



**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=xQKcBugAly4&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=JCAjbuVvXbA
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=PLEPI1RnS5drMCNