4	Analyze power system stability issues, machine dynamics, voltage instability conditions, and oscillatory phenomena based on their characteristics and system impact.	Level 4: Analyze

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

Unit-I

Power System Stability Problem: Rotor angle stability, voltage stability, short term and long-term stabilities, swing equation and its solution techniques.

Unit-II

Synchronous Machine and Its Modelling: Power transformation, flux linkage equations, voltage equation, formulation using state-space equations, normalizing voltage and torque eqns., equivalent circuit of

synchronous m/c, the flux linkage state-space model. Linearization of the flux linkage model, simplified linear model block diagram, state-space representation of simplified model.

Unit-III

Dynamic Stability: State-space representation, stability of a dynamic system, analysis of stability, Eigen properties of the state matrix, small signal stability of a single m/c infinite bus system, Effect of excitation systems, power system stabilizer, system state matrix with armature winding

Transient Stability: An elementary view of transient stability, numerical integration methods, simulation of power system dynamic response.

Unit-IV

Voltage Stability: Basic concept related to voltage stability, voltage collapse, voltage stability analysis, prevention of voltage collapse. Sub-Synchronous Oscillators: Turbine generator torsional characteristics, characteristics of series capacitor compensated transmission system, Self excitation, torsional interaction, counter measure to SSR problems, ferro resonance.

Suggested Readings

1. Power System Stability and Control by Prabha Kumar: MGH
2. Power System Control and Stability by Anderson and Fouad: Galgotia Publications
3. K. R. Padiyar, Power System Dynamics Stability and Control. Hyderabad, India: BS Publications, 2008.
4. Electrical energy theory: An Introduction by O.I. Elgerd: TMH

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to Power System Stability	https://youtu.be/70gLa0-1Rho?list=PLC3FFC85203B1EC18
UNIT-II	Modelling of Synchronous Machine	https://youtu.be/quYggqvMAw8?list=PLC3FFC85203B1EC18
UNIT-III	Numerical Integration Methods	https://youtu.be/MKlktzDjfTg?list=PLC3FFC85203B1EC18
UNIT- IV	Sub-Synchronous Oscillations	https://youtu.be/Zaw4C8S4u0s?list=PLC3FFC85203B1EC18

Course Code	PEC-EE-323A				
Category	Professional Elective Courses				
Course Title	Power System Planning and Reliability				
Scheme and Credits	L	T	P	Credits	Semester- V
	3	0	0	3	
Course Objectives	The objectives of this course are to • To make the students familiar with the principles, objectives, and methodologies of power system planning for generation, transmission, and distribution systems. • To develop the understanding of students in load and price forecasting techniques used for power system operation and expansion planning. • To familiarize the students with reliability concepts, probabilistic models, and reliability evaluation methods for power systems. • To make the students learn about reliability assessment of generation, transmission, and distribution systems for ensuring secure and economical power supply.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamentals of power system planning, load forecasting, and reliability concepts.	Level 1: Remember
CO2	Explain load forecasting techniques and reliability evaluation methods used in power systems.	Level 2: Understand
CO3	Apply reliability indices and forecasting methods for generation, transmission, and distribution systems.	Level 3: Apply
CO4	Analyze power system reliability and planning performance under different operating conditions and uncertainties.	Level 4: Analyze

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

Unit-I

Introduction: Objectives of planning, Long and short-term planning, Planning of generation, transmission and distribution systems. Least Cost Power Planning, Integration of DSM.

Unit-II

Load Forecasting: Classification and characteristics of loads. Approaches to load forecasting. Forecasting methodology. Short-run and Long run forecasting. Energy forecasting. peak demand forecasting, total forecasting, annual and monthly peak demand forecasting. Electricity Price Forecasting.

Unit-III

Basic Reliability Concepts: General reliability function, exponential distributions, meantime to failure, Markov Chains and processes and their applications, simple series and parallel system models.

Static Generating Capacity Reliability Evaluation: Outage definitions, loss of load probability methods, loss of energy probability method. Frequency and duration methods, load forecasting uncertainty.

Unit-IV

Transmission System Reliability Evaluation: Average interruption rate method. LOLP method. The frequency and duration method. Distribution System Reliability Analysis: distribution network reliability, reliability performance.

Suggested Readings:

1. Roy Billington, 'Power System Reliability Evaluation', Gordon & Breach Scain Publishers, 1990.
2. Endrenyi, J., 'Reliability modelling in Electric Power System John Wiley, 1980.
3. Billinton Roy, Allan Ronald, 'Reliability of Power System' Plenum Press, 1996.
4. David Elmakias, 'New Computational Methods in Power System Reliability' Springer-Verlag, 2008.
5. Ali Chowdhury, Don Koval, 'Power Distribution System Reliability: Practical Methods and Applications, Wiley-IEEE Press, 2009.
6. Dasari, S., Electric Power System Planning, IBT Publishers (1999).
7. Pabla, A.S., Electric Power Distribution, Tata McGraw Hill (2008).
8. Sullivan, R., Power System Planning McGraw (1977)
9. Knight, U.G., Power System Engineering and Mathematics, Pergamon Press (1972).
10. McDonald, J.R., Modern Power System Planning, McGraw (2007)

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to System Planning	https://youtu.be/RyD82sdTV1M?list=PLm_MSClsnwm8Cfe2XX4pT7OZeWdtlp-TR
UNIT-II	Load Forecasting	https://youtu.be/cmv1BV5UO9Y?list=PLm_MSClsnwm8Cfe2XX4pT7OZeWdtlp-TR
UNIT-III	Reliability Concepts, terms and Definitions	https://youtu.be/eAleNjyb7is?list=PLm_MSClsnwm8Cfe2XX4pT7OZeWdtlp-TR
UNIT- IV	Distribution System Reliability	https://youtu.be/v6srsNkxqXw?list=PLqNNYrlmv01BL0vtOc8RZgnYkfM06TC3Q

Course Code	PCC-EE-302A				
Category	Professional Core Courses				
Course Title	Power Systems-II				
Scheme and Credits	L	T	P	Credits	Semester- VI
	3	1	0	4	
Course Objectives	The objectives of this course are • To make the students familiar with power system network modeling and power flow analysis techniques used for system operation and planning. • To develop the understanding of students in economic operation and optimal scheduling of power generation resources. • To familiarize the students with voltage regulation, load frequency control, and automatic generation control in interconnected power systems. • To make the students learn about power system stability analysis and numerical methods used for evaluating dynamic system performance.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, models, control strategies, optimization techniques, and stability criteria used in power system operation and control.	Level 1: Remember
CO2	Discuss power flow analysis, economic operation, voltage and frequency control mechanisms, and stability phenomena in power systems.	Level 2: Understand
CO3	Apply power flow, economic dispatch, load frequency control, and stability analysis methods for the operation and assessment of power systems.	Level 3: Apply
CO4	Analyze power system operating conditions, control strategies, optimization approaches, and stability characteristics based on system performance requirements.	Level 4: Analyze

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

Unit-I

Power Flow Analysis: Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations.

Unit-II

Economic Operation of Power Systems: Distribution of loads between units within a plant. Distribution of loads between plants, Transmission loss equation, Classical Economic dispatch with losses. Optimal unit commitment problems and their solutions.

Unit-III

Voltage and Load Frequency Control: Introduction to control of active and reactive power flow, control of voltage, Excitation systems. Introduction to Load Frequency Control and Automatic generation control, Single area and modelling of AGC, Concept of multi area AGC.

Unit-IV

Power System Stability: Concepts, steady state and transient stability, swing equations, equal area criterion. Solution of Swing Equation, Transient stability algorithm using modified Euler's method and fourth order RungeKutta method, – multi-machine stability analysis.

Suggested Readings:

1. H. Saadat, Power System Analysis. New York, NY, USA: McGraw-Hill, 1999.
2. O.I. Elgerd, Electric Energy Systems Theory-An Introduction, Tata McGraw-Hill Edition, 2008
3. S. Sivanagaraju and G. Sreenivasan, Power System Operation and Control, 1st ed. New Delhi, India: Pearson Education India, 2009
4. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, 4th ed. New Delhi, India: Tata McGraw-Hill, 2011.
5. J. D. Glover, M. S. Sarma, and T. J. Overbye, Power System Analysis and Design, 5th ed. Stamford, CT, USA: Cengage Learning, 2012.
6. J. J. Grainger and W. D. Stevenson Jr., Power System Analysis. New York, NY, USA: McGraw-Hill, 1994.
7. M. M. E. EL-Hawary, Power System SCADA and Smart Grids. Hoboken, NJ, USA: Wiley-IEEE Press, 2014.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Classification of buses	https://www.youtube.com/watch?v=GuiDHThayS8
	Gauss Siedel Method	https://www.youtube.com/watch?v=GuiDHThayS8
	Newton-Raphson Methods	https://www.youtube.com/watch?v=m7BMdsZ7Swg
UNIT-II	Economic load dispatch	https://www.youtube.com/watch?v=JRbk0_Klhr4
	Unit commitment	https://www.youtube.com/watch?v=8n8ZNeQIldw
UNIT-III	Load Frequency Control of single area system	https://www.youtube.com/watch?v=y_r0MHv6cMU
	LFC of two area system, Area Control Error	https://www.youtube.com/watch?v=qborFmJUCv0
	Excitation systems.	https://www.youtube.com/watch?v=ZRDgn0u-rKo
UNIT-IV	Swing equation	https://www.youtube.com/watch?v=OO-bPCO-lyg&list=PL36A60B630E8C7B56&index=36
	Equal area criterion	https://www.youtube.com/watch?v=KJcxz3kl_Ik
	Multi-Machine Stability analysis	https://www.youtube.com/watch?v=yv6i9plC9nk

Course Code	PCC-EE-304A					
Category	Professional Core Courses					
Course Title	Power Electronics					
Scheme and Credits	L	T	P	Credits	Semester-VI	
	3	1	0	4		
Course Objectives	The objectives of this course are to • To make the students familiar with the characteristics, operation, and applications of power semiconductor devices used in power electronic systems. • To develop the understanding of students in switching, triggering, protection, and commutation techniques employed in power electronic converters. • To familiarize the students with the principles and operation of controlled rectifiers and AC–DC conversion systems. • To make the students learn about DC–AC and DC–DC power conversion techniques and their performance characteristics in power electronic applications.					
Assessment	40 Marks					
End Semester Examination	60 Marks					
Total	100 Marks					
Duration of Exam	03 Hours					

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

COs	Skills Demonstrated	RBT Level
CO1	Describe fundamental concepts, power semiconductor devices, converter topologies, switching techniques, and control methods used in power electronics.	Level 1: Remember
CO2	Discuss the operation, characteristics, triggering methods, protection schemes, and performance of power electronic devices and converters.	Level 2: Understand
CO3	Apply the operating parameters and performance characteristics of rectifiers, converters, inverters, and choppers used in power electronic systems.	Level 3: Apply
CO4	Classify power electronic devices, converter circuits, commutation techniques, and control schemes based on their operating characteristics and application requirements.	Level 4: Analyze

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

Unit-I

INTRODUCTION: Role of power electronics, review of construction and characteristics of power diode, Schottky diode, power transistor, power MOSFET, DIAC, Triac, GTO, IGBT & SIT.

Unit-II

SCR: Construction and characteristics of SCR, Ratings and protections, series and parallel connections, R, RC and UJT firing circuit and other firing circuits based on ICs and microprocessors, pulse transformer and opto-coupler, commutation techniques.

Unit-III

THYRISTOR RECTIFIER: Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

CONVERTERS: Six and Twelve pulse converters, fully and half controlled converters, continuous and discontinuous modes of operation, reactive power demand, effect of source inductance, introduction to four quadrant / dual converter, power factor improvement techniques, forced commutated converter.

Unit-IV

INVERTERS: Basic circuit, 120-degree mode and 180-degree mode conduction schemes, modified McMurray half bridge and full bridge inverters, current source inverter (CSI).

CHOPPERS: Basic scheme, output voltage control techniques, one, two, and four quadrant choppers, step up chopper, voltage commutated chopper, current commutated chopper.

Suggested Readings:

1. P.S Bhimra, "Power Electronics", Khanna publication.
2. MH Rashid, "Power Electronics", PHI
3. A.K. Gupta and L.P. Singh, "Power Electronics and Introduction to Drives", Dhanpat Rai
4. HC Rai, "Power Electronics", Galgotia
5. GK Dubey, "Thyristorised Power Controllers", PHI
6. PC Sen, "Power Electronics", TMH
7. MH Rashid, "Handbook of power electronics", Elsevier

Useful Video links

Unit No.	Topic	Link
UNIT-I	Construction and characteristics of power MOSFET	https://youtu.be/RyDdVd1hFkU
UNIT-II	SCR turn ON Methods in Power Electronics	https://youtu.be/u9r3YvtqPMA?list=PLgwJf8NK-2e5Hnu82T1CYLZ8kbZs4Jx8x
UNIT-III	Single phase half wave-controlled rectifier with r load	https://youtu.be/4zyTah3-P0k
UNIT-IV	Three Phase Inverter 180 Degree Conduction Mode (Working, Operation, Waveform, Operation & Modes)	https://youtu.be/L0XaK6L3p9A

Course Code	PCC-EE-306A				
Category	Professional Core Courses				
Course Title	Electrical Power Generation				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with various conventional and non-conventional energy resources, their availability, utilization, and role in power generation. • To develop the understanding of students in power generation planning, energy demand-supply scenarios, and emerging trends in the power sector. • To familiarize the students with the economic aspects of power generation, load forecasting, and tariff structures used in electrical power systems. • To make the students learn about the operating principles, configurations, and applications of conventional and renewable power generation technologies.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, energy resources, power generation technologies, economic parameters, and renewable energy systems used in electrical power generation.	Level 1: Remember
CO2	Discuss the principles, characteristics, economics, and operational aspects of conventional and non-conventional power generation systems.	Level 2: Understand
CO3	Apply economic and load-related parameters for the assessment and operation of power generation systems.	Level 3: Apply
CO4	Classify energy resources, power generation technologies, economic factors, and renewable energy systems based on their performance, suitability, and application requirements.	Level 4: Analyze

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

Unit-I

Introduction: Energy sources, their availability, classification, recent trends in Power Generation, Energy scene of supply and demand in India and the world, potential of non-conventional energy resources, Interconnected Generation of Power Plants, Present status and future trends.

Unit-II

Power Generation Economics: Economic scheduling principle, Load curves, Base load and Peak load power plants, Load forecasting, Cost of electrical energy, Tariffs, Peak load pricing, connected load, maximum demand, demand factor, Group diversity factor, significance of load factor, plant factor, capacity factor, Load forecasting, Concept of Net metering.

Unit-III

Conventional Energy Generation: General developing trends, layout and working of thermal power stations, Introduction to super thermal technology, hydroelectric plant, site selection, pumped storage power plant, mini and micro hydroelectric plants, nuclear power plants, and gas turbine power plants.

Unit-IV

Non-Conventional Methods: Fundamental of Solar power generation, PV array construction and working, Introduction to wind turbine, construction, working principle, horizontal and vertical wind turbine system. Power in the wind, Basic principle of design and different types of fuel cells and their applications, future prospects.

Suggested Readings:

1. H. P. Garg, Solar Energy: Fundamentals and Applications. New Delhi, India: McGraw-Hill, 2012.
2. S. P. Sukhatme and J. K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd ed. New Delhi, India: McGraw-Hill, 2008.
3. B. R. Gupta, Generation of Electrical Energy. New Delhi, India: S. Chand, 2014.
4. M. M. El-Wakil, Powerplant Technology. New York, NY, USA: McGraw-Hill, 1984.
5. B. H. Khan, Non-Conventional Energy Resources, 3rd ed. New Delhi, India: McGraw-Hill Education, 2017.
6. G. D. Rai, Non-Conventional Sources of Energy, 6th ed. New Delhi, India: Khanna Publishers, 2018.
7. K. R. Rao, Ed., *Energy and Power Generation Handbook: Established and Emerging Technologies*. New York, NY, USA: ASME Press, 2011.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Energy sources, their availability	https://www.youtube.com/playlist?list=PLD4ED2FAF3C155625
	recent trends in Power Generation, Energy scene of supply and demand in India	https://www.youtube.com/watch?v=Yg6XsepGCKY&list=PLD4ED2FAF3C155625&index=2
UNIT-II	Load curves, Base load and Peak load power plants	https://www.youtube.com/watch?v=jb28ZGAUTx8
	connected load, maximum demand, demand factor, Group diversity factor,	https://www.youtube.com/watch?v=jb28ZGAUTx8
UNIT III	working of thermal power stations	https://www.youtube.com/watch?v=45_nQN-9XSs&list=PLD4ED2FAF3C155625&index=3
	hydroelectric plant	http://youtube.com/watch?v=JBrdUoU2uTE&list=PLD4ED2FAF3C155625&index=4
UNIT-IV	Non-Conventional Sources of Energy	https://www.youtube.com/watch?v=GRwJqD4StEU&list=PLD4ED2FAF3C155625&index=5
	Solar, wind conversion systems	https://www.youtube.com/watch?v=UW4HYJ36q0Y&list=PLD4ED2FAF3C155625&index=6

Course Code	PCC-EE-308A				
Category	Professional Core Courses				
Course Title	Computer Aided Electrical Machine Design				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental principles, design factors, and modern practices involved in the design of electrical machines. • To develop the understanding of students in the selection of design parameters, dimensions, and performance considerations of electrical machines. • To familiarize the students with the design methodologies of transformers, induction motors, synchronous machines, and DC machines. • To make the students learn about computer-aided design techniques, performance prediction, and optimization methods applied to electrical machine design.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental principles, design factors, specifications, and constructional features of electrical machines.	Level 1: Remember
CO2	Explain the design procedures and selection criteria of specific electric and magnetic loadings, dimensions, slots, windings, and magnetic circuits of electrical machines.	Level 2: Understand
CO3	Apply design equations and standard specifications to determine the main dimensions and winding parameters of electrical machines.	Level 3: Apply
CO4	Analyze electrical machine design problems using computer-aided design techniques, optimization methods, and performance prediction approaches.	Level 4: Analyze

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

Unit-I

FUNDAMENTAL ASPECTS OF ELECTRICAL MACHINE DESIGN: Design of Machines, Design Factors, Limitations in design, Modern Trends in design, manufacturing Techniques.

BASIC DESIGN PRINCIPLES: Output equation and output coefficient, Specific electric and Magnetic loading. Relation between rating and main dimension of rotating machine, Effect of size and ventilation/Factors affecting size of a rotating machine.

Unit-II

DESIGN OF INDUCTION MOTORS: Three Phase Induction Motor: Standard specifications, output equations, choice of specific loadings, main dimensions, conductor size and turns, air gap length, no. of slots, slot design, stator core depth, rotor design, rotor bars & slots area, end rings.

Unit-III

DESIGN OF TRANSFORMER: Output Equations of Single Phase and Three Phase Transformers, Expression for Volts/Turn, Determination of Main Dimensions of the Core, Estimation of Number of Turns and Conductor Cross Sectional area of Primary and Secondary Windings, Main Dimensions - kVA output for single and three phase transformers, Window space factor, Design of core, yoke and winding, overall dimensions.

DESIGN OF SYNCHRONOUS MACHINE: Output Equation, Choice of Specific Loadings, Short Circuit Ratio, Main Dimensions of Stator. Design of stator slots and Winding. Design of Salient and non-salient Pole Rotors. Magnetic Circuit and Field Winding, design difference between turbo alternator & salient pole generators.

Unit-IV

DESIGN OF DC MACHINES: Output equation, choice of specific loadings, choice of poles and speed, Design of core length, armature diameter, depth of armature core, air gap length, cross section of armature conductors, armature slots, design of field system field poles, field coils, commutator.

COMPUTER AIDED DESIGN: Computerization of design Procedures. Development of Computer program and performance prediction. Optimization techniques and their applications to design Problems.

Suggested Readings:

1. A course in Electrical Machine Design by A.K. Sawhney, Khanna Pub.
2. Principles of Electrical Machine Design by R. K. Aggarwal.
3. Theory, performance and Design of alternating current machines by MG Say, ELBS, 15th Ed. 1986.
4. Theory, Performance and Design of Direct Current machines by A.E. Clayton, 3rd Ed. 1967.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to Computer Design	https://youtu.be/UusLpwO7DMo?list=PLp6ek2hDcoNCOQduaaLYTBE9GqTdMbNUC
UNIT-II	Design of Induction Machine	https://youtu.be/m7P6wjAd2o4?list=PLp6ek2hDcoNCOQduaaLYTBE9GqTdMbNUC
UNIT III	Design of Transformer	https://youtu.be/65RYZSUQ41U?list=PLp6ek2hDcoNCOQduaaLYTBE9GqTdMbNUC
UNIT-IV	Design of DC Machine	https://youtu.be/zBTFqblgM8?list=PLp6ek2hDcoNCOQduaaLYTBE9GqTdMbNUC

Course code	LC-EE-310A				
Category	Professional Core Courses (Lab Course)				
Course title	Power System-II Lab				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Course Objectives	The objectives of this course are to • Develop understanding of voltage and frequency control mechanisms including turbine governing systems, and excitation systems. • Develop analytical and problem-solving skills related to generation scheduling, transmission losses, and optimization methods used in power system operation.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Understand concepts of interconnected power system representation, power flow paths, speed governing characteristics	Level 2: Understand
CO2	Apply economic load dispatch and unit commitment techniques to optimize generation scheduling.	Level 3: Apply
CO3	Analyze power system behavior under disturbances and recommend control actions to maintain system stability and reliability	Level 4: Analyze
CO4	Evaluate real and reactive power control mechanisms, including frequency control in interconnected power systems.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	Draw the flow chart and develop the computer program for the formation of the Y Bus of a generalized network.
2	Draw the flow chart and develop the computer program for the formation of the Z Bus of a generalized network.
3	To plot the swing curve and observe the stability.
4	To perform load flow analysis using Gauss Seidel method.
5	To perform load flow analysis using Newton-Raphson method.
6	To study comparison of different load flow methods
7	To develop the program for stability analysis.

8	To observe transmission losses and efficiency with variations in power for the given example.
9	Simulation study on LFC of two area interconnected power system.
10	Simulation study on voltage control in multi area interconnected power system.

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

Virtual Lab Links

Experiment Name	Virtual Lab Link
Y-Bus Formation	https://srmeeevlab.github.io/PSA/3_Formation_of_Bus_admittance_Matrix_(without_mutual_coupling)/index.html
To perform load flow analysis using Gauss Seidel method.	https://srmeeevlab.github.io/PSA/4_Power_Flow_Analysis_by_Gauss_Seidel_method/index.html
To perform load flow analysis using Newton-Raphson method.	https://srmeeevlab.github.io/PSA/5_Power_Flow_Analysis_by_Newton_Raphson_method/index.html
To develop the program for stability analysis.	https://ps2-iitr.vlabs.ac.in/exp/smib-transient-stability/simulation.html
Simulation study on LFC of two area interconnected power system.	https://ps2-iitr.vlabs.ac.in/exp/load-frequency-control/

Course code	LC-EE-312A				
Category	Professional Core Courses (Lab Course)				
Course title	Power Electronics Lab				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Course Objectives	The objectives of this course are to ● Provide practical exposure to the operation, characteristics, and applications of power semiconductor devices ● Develop hands-on skills in designing, implementing, and analyzing power electronic circuits.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Explain the operating principles and characteristics of power semiconductor devices.	Level 2: Understand
CO2	Apply appropriate techniques to perform experiments on power electronic circuits.	Level 3: Apply
CO3	Analyze the performance of power electronic circuits under various operating conditions.	Level 4: Analyze
CO4	Evaluate the efficiency, switching behavior, and overall performance of power electronic systems and motor control	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	To study the performance characteristics of MOSFET.
2	To study the performance characteristics of IGBT.
3	To Study the Step-up Chopper with R Load.
4	To study the three phase half wave silicon controlled rectifier with R load and RL load.
5	To study the three phase full wave silicon controlled rectifier with R load RL load.
6	To Study of SCR Communication Technique Class A-E.
7	Speed control of small motor using Single Phase Dual Converter (Continuous and discontinuous Control).
8	Static Characteristics of Power diode & Schottky diode and to study reverse recovery of Power Diode & Schottky diode.
9	To Study the three phase voltage source inverter with 120° & 180° conduction mode.
10	Speed control of small motor using Single Phase Half wave & Full wave fully controlled Converter
11	To study of Firing Circuit based on ICs NE555, 7408 & 3140.

12	To study R, RC and UJT firing Circuit with Pulse transformer.
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Virtual Lab Links

Experiment Name	Virtual Lab Link
To study the performance characteristics of MOSFET.	https://pe2-iitd.vlabs.ac.in/exp/mosfet-switching-power/
To study the performance characteristics of IGBT.	https://pe2-iitd.vlabs.ac.in/exp/igbt-switching-power/
To Study the Step-up Chopper with R Load.	https://pe-iitr.vlabs.ac.in/exp/step-up-chopper/
To study the three phase half wave silicon controlled rectifier with R load an RL load.	https://pe-iitr.vlabs.ac.in/exp/three-half-silicon/
To study the three phase full wave silicon controlled rectifier with R load RL load.	https://pe-iitr.vlabs.ac.in/exp/three-full-silicon/
To Study the three phase voltage source inverter with 120° & 180° conduction mode.	https://pe-iitr.vlabs.ac.in/exp/three-phase-conduction/

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

Course code	LC-EE-314A				
Category	Professional Core Courses (Lab Course)				
Course title	Computer Aided Electrical Machine Design Lab				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Course Objectives	The objectives of this course are to • Develop understanding of control mechanisms including turbine governing systems, and excitation systems. • Develop analytical and problem-solving skills related to generation scheduling, transmission losses, and optimization methods used in power system operation.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Explain the design factors, limitations, and computer-aided design concepts used in electrical machines and transformers.	Level 2: Understand
CO2	Apply programming techniques to determine the main dimensions, stator, rotor, slot, core, and yoke design parameters of electrical machines.	Level 3: Apply
CO3	Analyze the performance of induction motors and transformers using computational methods.	Level 4: Analyze
CO4	Evaluate and optimize the design procedures of rotating electrical machines.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	To study about design factors and its limitations.
2	To study about CAD of rotating electrical machine.
3	To study of computer aided design of transformer.
4	Write a program to measure the main dimension of an induction motor.
5	Write a program for stator design of an induction motor.
6	Write a program for rotor design of an induction motor.
7	Write a program to measure the losses and the efficiency of an induction motor.
8	Write a program to design the armature of a D.C. motor.
9	Write a program to measure the slot design of a synchronous machine.
10	Write a program to measure the core and yoke design of transformer.
11	Write a program to measure the losses in a transformer.

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

Course Code	MC-301A				
Category	Mandatory Non Credit Courses – Audit Courses				
Course Title	Essence of Indian Traditional Knowledge				
Scheme and Credits	L	T	P	Credits	Semester -V
	2	0	0	-	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamentals, structure, and components of the Indian Knowledge System including Vedas, Upavedas, Vedangas, and Upangas. • To develop the understanding of students regarding the relationship between modern science and the Indian Knowledge System. • To familiarize the students with the principles of yoga, holistic healthcare, and their significance in physical and mental well-being. • To make the students learn the practical relevance and applications of the Indian Knowledge System through case studies and interdisciplinary approaches.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the concepts related to the Indian Knowledge System, Vedas, Upavedas, Vedangas, Upangas, yoga, and holistic healthcare.	Level 1: Remember
CO2	Explain the structure, principles, and interdisciplinary relevance of the Indian Knowledge System in relation to modern science and healthcare practices.	Level 2: Understand
CO3	Apply the concepts of yoga, holistic healthcare, and Indian Knowledge traditions for promoting well-being and understanding their practical significance in contemporary society.	Level 3: Apply
CO4	Analyze the contributions and applications of the Indian Knowledge System in science, healthcare, education, and societal development through case studies and interdisciplinary perspectives.	Level 4: Analyze

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

Course Contents

- Basic Structure of Indian Knowledge System: Ashtadasha Vidya (Eighteen Branches of Knowledge in the Indian Knowledge System), Veda, Upaveda (Ayurveda, Dhanurveda, Gandharvaveda, Sthapatyaveda etc.), Vedanga (Shiksha, Kalpa, Nirukta, Vyakarana, Jyotisha, Chhanda), Upanga (Dharmashastra, Mimansa, Purana, Tarkashastra).
- Modern Science and Indian Knowledge System.
- Yoga and Holistic Healthcare.
- Case Studies.

Suggested Readings:

- Cultural Heritage of India – Course Materials by V. Sivaramakrishnan, Bharatiya Vidya Bhavan, Mumbai
- Modern Physics and Vedant by Swami Jitatmanand, Bharatiya Vidya Bhavan
- Holistic Science and Vedant by Swami Jitatmanand, Bharatiya Vidya Bhavan
- Tarkasangraha of Annam Bhatta by V. N. Jha (English Translation), International Chinmaya Foundation, Veliyanad, Ernakulam
- Yoga Sutra of Patanjali by Ramakrishna Mission, Kolkata
- Yoga-Darshanam with Vyasa Bhashya by G. N. Jha (English Translation), Edited by R. N. Jha, Vidyanidhi Prakashan, Delhi
- Science of Consciousness, Psychotherapy and Yoga Practices by R. N. Jha, Vidyanidhi Prakashan, Delhi
- Shodashang Hridayam by P. B. Sharma (English Translation)

Course Code	PEC-EE-316A				
Category	Professional Elective Courses				
Course Title	Power Management				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the planning, development, and resource assessment aspects of power projects and power systems. • To develop the understanding of students in project procurement, engineering practices, cost management, and maintenance strategies in the power sector. • To familiarize the students with the structure, operation, financing, and management of power utilities and power stations. • To make the students learn about risk assessment, safety regulations, environmental considerations, and regulatory frameworks governing the electricity industry.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, resources, management practices, regulatory frameworks, and safety requirements associated with power sector projects and operations.	Level 1: Remember
CO2	Discuss power project planning, procurement processes, engineering practices, utility management, risk assessment, and electricity industry regulations.	Level 2: Understand
CO3	Determine appropriate project management, resource planning, cost control, maintenance, and safety practices for power sector applications.	Level 3: Apply
CO4	Analyze and classify power sector structures, project management strategies, resource utilization methods, regulatory mechanisms, and risk management approaches based on operational requirements.	Level 4: Analyze

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

Unit-I

INTRODUCTION: Power Scenario, Power Development, Planning, Power resources, Environment Power matters Plan, Pre-feasibility and feasibility studies, State relations for Power etc.

RESOURCES: Resources, Geophysical study, Seismic Considerations, Environmental Restraints, Resettlement and Rehabilitation.

Unit-II

PROCUREMENT: Contracting and Procurement, Consulting Services, Types of Contracts, Project Management, Organization and Economy Management, Organizational Planning and Time Scheduling, Project Cost Control.

ENGINEERING: Engineering & General Layout of Equipment's, Generator, Transformer and Switch Gear and Control Equipment, Construction Methods, Operation and Maintenance Principle, Maintenance organization and planning, Availability, life cycle cost & future development. Visits to sites.

Unit-III

POWER SECTOR: Power sector structure in different states, Regulatory Regime in those states, Power utilities in Haryana, Grid management, Power financing, Visit to sites.

POWER STATION: Management of Fuel, water Resource Electricity deviating scenario storage and handling, Pricing, Contract etc., Human resource management. Visit to sites.

Unit-IV

RISK & HAZARD: Introduction to risk, rules and regulation Aspects of Risk & Hazard Health & risk assessment visit to site.

ELECTRICITY INDUSTRY STRUCTURE & SAFETY REGULATIONS BILL: State and Central Power boards / Power corporations.

Suggested Readings:

1. Electricity Bill, Safety & Conservation Act
2. Arora & Dom Kundwar, A Course in Power Plant Engineering, Pub.: Dhanpat Rai Pub, 2000.
3. Jain & Bala Subramanyam, "Power Plant Engineering", Dhanpat Rai Pub.,
4. Butter Worth, A.B. Gill, "Power Plant Performance Management", Pub: 1984.
5. P.C. Sharma, "Power Plant Engineering", Dhanpat Rai Pub.,
6. David A. Decenzo, Stephen P. Robbins, Human Resource Management. New Delhi: PHI Pvt. Ltd., 2004.
7. P.K. Nag, Power Plant Engg. N.Delhi: TMH, 2003

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction of Power scenario	https://www.youtube.com/watch?v=9qBxkyihhyg&list=PLw-dnzIV3ogoVFadTCr-N2b_TSBPEeBJdU&index=2&pp=iAQB
UNIT-II	Engineering & General Layout of Equipment's,	https://www.youtube.com/watch?v=s0xWtOLXH8&pp=vgW5ASBQT1dFUiBTRUNUT1I6IFBvd2VyIHNIY3RvciBzdHJ1Y3R1cmUgaW4gZGlm
UNIT-III	Power sector structure in different states	https://www.youtube.com/watch?v=s0xWtOLXH8&pp=vgW5ASBQT1dFUiBTRUNUT1I6IFBvd2VyIHNIY3RvciBzdHJ1Y3R1cmUgaW4gZGlm
UNIT-IV	State and Central Power boards	https://www.youtube.com/watch?v=Oiyh7J1pDgg&list=PLP0yMcMjdG7WrDGnr1EsLT1os6JvxPuGw

Course Code	PEC-EE-318A				
Category	Professional Elective Courses				
Course Title	Renewable Energy Converters				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are to • Understand the operation, control, and performance of power electronic converters used in renewable energy systems. • Develop knowledge of converter topologies, modulation techniques, and grid integration of solar, fuel cell, and wind energy systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, converter topologies, modulation techniques, control methods, and renewable energy interfaces used in power electronic conversion systems.	Level 1: Remember
CO2	Discuss the operation, performance characteristics, harmonic behavior, and control strategies of power converters used in renewable energy systems.	Level 2: Understand
CO3	Calculate the operating parameters and performance characteristics of power converters for solar photovoltaic, fuel cell, and wind energy applications.	Level 3: Apply
CO4	Analyze power converter configurations, modulation techniques, harmonic characteristics, and grid integration methods based on system requirements and performance criteria.	Level 4: Analyze

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

Unit-I

Introduction Review of 2-pulse and 6-pulse converters and their performance with inductive and capacitive loads. Harmonic analysis of single-phase and three-phase converters.

Unit-II

Power Converters for Solar PV Systems, Multi-level converters, topologies and control techniques, PWM Techniques.

Unit-III

Power Converters for Fuel Cells, Buck converter, Boost converter, interleaved buck/boost converter, advanced Modulation techniques.

Unit –IV

Power Converters in WECS Multi-channel interleaved boost converters, voltage source converters, control of grid-tied Converters, matrix converter, and modular multi-level inverters.

Suggested Readings:

1. V. Yaramasu and B. Wu, "Model Predictive Control of Wind Energy Conversion Systems," Wiley- IEEE Press, 2016.
2. Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education, 2008.
3. Lander Cyril W., "Power Electronics", Prentice Hall of India Private Limited, 2004.
4. Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India, 2008.
5. Paice D. A., "Power Electronic Converter Harmonics – Multipulse Methods for Clean Power", IEEE press, 1995.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Review of 2-pulse and 6-pulse converters	https://www.youtube.com/watch?v=OxIQhyAn9JE&list=PLbMVogVj5nJQoZqvLxx-cg_dYE_Dt2UMH&index=2&pp=iAQB
UNIT-II	Power Converters for Solar PV Systems	https://www.youtube.com/watch?v=khzMZ8VL8Q4&list=PLRQCRCvsI8vfilPpilbsLz3NB-gTMLG8f
UNIT-III	Power Converters for Fuel Cells	https://www.youtube.com/watch?v=Q7cTuZIH8IA&list=PLgwJf8NK-2e6tDV4SbRn6RzOPNXjqODO2
UNIT-IV	Power Converters in WECS Multi-channel	https://www.youtube.com/watch?v=VA0gkIIC7qw&list=PLp6ek2hDcoNAZzkG0zfABMmFNtGUI9QMB

Course Code	PEC-EE-320A				
Category	Professional Elective Courses				
Course Title	Advanced Control Systems				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with controller configurations, compensation techniques, and their role in control system performance improvement. • To develop the understanding of students in state-space modeling and representation of dynamic systems. • To familiarize the students with state feedback design, controllability, observability, and sampled-data control systems. • To make the students learn about nonlinear system characteristics and methods for stability analysis of nonlinear control systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, controller types, compensation techniques, state-space representations, sampled-data systems, and nonlinear system characteristics used in advanced control systems.	Level 1: Remember
CO2	Discuss the principles of controller design, state-space analysis, sampled-data control, and nonlinear system behavior.	Level 2: Understand
CO3	Determine controller design, state-space modeling, pole placement, and stability analysis techniques for control system applications.	Level 3: Apply
CO4	Analyze control system configurations, state-space models, sampled-data systems, and nonlinear characteristics based on stability and performance requirements.	Level 4: Analyze

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

Unit-I

Types of controllers- Feedforward-feedback-cascade-Proportional, Proportional -Integral and PID controllers.

Compensator design: Compensator design: Realization of Compensators – lag, lead and lag-lead -Design of compensator using bode plot.

Unit-II

State space analysis of systems: Introduction to state concept - state equation of linear continuous time systems, matrix representation of state equations. Phase variable and canonical forms of state representation- controllable, observable, and diagonal and Jordan canonical forms- solution of time invariant autonomous systems.

Unit-III

State feedback controller design: Controllability & observability. State feed-back design via pole placement Technique. Sampled data control system: Pulse Transfer function-Stability of sampled data system –Routh Hurwitz criterion. Introduction to state-space representation of sampled data systems.

Unit –IV

Nonlinear systems: Introduction - characteristics of nonlinear systems. Types of nonlinearities. Analysis through harmonic linearization - Determination of describing function of nonlinearities (relay, dead zone and saturation only) - application of describing function for stability analysis of autonomous system with single nonlinearity.

Suggested Readings:

1. Hassan K Khalil, Nonlinear Systems, Prentice - Hall International (UK), 2002.
2. Kuo B.C, Analysis and Synthesis of Sampled Data Systems, Prentice Hall Publications.
3. Nagarath I. J. and Gopal M., Control System Engineering, Wiley Eastern, 2008.
4. Nise N. S., Control Systems Engineering, 6/e, Wiley Eastern, 2010.
5. Ogata K., Modern Control Engineering, Prentice Hall of India, New Delhi, 2010
6. Alberto Isidori, Nonlinear Control Systems, Springer Verlag, 1995.
7. Gibson J. E., F.B. Tuteur and J. R. Ragazzini, Control System Components, Tata McGraw Hill, 2013
8. Gopal M., Control Systems Principles and Design, Tata McGraw Hill, 2008.
9. Jean-Jacques E. Slotine & Weiping Li, Applied Nonlinear Control, Prentice-Hall., NJ, 1991. C

Useful Video links

Unit No.	Topic	Link
UNIT-I	Types of Controllers	https://www.youtube.com/watch?v=39Ggoj2fQ2c&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ
UNIT-II	State space analysis of systems	https://www.youtube.com/watch?v=t_k7oRICmWo&pp=ugUHEgVlbi1VUw%3D%3D
UNIT-III	State feedback controller design	https://www.youtube.com/watch?v=OodHgOY5Rjs&pp=ygUpIFN0YXRlIGZlZWRIYWNRlGNvbnRyb2xsZXIeZGVzaWduOiAgbnB0ZWw%3D
UNIT-IV	Linearization of nonlinear systems.	https://www.youtube.com/watch?v=ozq9Qs75JQ0&pp=ygU0ICAgbnB0ZWxjaGFvYWNoZlJpc3Rpb3R5b2YgYm9ubGluZWVlIH5c3RlbXMuICBucHRlbnA%3D%3D

Course Code	PEC-EE-322A				
Category	Professional Elective Courses				
Course Title	Power Quality and FACTS Controller				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are to • To make the students familiar with power quality issues, reactive power compensation techniques. • To develop the understanding of students in the operating principles, configurations, and control strategies of FACTS devices. • To familiarize the students with voltage source converter-based controllers and their applications in power flow control. • To make the students learn about power quality improvement techniques and the use of custom power devices in distribution systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, compensation techniques, FACTS devices, power quality disturbances, and custom power devices used in modern power systems.	Level 1: Remember
CO2	Discuss the principles, operating characteristics, control strategies, and applications of FACTS and power quality improvement devices in transmission and distribution systems.	Level 2: Understand
CO3	Apply and determine reactive power compensation, voltage control, power flow control, and power quality enhancement techniques using FACTS and custom power devices.	Level 3: Apply
CO4	Analyze and classify transmission and distribution system performance, power quality issues, compensation methods, and FACTS-based solutions based on system requirements and operational characteristics.	Level 4: Analyze

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

Unit-I

Transmission Lines and Series/Shunt Reactive Power Compensation: Introduction to power quality and their issues, Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

Thyristor-based Flexible AC Transmission Controllers (FACTS): Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.

Unit-II

Voltage Source Converter based (FACTS) controllers: Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation.

STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.

Unit-III

Application of FACTS: Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Power Quality Problems in Distribution Systems: Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.

Unit –IV

DSTATCOM: Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.

Dynamic Voltage Restorer and Unified Power Quality Conditioner: Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

Suggested Readings:

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to power quality	https://www.youtube.com/watch?v=19eIVIVBrfE&list=PLp6ek2hDcoNBczPs_OoWYh4Siixdm20wQ
UNIT-II	Voltage Source Converters	https://www.youtube.com/watch?v=jsj0Vg8CTtE&pp=ygUiICAgVm9sdGFnZSBTh3VyY2UgQ29udmVydGVvYcyBucHRlbA%3D%3D
UNIT-III	Application of FACTS devices for power-flow control	https://www.youtube.com/watch?v=Ge3yPLoGb6E&list=PLLy_2iUCG87AVyRAN4QwVQrC8vSg1vWa6&index=4&pp=iAQB
UNIT-IV	Reactive Power Compensation	https://www.youtube.com/watch?v=L5orDG9TJQg&pp=ygUi5cmVhY3RpdmUgcG93ZXIgaY29tcGVuc2F0aW9uIGluIHRyYW5zbWlzc2lvaW50ZW1zIG5wdGVs

Course Code	OEC-05A				
Category	Open Elective Courses				
Course Title	Renewable Energy Resources				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are to • Introduce the fundamentals, sources, and significance of renewable and green energy systems. • Develop understanding of solar, wind, biomass, tidal, and hydrogen energy conversion technologies. • Analyze the applications, performance, and sustainability aspects of renewable energy systems for modern energy needs.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the principles, sources, and importance of renewable and green energy systems.	Level 1: Remember
CO2	Explain the working and components of solar, wind, biomass, tidal, and hydrogen energy systems.	Level 2: Understand
CO3	Apply renewable energy concepts for solar radiation, wind power, biomass conversion, and hydrogen energy applications.	Level 3: Apply
CO4	Analyze the performance, benefits, and limitations of different renewable energy technologies.	Level 4: Analyze

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

Unit-I

Introduction: Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale. Introduction to Internet of energy (IOE).

Unit-II

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements, Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind;

Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and muliblade system. Vertical axis- Savonius and darrieus types.

Unit-III

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies-fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).

Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations.

Unit –IV

Green Energy: Introduction, Fuel cells: Classification of fuel cells – H₂; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.

Suggested Readings:

1. Renewable Energy Sources and Emerging Technologies : D.P Kothari, K.C.Singla, Rakesh Ranjan- PHI Publications, 'Latest Edition'.
2. Electric Power Generation, B.R.Gupta, 'Latest Edition'.
3. Power Generation, Operation and Control, Wood and Wollenberg, John Wiley & Sons, Latest Edition.
4. A Course in Electric Power System, Soni, Gupta, Bhatnagar, Dhanpat Rai & Sons, Latest Edition
5. Power System Engineering, Nagrath & Kothari, Tata Mc-Graw Hill, New Delhi, 'Latest Edition'.
6. Power Plant Engg: G.D. Rai, 'Latest Edition'.
7. Electric Power: S.L. Uppal (Khanna Publishing), 'Latest Edition'.

Useful Video links

Unit No.	Topic	Link
UNIT-I	Introduction to Renewable Energy Engineering	https://youtu.be/mh51mAUexK4?list=PLwdnzlV3ogoXUifhvYB65ILJCZ74o_fAk
UNIT-II	Solar Radiation	https://youtu.be/Og4LEc7SpdQ?list=PLwdnzlV3ogoXUifhvYB65ILJCZ74o_fAk
UNIT-III	Classification of Bio gas plants	https://youtu.be/TUu40kDqcEc?list=PLwdnzlV3ogoXUifhvYB65ILJCZ74o_fAk
UNIT-IV	Fuel Cells	https://youtu.be/L2VSOccUrSk



**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA
(JHAJJAR)**

An Autonomous Institute

‘A’ GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations

(Under NEP-2020)

B-SCHEME

Common for Bachelor of Technology Electrical Engineering

And

Bachelor of Technology Electrical Engineering-Working Professionals

Effective from

Academic Session 2026-27 (From 2nd Year onwards)



**APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU,
ROHTAK**

5. DEFINITION OF CREDIT

1	1 Lecture (L) per week	1 Credit
2	1 Tutorial (T) per week	1 Credit
3	1 Practical (P) per week	0.5 Credit
4	2 Practical (Lab) per week	1 Credit

6. RANGE OF CREDIT

A range of credits from 160 to 170 for a student to be eligible to get Under Graduate degree in Electrical Engineering. A student will be eligible to get Under Graduate degree with Honours or additional Minor Engineering, if he/she completes an additional 18-20 credits. These could be acquired through MOOCs.

7. STRUCTURE OF UNDERGRADUATE ENGINEERING PROGRAM (B.TECH)

Sr. No.	Category	Breakup of Credits
1	Basic Science Courses	21
2	Engineering Science Courses	22
3	Professional Core Courses	71
4	Professional Elective Courses (Relevant to chosen specialization/branch)	12
5	Open Electives Courses	9
6	Humanities and Social Sciences including Management courses	12
7	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	20
8	Value Added Courses	03
9	Mandatory Non Credit Courses – Audit Course	(Non-Credit)
	Total Credits	170

8. COURSE CODE AND DEFINITIONS

Sr. No.	Category	Course Code
1	Basic Science Courses	BSC
2	Engineering Science Courses	ESC
3	Professional Core Courses	PCC
4	Professional Elective Courses (Relevant to chosen specialization/branch)	PEC
5	Indian Knowledge System	IKS
6	Multidisciplinary Open Electives Courses	OEC
7	Humanities and Social Sciences including Management courses	HSMC
8	Laboratory Courses	LC
9	Mandatory Non-Credit Courses (Audit Course)	MC
10	Project	PR
11	Internship/ Practical Training/ Seminar	INT

**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA,
JHAJJAR (HR.)**

Scheme of Studies and Examinations

Common for B.Tech (Electrical Engineering) – 3rd Semester

and

B.Tech (Electrical Engineering-Working Professionals) – 3rd Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Humanities and Social Sciences including Management courses	HSMC-02B	Economics for Engineers	3	0	0	3	3	30	45		75	3
2	Professional Core Courses	PCC-EE-201B	Analog Electronics	3	0	0	3	3	30	45		75	3
3	Professional Core Courses	PCC-EE-203B	Electric Circuit Analysis	3	1	0	4	4	40	60		100	3
4	Professional Core Courses	PCC-EE-205B	Measurement and Instrumentation	3	0	0	3	3	30	45		75	3
5	Professional Core Courses	PCC-EE-207B	Electrical Machines-I	3	0	0	3	3	30	45		75	3
6	Professional Core Courses	PCC-EE-209B	Electrical Engineering Materials	3	0	0	3	3	30	45		75	3
7	Professional Core Courses	LC-EE-211B	Analog Electronics Lab	0	0	2	2	1	10		15	25	3
8	Professional Core Courses	LC-EE-213B	Electric Circuit Analysis Lab	0	0	2	2	1	10		15	25	3
9	Engineering Science Courses	LC-EE-215B	Measurement and Instrumentation Lab	0	0	2	2	1	10		15	25	3
10	Professional Core Courses	LC-EE-217B	Electrical Machines-I Lab	0	0	2	2	1	10		15	25	3
Total Credits								23				575	

**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA,
JHAJJAR (HR.)**

Scheme of Studies and Examinations

Common for B.Tech (Electrical Engineering) – 4th Semester

and

B.Tech (Electrical Engineering-Working Professionals) – 4th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				L	T	P			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Basic Science Course	BSC-MEE-202B	Engineering Mathematics-III	3	1	0	4	4	40	60		100	3
2	Professional Core Course	PCC-EE-204B	Electrical Machines-II	3	0	0	3	3	30	45		75	3
3	Professional Core Course	PCC-EE-206B	Digital Electronics	3	0	0	3	3	30	45		75	3
4	Professional Core Course	PCC-EE-208B	Power Systems-I	3	0	0	3	3	30	45		75	3
5	Engineering Science Course	PCC-CSE-207B	Python Programming (Common with CSE 3 rd Sem)	3	0	0	3	3	30	45		75	3
6	Professional Elective Course	Refer Table-I	Professional Elective-I	3	0	0	3	3	30	45		75	3
7	Professional Core Course	LC-EE-210B	Electrical Machines-II Lab	0	0	2	2	1	10		15	25	3
8	Professional Core Course	LC-EE-212B	Digital Electronics Lab	0	0	2	2	1	10		15	25	3
9	Professional Core Course	LC-EE-214B	Power Systems-I Lab	0	0	2	2	1	10		15	25	3
10	Engineering Science Course	LC-CSE-213B	Python Programming Lab	0	0	2	2	1	10		15	25	3
11	Mandatory Courses	MC-201B	Environmental Science	2	0	0	2	0	20		30	50*	3
Total Credits								23				575	

Notes:

- I. Note-1: MC-201B 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.
- II. At the end of 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 typed report along with a certificate from the organization & its evaluation shall be carried out in the 5th Semester. For students who didn't attend practical training: If you didn't attend practical training, discuss with your Coordinator/Head of Department to explore options and create a plan to complete the requirement. Students who miss practical training due to personal or technical reasons can pursue it during session timings after classroom hours with the Head of Department's permission. The student has to undergo Practical Training of 4/6 weeks in an Industry/ Institute/ Professional Organization/ Research Laboratory/ training centre/Project/Seminar report, etc.
- III. The students under working professionals must obtain training certificate preferably from the company in which currently working.
- IV. Students should take Massive Open Online Courses (MOOCs) approved by the concerned Chairperson Board of Studies (BoS)
- V. Choose any one from Professional Elective-I

Table 1 Professional Elective – I

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

*A student can do only one course from MOOC in leu of elective courses in a semester with a approval of Head of the Department.

Course Code	HSMC-02B				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Economics for Engineers				
Scheme and Credits	L	T	P	Credits	Semester- III
	3	0	0	3	
Course Objectives	The objectives of this course are to • Introduce the basic concepts of economics and their relevance to science, engineering, and national development. • Develop a foundational understanding of microeconomic principles such as demand, supply, production, cost, and market structures. • Equip students with tools to apply economic reasoning to real-world pricing, output, and market decisions. • Familiarize students with macroeconomic elements like the Indian economy, banking system, privatization, and globalization.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

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

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

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

Unit-II

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

Unit-III

Market: Meaning of Market, Types of Market- Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly (main features).

Supply: Supply and Law of Supply, Role of Demand and Supply in Price Determination and Effect of Changes in Demand and Supply on Prices.

Unit-IV

Indian Economy: Nature and Characteristics of Indian Economy as underdeveloped, developing and mixed economy (brief and elementary introduction).

Privatization: Meaning, Merits and Demerits.

Globalization of the Indian Economy: Merits and Demerits

Banking: Concept of a Bank, Commercial Bank, Central Bank, Functions of a Bank, Difference between Commercial and Central Bank.

Suggested Readings:

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

Useful Video Links:

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

Course Code	PCC-EE-201B				
Category	Professional Core Courses				
Course Title	Analog Electronics				
Scheme and Credits	L	T	P	Credits	Semester-III
	3	0	0	3	
Course Objectives	The objectives of this course are • To understand response of BJT and MOSFET. • To develop the ability to design and implement OP-AMP-based applications. • To design oscillator and power amplifier circuits. • To impart knowledge of feedback principles and feedback topologies				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Remember the fundamentals and characteristics of semiconductor devices and analog electronic circuits.	Level 1: Remember
CO2	Understand the principles and operation of amplifiers, feedback circuits, and operational amplifiers.	Level 2: Understand
CO3	Apply the concepts of analog electronics to basic circuit analysis and electronic applications.	Level 3: Apply
CO4	Analyze the performance and behavior of analog electronic circuits and systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Semiconductor Devices: P-N Junction Diode: I-V characteristics of a diode; review of half-wave and full-wave rectifiers, Zener diodes, clamping and clipping circuits, Special Purpose Diodes: LED, Photodiode, Varactor diode, Schottky diode.

Bipolar Junction Transistors (BJT): Structure and characteristics, Common base, common collector and common emitter configuration, BJT as Switch, BJT as an amplifier, RC Coupled amplifier: Frequency response curve, Bandwidth.

MOSFET: Structure and I-V characteristics, MOSFET as a switch, MOSFET as amplifier.

Unit-II

Feedback: Concept of Feedback, Negative Feedback and Positive feedback, properties of negative feedback, Advantages and Disadvantages of Negative Feedback, the four basic feedback topologies, the series-shunt feedback amplifier, the series-series feedback amplifier, and the shunt-shunt and shunt series feedback amplifier.

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

Unit-III

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

Unit-IV

Operational Amplifier Applications: Linear and non-linear applications- Instrumentation Amplifier, voltage regulator, Active Filters, ADC and DAC, Square wave and triangular wave generator, Multivibrators.

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

Suggested Readings:

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

Useful Video Links

Unit No.	Topics	Links
Unit-I	RC Coupled Amplifiers	https://youtu.be/BSR26SU3R2U
Unit-II	Power Amplifiers	https://youtu.be/huDZjQcEBMg
Unit-III	Voltage regulators	https://youtu.be/R_QnIAEk7Go
Unit-IV	Operational Amplifier	https://youtu.be/cITA0pONnMs

Course Code	PCC-EE-203B				
Category	Professional Core Courses				
Course Title	Electric Circuit Analysis				
Scheme and Credits	L	T	P	Credits	Semester-III
	3	1	0	4	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental principles and analysis techniques of electrical circuits using network theorems and circuit laws. • To develop the understanding of students in the transient and steady-state behavior of electrical circuits under various excitation conditions. • To familiarize the students with AC circuit analysis, resonance phenomena, and transform-based methods for circuit evaluation. • To make the students learn about passive network synthesis and two-port network representations for electrical network analysis and design.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, circuit laws, network theorems, transient and steady-state parameters, synthesis methods, and two-port network representations used in electrical circuit analysis	Level 1: Remember
CO2	Discuss the behavior of electrical circuits under transient and steady-state conditions, network synthesis techniques, and two-port network characteristics.	Level 2: Understand
CO3	Determine circuit parameters, network responses, resonance conditions, transform-based solutions, and two-port network characteristics for electrical circuits.	Level 3: Apply
CO4	Classify electrical networks, transient and steady-state responses, synthesized networks, and two-port network configurations based on their characteristics and performance.	Level 4: Analyze

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

Unit-I

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

Unit-II

Transient State Analysis: Forced and free response, Time constants, Transient behavior of circuit elements under switching conditions and their representations, Solution of first and second-order

circuits, Evaluations of initial and final states in series and parallel RL, RC and RLC circuits with AC and DC excitation.

Unit-III

Steady State Analysis: Sinusoidal response of series and parallel RL, RC and RLC circuits, Power in AC circuits, Three-phase circuits, Resonance, Laplace Transform and its application in circuit analysis.

Unit-IV

Synthesis of passive networks: Hurwitz polynomials, Positive real functions, Concept of Network Synthesis, RL, RC & LC network synthesis, Network graphs.

Two Port Network: Impedance parameter, Admittance parameter, Transmission parameter, Hybrid parameter, Inverse hybrid parameter, Inverse transmission parameter, Relationship between parameter sets, Interconnection of two-port networks.

Suggested Readings

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

Useful Video Links

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

Course Code	PCC-EE-205B				
Category	Professional Core Courses				
Course Title	Measurement and Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester-III
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the fundamental principles, characteristics, and standards of electrical measurements and measuring instruments. • To develop the understanding of students in measurement errors, instrument performance, and techniques for accurate electrical measurements. • To familiarize the students with analog and digital measuring instruments, transducers, and display devices used in electrical engineering applications. • To make the students learn about bridge methods and measurement techniques for determining electrical parameters and resistances with high accuracy.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, characteristics, errors, measuring instruments, transducers, and bridge circuits used in electrical measurements.	Level 1: Remember
CO2	Explain the operating principles, performance characteristics, error sources, and measurement techniques of electrical measuring instruments and systems.	Level 2: Understand
CO3	Determine electrical quantities, instrument parameters, bridge balance conditions, and measurement results using appropriate measurement techniques.	Level 3: Apply
CO4	Classify measuring instruments, transducers, measurement errors, and bridge circuits based on their characteristics, accuracy, and application requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

Introduction: 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-II

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-III

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-IV

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

Suggested Readings:

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

Useful Video Links

Unit No.	Topic	Link
Unit-I	Sources of Errors in measurements	https://www.jove.com/v/14506/types-of-errors-detection-and-minimization
	Loading effects of instruments	https://www.electricalengineering.xyz/loading-effect-of-electrical-measurement-instruments/
Unit-II	Single phase energy meter	https://emimnit.wordpress.com/2016/10/16/single-phase-energy-meter/?utm_source=chatgpt.com
	Introduction of virtual instruments	https://www.youtube.com/watch?v=iGYOlNp6vw
Unit-III	Comparison of analog & digital techniques	https://www.youtube.com/watch?v=rkOWP9oVaXk
	Oscilloscope & its application	https://www.tek.com/en/documents/primer/oscilloscope-basics?utm_source=chatgpt.com
Unit-IV	Limitation of Wheatstone bridge	https://www.shiksha.com/online-courses/articles/learning-wheatstone-bridge-principle/?utm_source=chatgpt.com
	General balance equation, CKT diagram, phasor diagram	https://www.electrical4u.com/wheatstone-bridge-circuit-theory-and-principle/

Course Code	PCC-EE-207B				
Category	Professional Core Courses				
Course Title	Electrical Machines-I				
Scheme and Credits	L	T	P	Credits	Semester-III
	3	0	0	3	
Course Objectives	The objectives of this course are • To make the students familiar with the principles of electromagnetic induction, magnetic circuits, and the constructional features of electrical machines. • To develop the understanding of students in the operation, characteristics, testing, and performance of DC machines. • To familiarize the students with the construction, operation, equivalent circuits, testing, and performance evaluation of transformers. • To make the students learn about three-phase transformers, special transformer connections, parallel operation, and transformer performance enhancement techniques.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concept of magnetic circuits, constructional features, operating principles, characteristics, and testing methods of DC machines and transformers.	Level 1: Remember
CO2	Discuss the general laws and rules of electromagnetic induction, operation, performance characteristics, losses, testing procedures, and transformer connections used in electrical machines.	Level 2: Understand
CO3	Calculate machine and transformer parameters, performance characteristics, efficiency, voltage regulation, and operating conditions using appropriate methods.	Level 3: Apply
CO4	Analyze DC machine characteristics, transformer configurations, operating performance, testing results, and connection schemes based on application requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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.

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

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 output side; Regulation, efficiency and all-day efficiency expressions and calculations. Parallel operation.

Unit-IV

Autotransformer: Basic constructional features; Comparative study with two winding transformers. 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.

Suggested Readings:

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

Useful Video Links

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

Course code	PCC-EE-209B				
Category	Professional Core Courses				
Course title	Electrical Engineering Materials				
Scheme and Credits	L	T	P	Credits	Semester- III
	3	0	0	3	
Course Objectives:	The objectives of this course are • To develop a comprehensive understanding of the electrical and thermal conductivity properties of materials. • To explore magnetic and dielectric properties of materials and their applications. • To analyze magnetic materials and their practical utilization. • To develop an understanding of semiconductor physics for electrical and electronic applications.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skill demonstrated	RBT Level
CO1	Describe the fundamental concepts, properties, classifications, and phenomena associated with conducting, dielectric, magnetic, and semiconductor materials.	Level 1: Remember
CO2	Discuss the electrical, thermal, magnetic, and dielectric behavior of engineering materials and the factors influencing their characteristics.	Level 2: Understand
CO3	Calculate material parameters and electrical characteristics related to conduction, polarization, magnetization, and semiconductor behavior.	Level 3: Apply
CO4	Classify engineering materials based on their electrical, dielectric, magnetic, and semiconductor properties for suitable electrical applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

Dielectric Materials: Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, dielectric losses, significance of the loss tangent, frequency and

temperature dependence of the dielectric constant, dielectric properties of polymeric system, ionic conductivity in insulators, insulating materials, ferroelectricity, piezoelectricity.

Unit-III

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

Unit-IV

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

Suggested Readings

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

Useful Video Links:

Unit No.	Topic	Link
Unit-I	Expression for electrical conductivity in metals	https://www.youtube.com/watch?v=wzWJwjju9I
Unit-II	Insulating Materials	https://www.youtube.com/watch?v=-fAphSvtVKA
Unit-III	Magnetic Materials	https://www.youtube.com/watch?v=-fAphSvtVKA
Unit-IV	Semiconductor materials	https://www.youtube.com/watch?v=-5iR1H2nxvo

Course code	LC-EE-211B				
Category	Professional Core Courses				
Course title	Analog Electronics Lab				
Scheme and Credits	L	T	P	Credits	Semester-III
	0	0	2	1	
Course Objectives	The objectives of this course are to • Understand the characteristics and AC analysis of RC coupled amplifiers, oscillators, regulators and timers. • Developing Knowledge of Rectifiers, Regulators, and Power Supplies • Analyzing and Designing Amplifiers and Oscillators • Application of Operational Amplifiers and Timer Circuits in Signal Processing				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

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

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

Virtual Lab Links

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

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

Course code	LC-EE-213B				
Category	Professional Core Courses				
Course title	Electric Circuit Analysis Lab				
Scheme and Credits	L	T	P	Credits	Semester-III
	0	0	2	1	
Course Objectives	The objectives of this course are to • Enhance problem-solving abilities by verifying network theorems, Nodal and Mesh analysis techniques for systematic circuit analysis. • Analyse transient responses of RL and RC circuits and interpret their time-domain behaviour. • Learn to synthesise a network from a given network function and experimentally verify its response. • Evaluate and experimentally verify Z, Y, and T parameters of two-port networks.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

Sr. No.	Content
1	To study Nodal Analysis.
2	To study Mesh Analysis.
3	To verify Thevenin's theorem in AC circuit.
4	To verify Norton's theorem in AC circuit.
5	To verify Superposition theorem in AC circuit.
6	To verify Maximum Power Transfer Theorem in AC circuit.
7	To Study transient state response of RL and RC circuit.
8	To plot current locus diagram of RL, RC and RLC series circuit.
9	To synthesize a network of give network function and verify its response.
10	To study resonance in series and parallel AC circuits.

11	To evaluate and verify Z, Y and T parameters of a two port network.
12	To determine equivalent parameters of various interconnections of a two port network.

Virtual Lab Links

Experiment Name	Virtual Lab Link
To study Nodal Analysis.	https://pltw.multisim.com/content/rhoaBoJsuRZbvGTWpdmz3E/lab-3-kirchhoffs-laws-and-mesh-and-nodal-analysis/
To study Mesh Analysis.	https://pltw.multisim.com/content/rhoaBoJsuRZbvGTWpdmz3E/lab-3-kirchhoffs-laws-and-mesh-and-nodal-analysis/
To Study transient state response.	https://asnm-iitkgp.vlabs.ac.in/exp/transient-state-response/
To plot current locus diagram of RL, RC and RLC series circuit.	https://asnm-iitkgp.vlabs.ac.in/exp/current-locus-diagrams/
To synthesize a network of give network function and verify its response.	https://asnm-iitkgp.vlabs.ac.in/exp/network-function-synthesis/
To study resonance in circuits.	https://asnm-iitkgp.vlabs.ac.in/exp/resonance-in-circuits/
To evaluate and verify Z, Y and T parameters of a two port network.	https://asnm-iitkgp.vlabs.ac.in/exp/two-port-network/
To determine equivalent parameters of various interconnections of a two port network.	https://asnm-iitkgp.vlabs.ac.in/exp/two-port-network/

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

Course code	LC-EE-215B				
Category	Professional Core Courses				
Course title	Measurement and Instrumentation Lab				
Scheme and Credits	L	T	P	Credits	Semester-III
	0	0	2	1	
Course Objectives	The objectives of this course are to • To understand the construction, working principles, and proper connections of various electrical and electronic measuring instruments. • To develop the ability to calibrate electrical measuring instruments for accurate measurement. • To acquire practical skills in measuring electrical quantities, power, power factor, and circuit parameters using conventional and advanced methods. • To understand the application of transducers for the measurement of physical parameters and their characteristics.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

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

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

Virtual Lab Links

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

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

Course code	LC-EE-217B				
Category	Professional Core Courses				
Course title	Electrical Machines-I Lab				
Scheme and Credits	L	T	P	Credits	Semester-III
	0	0	2	1	
Course Objectives	The objectives of this course are • To understand the working of DC machines and transformers. • To perform key tests to analyze machine performance. • To develop practical skills in handling electrical equipment.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

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

Virtual Lab Links

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

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

Course Code	MC-201B				
Category	Mandatory Courses				
Course Title	Environmental Science				
Scheme and Credits	L	T	P	Credits	Semester-IV
	2	0	0	-	
Course Objectives	The objectives of this course are to • Create awareness of the multidisciplinary nature and importance of environmental studies, including the sustainable management and conservation of natural resources. • Develop an understanding of ecosystem dynamics, biodiversity, pollution types, and their impacts on environmental and human health. • Foster critical thinking on social, ethical, and legislative aspects of environmental protection, emphasizing the role of individuals and society. • Engage students in practical learning through fieldwork and case studies to apply environmental concepts for sustainable development and responsible citizenship.				
Practical/Field Visits	20 Marks				
End Semester Examination	30 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				
Remarks	The subject of Environmental Studies will be included as a qualifying paper in all UG Courses and the students will be required to qualify the same otherwise the final result will not be declared and degree will not be awarded. The duration of the course will be 40 lectures. The examination will be conducted along with the semester examinations. The marks in this qualifying paper will not be included in determining the percentage of marks obtained for the award of degree. However, these marks will be shown in the detailed marks certificate of the students.				

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

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

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I.

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

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

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

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

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

e) Land resources: Land as a source, land degradation, man induced landslides, soil erosion and desertification.

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

Unit-II

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

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

Unit-III

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

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

Disaster Management: Floods, Earthquake, Cyclone and Landslides.

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

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

Unit-IV

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

Field Work (Field work equal to 10 lecture hours)- Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain, Visit to a local polluted site-urban/Rural/Industrial/ Agricultural, Study of

common plants, insects, birds, Study of simple ecosystems-pond, river, hills, slopes, etc.

Suggested Readings:

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

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Environment Science: Introduction	https://www.youtube.com/watch?v=5QxxaVfgQ3k
	Natural Resources	https://www.youtube.com/watch?v=CXCT2R1K6Ts
	Ecosystem	https://www.youtube.com/watch?v=ldBU6HB8G6s
Unit-II	Biodiversity and its conservation	https://archive.nptel.ac.in/courses/102/104/102104068/
Unit-III	Sustainable Water Management In Urban Areas	http://digimat.in/nptel/courses/video/127106004/L29.ht
	Environmental Pollution	https://archive.nptel.ac.in/courses/123/105/123105001/
Unit-IV	Population and population growth	https://archive.nptel.ac.in/courses/102/104/102104068/
	National Family Welfare Programme	https://www.youtube.com/watch?v=X5F99L8ZEtc

Course Code	BSC-MEE-202B				
Category	Basic Science Courses				
Course Title	Engineering Mathematics-III				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	1	0	4	
Course Objectives	The objectives of this course are to • Provide fundamental knowledge of partial differential equations, numerical methods, probability, and statistical concepts relevant to engineering problems. • Make the students familiar with analytical and numerical techniques for solving differential equations and problems involving probabilistic and statistical models. • Emphasize the application of appropriate mathematical and statistical methods in the modelling, analysis, and solution of engineering problems.				
Course Pre-requisite	Mathematics up to 12 th Standard and Engineering Mathematics-I& II				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall fundamental concepts, definitions, formulae, and standard methods related to partial differential equations, probability and statistics and numerical methods.	Level 1: Remember
CO2	Explain the fundamental concepts of partial differential equations, probability distributions, statistical measures and numerical methods.	Level 2: Understand
CO3	Apply appropriate analytical, numerical and statistical methods and techniques to solve engineering problems.	Level 3: Apply
CO4	Analyze engineering problems to select suitable methods for their solution and interpret the results.	Level 4: Analyze

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

Unit-I

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

Unit-II

Numerical Methods: Solution of polynomial and transcendental equations – Bisection method, Regula-Falsi method and Newton-Raphson method, Interpolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae, Numerical integration, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.

Unit-III

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

Unit-IV

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

Suggested Readings:

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

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Definition of Partial Differential Equations.	https://www.youtube.com/watch?v=KIZqe4UC1jk
	Solution to homogenous and non-homogenous linear partial differential equations	https://www.youtube.com/watch?v=5eZbgxmpK3O&t=520s
	Initial and boundary conditions of partial differential equations of second order	https://www.youtube.com/watch?v=PvUfuiWazQ
Unit-II	Bisection method, Regula-Falsi method and Newton-Raphson method	https://www.youtube.com/watch?v=3j0c_FhOt5U&list=PLU6SqdYcYsflk1VhXxIYNPFU67vm6gae8
	Interpolation using Newton's forward and backward difference formulae, Newton's divided difference and Lagrange's formulae	https://www.youtube.com/watch?v=Y-yMOvYpltU https://www.youtube.com/watch?v=zdyUwzOm1zw https://www.youtube.com/watch?v=2h0R0Uka1HI
	Numerical integration, Trapezoidal rule and Simpson's 1/3rd and 3/8 rules	https://www.youtube.com/watch?v=EA76ONWBgK4&list=PLhSp9OSVmevJBkLSO51JEPSEIloeRiaJy
Unit-III	Basic concept of Probability, Conditional probability, Bays' theorem	https://youtu.be/60vHy2IA4e4 https://www.youtube.com/watch?v=ZFMcWe_SNvI https://www.youtube.com/watch?v=-ELHOnLwE9U
Unit-IV	Testing of Hypothesis & Levels of significance, Large Sample Test	https://aucece.digimat.in/nptel/courses/video/111105090/1.72.html
	Chi-Square Test	https://youtu.be/SICsNb-VXds?feature=shared
	Miscellaneous	https://onlinecourses.nptel.ac.in/noc22_ma81/preview

Course Code	PCC-EE-204B				
Category	Professional Core Courses				
Course Title	Electrical Machines-II				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	0	0	3	
Course Objectives	The objectives of this course are ● To understand the construction, working principles, and performance of induction machines. ● To learn the operation, characteristics, and control of synchronous machines. ● To gain basic knowledge of special machines and their industrial applications.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, constructional features, operating principles, characteristics, testing methods, and applications of induction, synchronous, and special electrical machines.	Level 1: Remember
CO2	Discuss the operation, performance characteristics, control methods, testing procedures, and applications of induction, synchronous, and special machines.	Level 2: Understand
CO3	Calculate machine parameters, performance characteristics, speed control methods, voltage regulation, and operating conditions of electrical machines.	Level 3: Apply
CO4	Classify electrical machines based on their construction, operating characteristics, performance, control techniques, and application requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

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

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

Unit-III

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

Unit-IV

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

Suggested Readings:

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

Useful Video Links

Unit No.	Topic	Link
Unit-I	Poly-phase Induction Motor	https://youtu.be/leXNHZM-CZE
	Speed and Slip	https://youtu.be/DANGZvHOgj0
Unit-II	Single Phase Induction motors	https://youtu.be/KPMY_L7oyOk
	Equivalent circuit of 1 phase I.M	https://youtu.be/h8386o98deY
Unit-III	Construction of synchronous machine	https://youtu.be/D-uPPjFBKDI
	Armature reaction and synchronous reactance	https://youtu.be/FCKx-1xR4To
Unit-IV	Synchronous motor operation, phasor diagram	https://youtu.be/edJFTap0zYw
	Phasor diagram of salient pole synchronous motor under various conditions	https://youtu.be/hx_QAyjgrNM

Course Code	PCC-EE-206B				
Category	Professional Core Courses				
Course Title	Digital Electronics				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To learn the fundamentals of logic simplification using logic gates, Boolean algebra, De Morgan’s theorem, and canonical forms (SOP & POS) • To understand mastering number systems, complements, and operations on complement numbers, along with techniques like Karnaugh Maps (up to 6 variables) and the Quine-McCluskey (QM) method for systematic logic reduction • To Design and Analyze Combinational Logic Circuits and Implement Sequential Logic Systems • To Explore Data Conversion Techniques and Programmable Logic Devices				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, logic functions, combinational and sequential circuit elements, data converters, and programmable logic devices used in digital systems.	Level 1: Remember
CO2	Discuss the operation, design principles, and functional characteristics of digital logic circuits, data converters, and programmable logic devices.	Level 2: Understand
CO3	Apply logic simplification, combinational circuit design, sequential circuit design, and data conversion techniques for digital system applications.	Level 3: Apply
CO4	Analyze digital circuits, sequential systems, data converters, and programmable logic devices based on their characteristics, performance, and application requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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.

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

Unit-III

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

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.

Suggested Readings

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

Useful Video Links

Unit No.	Topics	Links
Unit-I	Boolean Algebra	https://www.youtube.com/shorts/xtAYbY_Pz7I
Unit-II	Multiplexer	Introduction to Multiplexer What are Multiplexers Digital Electronics
	Combinational Circuits	https://www.youtube.com/watch?v=fXrbYMDDevDU
Unit-III	Sequential Circuits	https://www.youtube.com/watch?v=S0mKCNLmCh4&list=PLgwJf8NK-2e4mEQv0ttgW-am4wiqrpdX
	Counter	https://www.youtube.com/watch?v=NTCrCYPoA5A&list=PLgwJf8NK-2e6lcDg0NxW-_yO6Bl5dPBp8
Unit-IV	Finite state machines	https://www.youtube.com/watch?v=LOZxYBOKRLg

Course Code	PCC-EE-208B				
Category	Professional Core Courses				
Course Title	Power Systems-I				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To provide knowledge of the evolution, structure, and components of modern power systems, including substations, bulk grids, micro-grids, and AC/DC distribution systems. • To develop the ability to calculate line parameters, analyze transmission line models, voltage regulation, reactive power compensation, and evaluate distribution system performance. • To understand sag and stress analysis, effects of environmental conditions, and insulation design for reliable and safe power transmission. • To study cable types, corona effects, and HVDC transmission technology for efficient and advanced power delivery.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, components, parameters, transmission systems, distribution systems, insulation systems, cables, and HVDC technologies used in power systems.	Level 1: Remember
CO2	Discuss the structure, operation, performance characteristics, mechanical design aspects, insulation requirements, and transmission technologies of power systems.	Level 2: Understand
CO3	Calculate transmission line parameters, performance indices, sag and stress values, cable characteristics, and voltage control measures for power system applications.	Level 3: Apply
CO4	Analyze power system components, transmission and distribution configurations, insulation systems, cable technologies, and HVDC transmission schemes based on operational and performance requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

INTRODUCTION: Evolution 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.

Unit-II

CALCULATION OF TRANSMISSION LINE PARAMETER: Inductance of line: Definition, Inductance of 1- ϕ two-wire line, Inductance of composite conductor line, Inductance of 3- ϕ single line, Inductance of 3- ϕ double line, and Proximity effect. Resistance of line and Skin effect.

Capacitance of line: Definition, Capacitance of 1- ϕ two-wire line, Capacitance of 3- ϕ 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.

Unit-III

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.

Unit-IV

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.

Suggested Readings

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

Useful Video Links

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

Course Code	PCC-CSE-207B				
Category	Engineering Science Courses				
Course Title	Python Programming				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce Python programming basics, including syntax, data types, and control structures. • To develop skills in Python data structures, functions, and recursion. • To explore Python's graphical programming, image processing, and GUI development. • To explain object-oriented programming, exception handling, and multithreading concepts.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skill Demonstrated	RBT Level
CO1	Define key terminology of Python syntax, data types, control structures, data structures, libraries, and GUI tools.	Level 1: Remember
CO2	Explain the functionality of Python programming constructs, data handling techniques, and graphical modules.	Level 2: Understand
CO3	Use Python programs for data processing, file handling, numerical computing, graphics, and GUI applications.	Level 3: Apply
CO4	Analyze Python programming constructs, data structures, libraries, graphics, image processing, and GUI techniques to solve real-world problems effectively.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

Lists, Tuple, dictionary and Design with functions: Basic list operators, replacing, inserting, removing an element; searching and sorting lists; Tuple: creating tuples, accessing elements, tuple immutability, operations, tuple methods, tuples vs. lists; dictionary literals, adding, and removing keys, accessing and replacing values;

traversing dictionaries. Hiding redundancy, complexity; arguments and return values; Program structure and design. Recursive functions.

Unit-III

Introduction to NumPy: NumPy arrays, Array Indexing and Slicing, Array Operations, Array Manipulation, Linear Algebra with NumPy, Random Number Generation and Statistics.

Introduction to Pandas: Pandas Series, Pandas Data Frames, Data Frame Indexing and Selection, Data Cleaning and Preprocessing, Data Manipulation, Group by Operations, Merging, Joining, and Concatenating Data Frames, Input/Output Operations.

Unit-IV

Simple graphics and image processing: Simple graphics, Turtle operations, manipulating turtle screen, drawing two dimensional shapes, examining an object attribute, taking a random walk, Color and RGB scheme, Image processing: Image manipulation operations, properties of images, image module, copying, blurring and reducing image.

Graphical User Interfaces using Tkinter: Terminal based and GUI based programs, Introduction to Tkinter, Simple GUI-Based Programs, Windows and Window Components, Input and Output with Entry Fields, Defining and Using Instance Variables, Other Useful GUI Resources.

Suggested Readings:

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

Useful Video Links

Unit No.	Topic	Link
Unit-I	Variables and Input Statement	https://youtu.be/ruQb8jzkGyQ
Unit-II	List operators	https://youtu.be/jMSHsdechMI
Unit-III	Graphical User Interfaces using Tkinter	https://youtu.be/-GhzipvIXIM?list=PLS1QulWo1RIY6fmY_iTjEhCMsdtAjbZM
Unit-IV	Fundamentals of Object Oriented Programming	https://youtu.be/K3g4srbkUNM?list=PLLy_2iUCG87Ah844iZW3w3nzWSTA8KSZA

Course code	LC-EE-210B				
Category	Professional Core Courses				
Course title	Electrical Machines-II Lab				
Scheme and Credits	L	T	P	Credits	Semester-IV
	0	0	2	1	
Course Objectives	The objectives of this course are • To study performance and circuits of induction and synchronous motors. • To explore speed control and voltage effects on motor performance. • To understand voltage regulation and load-sharing in generators. • To learn alternator synchronization and fault analysis techniques.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

Sr. No.	Contents
1	To perform the open circuit test and block rotor test on 3 phase induction motor and draw the circle diagram
2	To perform the speed control of an induction motor by rotor resistance control.
3	To conduct the load test to determine the performance characteristics of the I.M.
4	To compute the torque v/s speed characteristics for 3-phase induction motor.
5	To perform the open circuit test and blocked rotor test on a single-phase induction motor and determine equivalent circuit parameters
6	To perform O.C. test on synchronous generator and determine the full load regulation of a three phase synchronous generator by impedance method.
7	To perform and Measure Synchronous Impedance and Short Circuit Ratio of Synchronous Generator.

8	Study of Power (Load) sharing between two Three Phase alternators in parallel operation Condition.
9	To plot V- Curve of synchronous motor.
10	Synchronization of two Three Phase Alternators by a) Synchro scope Method b) Three dark lamp Method c) Two bright one dark lamp Method.
11	Determination of sequence impedances of synchronous machine for various stator voltages.

Virtual Lab Links

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

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

Course code	LC-EE-212B				
Category	Professional Core Courses				
Course title	Digital Electronics Lab				
Scheme and Credits	L	T	P	Credits	Semester-IV
	0	0	2	1	
Course Objectives	The objectives of this course are to • Understand digital logic fundamentals by studying basic and universal gates and minimising Boolean functions using K-map. • Analyse and design combinational circuits such as adders, subtractors, multiplexers, and demultiplexers. • Design and verify sequential circuits including flip-flops, counters, and sequence detectors. • Gain practical knowledge of data conversion through the design and verification of ADC and DAC.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Understand and demonstrate the working of basic logic gates and realize logic functions using universal gates.	Level 2: Understand
CO2	Analyze and simplify logic expressions up to five and six variables using the Karnaugh Map (K-Map) method for optimal circuit design.	Level 4: Analyze
CO3	Implement and validate the truth tables of S-R, J-K, T, and D type flip-flops to understand sequential circuit fundamentals.	Level 5: Evaluate
CO4	Design and test data conversion circuits, such as ADC and DAC for digital-analogue interfacing and 3-bit synchronous counters, synchronous UP/DOWN decade counters using JK flip-flops, and asynchronous counters.	Level 6: Create

List of Experiments

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

11	To design and implement a circuit to detect a count sequence.
12	To design & verify operation of ADC & DAC.

Virtual Lab Links

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

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

Course code	LC-EE-214B				
Category	Professional Core Courses				
Course title	Power Systems-1 Lab				
Scheme and Credits	L	T	P	Credits	Semester- IV
	0	0	2	1	
Course Objectives	The objectives of this course are • To enable the design and performance evaluation of transmission and distribution systems. • To enhance understanding of transmission line phenomena. • To develop proficiency in modeling and analyzing power system components using MATLAB. • To analyze and compare the performance of distribution systems under various configurations.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

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

Virtual Lab Links

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

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

Course code	LC-CSE-213B				
Category	Engineering Science Course (Lab Course)				
Course title	Python Programming Lab				
Scheme and Credits	L	T	P	Credits	Semester-IV
	0	0	2	1	
Course Objectives	The objectives of this course are • To introduce students to the basic syntax, data types, control structures, and functions in Python programming. • To enable students to implement mathematical, searching, and sorting algorithms using Python programming constructs. • To provide hands-on experience with file handling, object-oriented programming, and Python libraries such as Turtle, OpenCV, and Tkinter. • To develop students’ ability to analyze algorithmic logic, debug programs, and optimize solutions using Python.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

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

List of Experiments

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

14	Create a GUI based login page in Python language.
15	Write a program to implement inheritance in Python.

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

Course Code	PEC-EE-216B				
Category	Professional Elective Courses				
Course Title	Wind and Solar Energy Systems				
Scheme and Credits	L	T	P	Credits	Semester- IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce the fundamentals of wind energy, including wind characteristics, energy conversion principles, turbine classification, and system components. • To understand modern wind turbine technologies and the characteristics of various electrical generators used in wind energy systems, such as induction and synchronous generators. • To provide knowledge of solar thermal energy systems, including solar radiation measurement, collector types, orientation, and thermal performance analysis for practical applications. • To familiarise students with solar photovoltaic technology, covering solar cell fundamentals, types, performance evaluation, and Maximum Power Point Tracking (MPPT) for efficient PV system design.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, components, technologies, characteristics, and performance parameters associated with wind and solar energy systems.	Level 1: Remember
CO2	Discuss the principles of wind energy conversion, wind turbine operation, solar thermal systems, photovoltaic energy conversion, and MPPT techniques.	Level 2: Understand
CO3	Apply energy conversion parameters, solar radiation quantities, wind turbine performance indices, and photovoltaic system characteristics for renewable energy applications.	Level 3: Apply
CO4	Analyze wind energy systems, wind turbine generators, solar thermal collectors, photovoltaic technologies, and energy conversion methods based on their characteristics and performance requirements.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

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

Unit-III

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

Unit-IV

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

Suggestions Redding:

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

Useful Video Links

Unit No.	Topic	Link
Unit-I	Power Generation from Wind Energy	https://youtu.be/k7LX0a67V8A
Unit-II	Turbine Terms	https://youtu.be/z7HV-ixAjs4
Unit-III	Solar Radiation	https://youtu.be/Og4LEc7SpdQ
Unit-IV	Solar Collectors	https://youtu.be/_co3m8nVUg

Course Code	PEC-EE-218B				
Category	Professional Elective Courses				
Course Title	Electromagnetic Fields Theory				
Scheme and Credits	L	T	P	Credits	Semester- IV
	3	0	0	3	
Course Objectives	The objectives of this course are to • Familiarize yourself with various coordinate systems and electromagnetic vector fields. • Impart knowledge on the concepts of electrostatic, magneto static and electrodynamic Fields. • Disseminate concepts related to electromagnetic waves, Waveguides and applications of electromagnetic fields. • Understand transmission line equation and wave propagation in different medium.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, vector operations, field quantities, electromagnetic laws, wave parameters, and Maxwell's equations used in electromagnetic field theory.	Level 1: Remember
CO2	Discuss the behavior of electrostatic, magnetostatic, and time-varying electromagnetic fields, including field interactions and wave propagation phenomena.	Level 2: Understand
CO3	Apply electromagnetic field quantities, potentials, forces, energies, and wave propagation parameters using appropriate field equations and theorems.	Level 3: Apply
CO4	Analyze electromagnetic field distributions, boundary conditions, material responses, and wave propagation characteristics based on their physical and mathematical properties.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

Electrostatic Fields: Overview of electrostatic field, Coulomb's Law and field intensity. Electric fields due to point charge, continuous charge distributions like line charge, surface charge and volume charge distributions.

Electric flux density, Gauss's Law, Electric potential, Relationship between E and V - Maxwell's equation. Scalar potential. Electric Dipole, Electric field intensity due to electric dipole. Electric flux lines. Properties of Electric flux lines due to point charge and dipole. Energy density in Electrostatic field.

Convection and Conduction currents and current densities. Conductors, Point form of Ohm's law, Continuity equation of current and Relaxation time. Electrostatic Boundary conditions, Poisson's and Laplace's equations.

Unit-III

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

Unit-IV

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

Suggestions Redding

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

Useful Video Links

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

Course Code	PEC-EE-220B				
Category	Professional Elective Courses				
Course Title	Special Electrical Machines				
Scheme and Credits	L	T	P	Credits	Semester- IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To learn the fundamental principles, constructional features, and performance characteristics of poly-phase and single-phase AC machines, including induction motors, commutator motors, servo motors, and synchronous motors. • To impart knowledge of advanced control techniques for efficient machine operation. • To familiarize students with special-purpose electrical machines and their applications. • To prepare students for industrial and research-oriented applications in modern electrical drives.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall the knowledge of advanced control techniques for efficient machine operation.	Level 1: Remember
CO2	Explain the construction, operating principles, and performance characteristics of various poly-phase and single-phase AC machines	Level 2: Understand
CO3	Apply different control techniques for achieving constant torque and constant power operation in induction motors.	Level 3: Apply
CO4	Analyze performance and characteristics of special-purpose machines for specific industrial and automation applications.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

Unit-II

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

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

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

Unit-III

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

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

Unit-IV

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

Suggestions Redding:

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

Useful Video Links

Unit No.	Topic	Link
Unit-I	Static Slip power Recovery	https://youtu.be/6DctdwIDKhc
Unit-II	Single phase Induction Motor	https://youtu.be/trlmCvmUybk
Unit-III	Variable Reluctance Motor	https://youtu.be/1liY6YIPHck
Unit-IV	Permanent Magnet Machines	https://youtu.be/dGvSJ25bor4

Course Code	PEC-EE-224B				
Category	Professional Elective Courses				
Course Title	High Voltage Engineering				
Scheme and Credits	L	T	P	Credits	Semester- IV
	3	0	0	3	
Course Objectives	The objectives of this course are • To develop a fundamental understanding of conduction and breakdown mechanisms in different dielectric media. • To impart knowledge of generation and measurement techniques for high voltages and currents. • To impart knowledge of generation and measurement techniques for high voltages and currents. • To familiarise students with high-voltage testing procedures for various electrical apparatus.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, breakdown mechanisms, high-voltage generation methods, measurement techniques, insulation coordination principles, and testing procedures used in high-voltage engineering.	Level 1: Remember
CO2	Discuss the conduction and breakdown phenomena in dielectric materials, high-voltage generation and measurement techniques, overvoltage effects, and insulation coordination practices.	Level 2: Understand
CO3	Determine appropriate methods for high-voltage generation, measurement, insulation assessment, non-destructive testing, and testing of electrical apparatus.	Level 3: Apply
CO4	Analyze dielectric breakdown processes, overvoltage conditions, insulation performance, testing methods, and high-voltage equipment characteristics based on operational requirements and performance criteria.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (preferably 1 from each Unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each Unit. The students have to attempt five questions in total, first being compulsory and selecting one from each Unit.

Unit-I

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

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

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

Unit-II

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

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

Unit-III

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

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

Unit-IV

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

Suggestions Redding

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

Useful Video Links

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



**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA
(JHAJJAR)**

An Autonomous Institute

‘A’ GRADE ACCREDITED BY NAAC

Evaluation Scheme & Syllabus

Under NEP-2020 (B-Scheme)

For

Minor/Honors (Hons.)/Specialization Degree

in

Electric Vehicles

(Effective from the Session: 2026-27)



**APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU,
ROHTAK**

**GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA,
JHAJJAR (HR.)**

Scheme of Studies and Examination

Minor in Electric Vehicles

w.e.f. 2026-27

Sr. No.	Semester	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Scheme (Marks)				Exam Duration in (hr.)
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	III	MEEEV201B	Fundamentals of Electric Vehicles	3	0	0	3	3	30	45		75	3
2	IV	MEEEV202B	Introduction to Electric and Hybrid Vehicles	3	1	0	4	4	40	60		100	3
3	V	MEEEV301B	Battery Cell Technology for EV	3	0	0	3	3	30	45		75	3
4	VI	MEEEV302B	Electric Vehicle Dynamics and Electric Motor Drives	3	0	0	3	3	30	45		75	3
5	VII	MEEEV401B	Charging Infrastructure	3	0	0	3	3	30	45		75	3
6	III	MEEEV203B	Fundamentals of Electric Vehicles Lab	0	0	2	2	1	10		15	25	3
7	VI	MEEEV304B	Power Electronics and Drives for EVs Lab	0	0	2	2	1	10		15	25	3
8	VII	MEEEV403B	Project	0	0	4	4	2	20		30	50	3
Total Credits								20				500	

Note: To earn the required credits for the award of B.Tech Minor/Honors (Hons.)/Specialization Degree, students may choose either:

- (i) To enroll in courses offered through NPTEL/MOOCs that must be equivalent to the prescribed courses in the approved scheme, subject to availability in any semester.

OR

- (ii) To complete the prescribed courses in the same semester as offered by the department under the approved scheme and curriculum structure.

Course Code	MEEEV201B				
Category	Professional Core Courses				
Course Title	Fundamentals of Electric Vehicles				
Scheme and Credits	L	T	P	Credits	Semester-III
	3	0	0	3	
Course Objectives	The objectives of this course are: • To understand the basics, components, and classification of Electric and Hybrid Vehicles and their comparison with ICE vehicles. • To learn vehicle fundamentals, performance, transmission, and braking systems for EVs and HEVs. • To gain knowledge of electric motors, their characteristics, and power electronic converters used in EVs • To analyse hybrid architectures and perform powertrain sizing for EVs and HEVs.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall basic concepts, components, classifications, and history of Electric and Hybrid Electric Vehicles.	Level 1: Remember
CO2	Explain vehicle resistances, performance parameters, EV/HEV layouts, architectures, motors, and converter operations.	Level 2: Understand
CO3	Apply formulas to compute tractive effort, torque, braking performance, and size EV/HEV powertrain components.	Level 3: Apply
CO4	Analyze and compare EV and HEV technologies, motor characteristics, and powertrain architectures to evaluate performance.	Level 4: Analyse

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 9 marks each will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit.

Unit-I

Electric Vehicles: History, Basics of Electric Vehicles, Components of Electric Vehicles, General Layout of EV, EV classification & Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs.

Unit-II

Vehicle Fundamentals: Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag, vehicle performance, calculating the Acceleration Force, maximum speed, finding the Total Tractive Effort, Torque required on the Drive Wheel, Transmission: Differential, clutch & gearbox, Braking performance.

Hybrid Electric Vehicles: History, Components of Hybrid Electric Vehicle, General Layout of Hybrid EV, Comparison with Electric Vehicles, Advantages & Disadvantages of Hybrid EV.

Unit-III

Vehicle Architecture & Design: Hybrids Based on Architecture, Hybrids Based on Transmission Assembly, Hybrids Based on Degree of Hybridisation. Power Train Component Sizing: EV Powertrain sizing, HEV Powertrain Sizing, HEV Powertrain Sizing Example.

Unit-IV

Motors and Converters: Principle and working of DC Motor, Characteristics & Types of DC Motors- Overview, Speed Torque characteristics of Permanent magnet Motor, BLDC Motor, and Induction motor, Comparison of all motors. Introduction of DC-DC, AC-AC, AC-DC, DC-AC converters, four-quadrant operation, Driver circuits.

Suggested Readings:

- Electric Vehicle Technology Explained by John Lowry and James Larminie, Wiley.
- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, External, and Design by Mehrdad Ehsani and Yimin Gao, CRC Press.
- Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Hussain, CRC Press.
- Build Your Own Electric Vehicle by Seth Leitman and Bob Brant, McGraw Hill.
- Introduction to Hybrid Vehicle System Modeling and Control by Wei Liu.
- Electric and Hybrid Electric Vehicles by I.Husain ,CRC Press 2003, second edition.

Useful Video links:

Unit No.	Topics	Links
Unit-I	Basics of Electric Vehicles	https://nptel.ac.in/courses/108106170
	Components of an Electric Vehicle	https://nptel.ac.in/courses/108106170
Unit-II	Hybrid Electric Vehicles	https://youtu.be/_xM7X8k9g0s
Unit-III	Power Train Component Sizing	https://youtu.be/61VupMVdIK8
Unit-IV	Principle and working of DC Motor	https://youtu.be/NiHPu5PltCY
	BLDC Motor	https://youtu.be/EcXIxF-4Ws?list=PLJpKI3Fm4KzzxxDzhkObVrU_jaL1cm4u_

Course Code	MEEEV202B				
Category	Professional Core Courses				
Course Title	Introduction to Electric and Hybrid Vehicles				
Scheme and Credits	L	T	P	Credits	Semester-IV
	3	1	0	4	
Course Objectives	The objectives of this course are: • To understand the evolution of transportation, fundamentals of EVs, and their environmental, social, and economic impacts. • To study configurations and operating principles of EVs, HEVs, PHEVs, and fuel cell vehicles. • To gain knowledge of EV propulsion systems, motors, power electronics, control, and charging technologies.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall basic concepts of EVs, HEVs, ICE vehicles, components, charging systems, and policies.	Level 1: Remember
CO2	Explain the working principles of EV propulsion, energy storage, motors, power electronics, and technology comparisons.	Level 2: Understand
CO3	Apply EV system concepts to select suitable configurations, motors, batteries, and charging methods.	Level 3: Apply
CO4	Analyze EV systems, infrastructure, thermal management, safety, policies, and future mobility trends.	Level 4: Analyze

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

Unit-I

Introduction to Electric Vehicles, History & Impact: History of Transportation, History and Resurgence of Vehicular Electrification, Challenges and Way Forward for EVs, Environmental, Social, and Economic Impact of EV Adoption.

Vehicle Dynamics and Internal Combustion Engine (ICE) Basics: Vehicle Dynamics – I, Vehicle Dynamics – II, Overview, Operation and Characteristics of ICE Vehicles, Comparison of ICE Vehicles and Electric Vehicles.

Unit-II

Electric Vehicles & Hybrid Electric Vehicle (HEV) Configuration: Basics of Electric Vehicles, Hybrid EV Configuration and Operation – I, Hybrid EV Configuration and Operation – II, Hybrid EV Configuration and Operation – III.

Plug-in HEV, Fuel Cell Vehicles & Technology Comparison: Plug-in Hybrid Electric Vehicle (PHEV) and Operation, Fundamentals of Hydrogen Fuel Cell Vehicle (FCV), Power Management Techniques, Comparison of EV, HEV, PHEV, and FCV Technologies.

Unit-III

EV Propulsion Systems Motors, Control and Charging Technologies: Electric Propulsion System Structure and Components, Power Electronics Converters in EV Powertrains, Electronic Control Unit (ECU) in EV & HEVs, Ultracapacitors, Flywheels and Fuel Cell Technology. Induction Motor, PMSM, BLDC and SRM Motors – Principles & Control, EV Charging Infrastructure in India, Types of EV Charging, Architecture and Working of EV Charging Systems, Operation and Control of EV Charging Systems, AC-DC Converters with PFC, DC-DC Converters, RES Integration for EV Charging, Wireless EV Charging Systems.

Unit-IV

Thermal Management & Safety in EVs: EV Thermal Management Guidelines, Battery Thermal Management, Thermal Management of Motors and Power Converters, Safety Standards in EVs, Battery Recycling Guidelines.

Policies, Standards & Future Trends in EV Infrastructure: Policies and Economics for Grid Integration of EV Charging, Charging Specifications & Standards in EV Industry, Business Models and Economics of Vehicular Electrification, Role of Artificial Intelligence (AI) in EV Systems, Concept of Vehicle-to-Everything (V2X) and Smart Mobility.

Suggested Readings:

- Modern Electric Vehicle Technology, by C.C. Chan and K.T. Chau, Oxford University Press.
- Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, by Ehsani, M., Gao, Y., Longo, S., and Ebrahimi, K., CRC Press, 2018.
- Electric and Hybrid Vehicles: Design Fundamentals, by Iqbal Husain, Third Edition, CRC Press, 2021.
- Electric Propulsion System for Electric Vehicular Technology: A Review, by Kumar, Lalit, and Shailendra Jain, Renewable and Sustainable Energy Reviews 29 (2014): 924-940.

Useful Video links:

Unit No.	Topics	Links
Unit-I	Introduction to Electric Vehicles	https://youtu.be/gDOnBwjF55U?list=PLZnygY81tHUy_zqioA7oXed6qsztizMH8c
	Vehicle Dynamics	https://nptel.ac.in/courses/107106080
	Impact of EV Adoption	https://youtu.be/tBMHJ-6Wflk
Unit-II	Basics of Electric Vehicles	https://youtu.be/3E1SXG7VkJk?list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr
Unit-III	DC-DC Converters with control for EV Charging	https://youtu.be/ZWv2AGLiXqQ
Unit-IV	Battery Thermal Management	https://youtu.be/Y5NOQWTqJIo

Course Code	MEEEV301B				
Category	Professional Core Courses				
Course Title	Battery Cell Technology for EV				
Scheme and Credits	L	T	P	Credits	Semester- V
	3	0	0	3	
Course Objectives	The objectives of this course are: • To understand the principles of electrochemical energy storage by studying battery fundamentals. • To analyze battery materials, energy storage mechanisms, and degradation phenomena in lithium-ion and emerging battery technologies. • To study battery materials, energy storage mechanisms, and degradation. • To develop knowledge of cell engineering, electrochemical characterization techniques, battery management systems, and integration of batteries into electric vehicles				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall electrochemical cell fundamentals, kinetics concepts, battery materials, and basic cell engineering principles.	Level 1: Remember
CO2	Explain thermodynamics, overpotentials, energy storage mechanisms, electrochemical techniques, and battery performance in EVs.	Level 2: Understand
CO3	Apply electrochemical equations, kinetic models, material concepts, and diagnostic techniques to analyze battery behavior and safety.	Level 3: Apply
CO4	Analyze cell design, degradation, modelling, BMS integration, and EV adoption challenges using electrochemical and engineering principles.	Level 4: Analyse

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 9 marks each will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit.

Unit-I

Electrochemical Cell Fundamentals: Electrochemical cells: conversion of reaction rate to current density, conversion of potential to Gibbs free energy, Faraday constant (C and Ah), non-faradaic current and capacitor behavior, metal–solution interface, galvanic potential. Electrochemical series, galvanic and electrolytic cells, Nernst equation. Basic definition of cells, anatomy of a cell, internal processes, cell materials and chemistry.

Unit-II

Kinetics, Voltage Losses & Battery Performance: Voltage losses and kinetics: overpotential (activation, ohmic, concentration), Butler–Volmer kinetics, Tafel kinetics, Faraday’s laws, coulombic efficiency. Cells in vehicles and battery metrics, cell power and C-rate (fast charging), battery performance challenges, battery life and degradation, battery safety and thermal runaway.

Unit-III

Battery Materials & Energy Storage Mechanisms: Primary and secondary batteries, Li/Li-ion batteries, Na-ion battery materials. Anode and cathode materials, non-aqueous electrolytes, solid electrolyte interface (SEI), cathode electrolyte interface (CEI). Energy storage mechanisms (intercalation, conversion, alloying), irreversible capacity loss, theoretical capacity, volume strain, zero-strain materials, solid-state and superionic conductors.

Unit-IV

Cell Engineering, Characterization & EV Integration: Cell requirements and specifications, cell technology roadmap (current, near-term, long-term), cell manufacturing process, design and sizing, cell cost. Cell modelling and diagnostics. Electrochemical techniques: cyclic voltammetry, chronoamperometry, chronopotentiometry, differential pulse voltammetry, galvanostatic charge–discharge, dQ/dV analysis, impedance spectroscopy, GITT, symmetric cell analysis, Li^+ transport number. Battery pack design, internal management, BMS, battery reuse and recycling, EV adoption in India: challenges and recommendations.

Suggested Readings:

- Electric and Hybrid Vehicles: Design Fundamentals by Iqbal Hussain, CRC Press, 2003.
- Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, External and Applications by Mchrdad Ehsani, Yimi Gao, Sebastian E.gay and Ali Emadi, CRC Press, 2004.
- Electric Vehicles Technology Explained by James Larminie, John Lowry, Wiley Publications, 2013.
- Super capacitors- materials, Systems and Applications by F. Beguin and E. Frackowiak, Wiley-VCH Verlag GmbH & Company, 2013.
- Fuel Cells and Hydrogens: From Fundamentals to Applied Research by V. Hacker, S.Mitsushima, Elsevier, 2018.
- Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, By John G. Hayes and G. Abas Goodarzi, Wiley Publication.

Useful Video Links:

Unit No.	Topics	Links
Unit-I	Electrochemical Cell Fundamentals	https://youtu.be/9Z-FrvcPa-E?si=RCRgvDFnaVwjCtSo
Unit-II	Kinetics, Voltage Losses & Battery Performance	https://youtu.be/Eb7pv0oOf_k?si=e7LZtnTDyRTBzjcl https://youtu.be/62363H_I_Qk?si=josMfPpSDNBK_lat
Unit-III	Battery Materials & Energy Storage Mechanisms	https://youtu.be/no4vRKvKxcU?si=5odxvOC0iEQr13Go
Unit-IV	Cell Engineering, Characterization & EV Integration	https://www.youtube.com/live/tU8YKLKPMMA?si=iKFoxaEo_0E4fveh

Course Code	MEEEV302B				
Category	Professional Core Courses				
Course Title	Electric Vehicle Dynamics and Electric Motor Drives				
Scheme and Credits	L	T	P	Credits	Semester-VI
	3	0	0	3	
Course Objectives	The objectives of this course are • To introduce the fundamentals of electric vehicles and develop an understanding of vehicle dynamics and traction requirements. • To impart knowledge of electric motor drive systems, including DC and induction motor drives, used in electric vehicle applications. • To develop competency in modelling and control of advanced motor drives such as PMSM, IM vector control, and switched reluctance motor drives. • To enable analysis and evaluation of power electronic converters and motor drive architectures through practical case studies of modern electric vehicles.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Identify fundamentals of electric vehicles, vehicle dynamics, motor drives, and power electronic converters.	Level 1: Remember
CO2	Explain vehicle dynamic modelling, operating principles of DC, induction, PMSM, BLDC and SRM drives, and control concepts.	Level 2: Understand
CO3	Apply modelling and control techniques for vehicle dynamics, motor drives, vector control, and PWM converters in EV systems.	Level 3: Apply
CO4	Analyze and compare EV drive systems, motor control strategies, converter topologies, and real-world EV case studies.	Level 4: Analyse

Note: The examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 9 marks each will be set by taking two questions from each unit. The students have to attempt five questions in total, with the first being compulsory and selecting one from each unit.

Unit-I

Introduction to Electric Vehicles and Vehicle Dynamics: Introduction to electric vehicles and classification of Evs, Components and architecture of electric vehicles, Fundamentals of vehicle dynamics, Forces acting on electric vehicles, Longitudinal vehicle dynamics modelling, Tractive effort, rolling resistance, aerodynamic drag and gradient resistance, Basics of vehicle dynamics simulation for electric vehicles.

Unit-II

DC Drives and Induction Motor Drives for Electric Vehicles: Fundamentals of electric drives and power electronics for electric vehicle applications, DC motor characteristics and applications in Evs, Modelling and control of DC motor drives, Basics of induction motors. Mathematical modelling of induction motor, V/f control technique for induction motor drives, Power electronic converters and PWM techniques for induction motor drives.

Unit-III

PMSM Drives and Vector Control Techniques: Introduction to Permanent Magnet Synchronous Motors for EV applications. Modelling of PMSM drives. Mathematical modelling of general cylindrical rotor machines in a stationary reference frame. Concept of rotating reference frames. Modelling of PMSM in rotor flux-oriented reference frame. Vector control of PMSM drives. Sensored vector control of PMSM drive. Advanced modelling and control aspects of PMSM for electric vehicles.

Unit-IV

Advanced Motor Drives and EV Case Studies: Modelling of an induction motor in rotor flux oriented reference frame, Sensored and sensor-less vector control of induction motor drives, Magnetic materials and B-H curve characteristics, Principle of operation of a switched reluctance motor, Configurations of SRM and computation of step angle, Power converter realisation and control of SRM, Basics of BLDC motor drives, Converter realisation and control of BLDC drives, Case study of high-end electric vehicles and their drive systems.

Suggested Readings

- R. Krishnan, “Electric Motor Drives - Modeling, Analysis & Control”, PHI Learning Private Ltd, 2009.
- L. Ashok Kumar, S. Albert Alexander, “Power Converters for Electric Vehicles”, CRC Press, Taylor & Francis Group, 2021
- James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
- C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001

Useful Video links

Unit No.	Topics	Links
Unit-I	Introduction to Electric Vehicles and Vehicle Dynamics	https://youtu.be/L2HbpEMfryM?si=QghjLafduLlt6_rD
Unit-II	DC Drives and Induction Motor Drives for Electric Vehicles	https://youtu.be/bHrWjMVOpag?si=F0gviD5fgVkbkmqb
Unit-III	PMSM Drives and Vector Control Techniques	https://youtu.be/apM4GUnqLo?si=fJoR2wLw9XbQNMpr
Unit-IV	Advanced Motor Drives and EV Case Studies	https://youtu.be/ZAzTH4HOUvc?si=jWhIEOyyCLzEYHr9

Course Code	MVEEE401B				
Category	Professional Core Courses				
Course Title	Charging Infrastructure				
Scheme and Credits	L	T	P	Credits	Semester- VII
	3	0	0	3	
Course Objectives	The objectives of this course are: • To understand the fundamentals of EV charging systems, EVSE types, classifications, and standards. • To learn the principles, modelling, and control of AC–DC converters used in EV chargers. • To examine isolated DC-DC converters and their control strategies. • To analyze charging procedures, communication protocols, and overall challenges in modern EV charging infrastructure.				
Assessment	30 Marks				
End Semester Examination	45 Marks				
Total	75 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Recall the basic concepts of EV charging systems, EVSE types, charging classifications, and standards.	Level 1: Remember
CO2	Explain the operating principles and control of AC–DC and isolated DC–DC converters used in EV chargers.	Level 2: Understand
CO3	Apply suitable converter topologies and control methods for different EV charging applications.	Level 3: Apply
CO4	Analyze charger performance, losses, soft-switching, protocols, and communication (Type-2, CCS-2) in EV charging systems.	Level 4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 6 parts (1 from each unit/section) of 1.5 marks each and remaining eight questions of 9 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit-I

Introduction to Charging System: Electric Vehicle Supply Equipment (EVSE) for on-board charger, EVSE for off-board charger, Charging Infrastructure Challenges, Classification and standards.

Unit-II

AC-DC power converters: Various types of AC-DC converters, Single phase Boost derived topologies: operating principles, modelling and control, Single phase Bridgeless topologies: operating principles, modelling and control, Three phase AC-DC converter: operating principles, modelling and control

Unit-III

Isolated DC-DC converters: Various types of isolated converters, Losses and soft-switching criteria, Phase-shift full bridge: operating principles and control, Dual active bridge: operating principles, modulation and control.

Unit-IV

Charging procedure, protocols and communication: AC type2, DC CCS2 charging system.

Suggested Readings:

- Automotive Electrical and Electronic Systems, by Tom Denton, 5th Edition, Routledge, 2018.
- Electric and Hybrid Vehicles: Design Fundamentals, by Iqbal Husain, CRC Press, 2021.
- Fundamentals of Power Electronics, by Robert W. Erickson, and Dragan Maksimovic, 3rd, Springer, 2020.
- Power Electronics: Essentials and Applications, by L.Umanand, Wiley India, 2012.
- Power Electronics – Converters, Applications and Design, by Mohan N., Underland T.M. and Robbins W.P., 3rd Ed., Wiley India.

Useful Video links:

Unit No.	Topics	Links
Unit-I	Introduction to Charging System	https://youtu.be/xPIFmwKonu8
	Electric Vehicle Supply Equipment (EVSE) for on-board charger	https://nptel.ac.in/courses/108107715
	EVSE for off-board charger	https://nptel.ac.in/courses/108107715
Unit-II	Single phase Boost derived topologies	https://nptel.ac.in/courses/108107715
	Three-phase AC-DC converter	https://youtu.be/rACh_DwIf7E
Unit-III	Various types of isolated converters	https://nptel.ac.in/courses/108107715
	Dual active bridge	https://youtu.be/XsicKDSRQhk
	Phase-shift full bridge	https://youtu.be/YINqDUxMemQ
Unit-IV	AC type2 charging system	https://nptel.ac.in/courses/108107715
	DC CCS2 charging system	https://youtu.be/cEaVn-3aSNk

Course Code	MEEEV403B				
Category	Project Courses				
Course Title	Project				
Scheme and Credits	L	T	P	Credits	Semester-VII
	0	0	4	2	
Course Objectives	The objectives of this course are: • To identify suitable research topics in Electrical Engineering for independent investigation. • To understand research methodologies, documentation, and referencing aligned with existing literature. • To develop technical writing skills using appropriate tools, formats, and referencing techniques. • To analyze, interpret, and synthesize research findings within a defined research scope or topic.				
Assessment	20 Marks				
End Semester Examination	30 Marks				
Total	50 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Identify complex engineering problems relevant to project work based on domain knowledge and real-world challenges.	Level 1: Remember
CO2	Describe the workflow, technical background, and tools required for planning and executing engineering projects.	Level 2: Understand
CO3	Apply appropriate methods, tools, and techniques to carry out project development and prepare technical documentation.	Level 3: Apply
CO4	Analyze the key stages of project development to ensure systematic execution and identify performance issues.	Level 4: Analyze
CO5	Evaluate alternative approaches and select suitable methodologies to achieve optimal and feasible project outcomes.	Level 5: Evaluate
CO6	Design innovative and practical engineering solutions to address societal and industrial needs.	Level 6: Create

Project Guidelines:

- Students shall undertake projects individually or in small teams (2–4 members).
- Projects must be approved by the department project committee before commencement.
- Regular progress reviews will be conducted throughout the semester.

Course code	MEEEV203B				
Category	Lab Courses				
Course title	Fundamentals of Electric Vehicles Lab				
Scheme and Credits	L	T	P	Credits	Semester- III
	0	0	2	1	
Course Objectives	The objectives of this course are: ● To understand and apply DC/AC power conversion techniques. ● To analyze performance and control of electrical machines and transmission systems. ● To explore electric/hybrid vehicle technologies and efficiency comparisons.				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	Skill Demonstrated	RBT Level
CO1	Understand the working principles of converters, electrical machines, and automotive systems.	Level 2: Understand
CO2	Apply simulation and experimental methods to study power electronic devices and motor control.	Level 3: Apply
CO3	Analyze performance of motors, transmission, and braking systems.	Level 4: Analyze
CO4	Evaluate efficiency and compare electric/hybrid vehicles with conventional IC engines.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	Experiment for the conversion of DC-to-DC voltage using a converter.
2	Simulation for AC-to-AC conversion.
3	Simulation for AC to DC conversion.
4	Simulation for DC to AC conversion.
5	Study of 3-Phase Induction Motor.
6	Speed control of a DC motor using an IGBT.
7	To perform speed reversal of the DC Shunt Motor.
8	Study of various elements of transmission systems (Clutch, Differentials, Gearbox, etc.)
9	Calculate and compare the Brake Power and Mechanical Efficiency of an IC Engine and an electrical motor of the same configuration.
10	Study of various types of Braking systems.
11	Case study of any Electric/ Hybrid car manufactured/sale in India.

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

Course code	MEEEV304B				
Category	Professional Core Courses (Lab Course)				
Course title	Power Electronic Drives and Controllers for Electric Vehicle Lab				
Scheme and Credits	L	T	P	Credits	Semester-VI
	0	0	2	1	
Course Objectives	The objectives of this course are: • To develop the skills related to Power Electronics drives. • To analyze the important parameters for converters and Controllers				
Assessment	10 Marks				
End Semester Practical Examination	15 Marks				
Total	25 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Explain characteristics of power devices and electrical machines.	Level 2: Understand
CO2	Apply test procedures to control speed of DC and AC motor drives.	Level 3: Apply
CO3	Analyze the characteristics of converter-fed AC & DC motor drives.	Level 4: Analyze
CO4	Evaluate drive performance by experimental and simulation results.	Level 5: Evaluate

List of Experiments

Sr. No.	Content
1	To draw V-I characteristics of power diode.
2	To draw the V-I characteristics of a Schottky diode.
3	To draw V-I characteristics of IGBT & GTO.
4	To perform a load test on a DC shunt motor.
5	To perform speed control of a DC shunt motor.
6	To draw speed-torque characteristics of a DC series motor.
7	Modelling and simulation of Permanent Magnet Brushless DC motor with MATLAB/Simulink.
8	Modelling and simulation of a switched reluctance motor with MATLAB/Simulink.
9	To perform single phase bridge converter drive
10	To perform single phase AC motor control drive
11	To draw Speed – Torque Characteristics of a 3-phase Induction Motor using a VSI Inverter
12	To draw Speed – Torque Characteristics of a 3-phase Induction Motor using a CSI Inverter

Virtual Lab Links

Experiment Name	Virtual Lab Link
To draw the V-I characteristics of the IGBT	https://pe-iitr.vlabs.ac.in/exp/bipolar-transistor/simulation.html
To draw the V-I characteristics of a power diode.	https://pe1-iitd.vlabs.ac.in/exp/controlled-switching/
To perform single phase bridge converter drive	https://pe1-iitd.vlabs.ac.in/exp/single-phase-controlled/
To perform single phase AC motor control drive	https://pe1-iitd.vlabs.ac.in/exp/single-phase-voltage-controller/

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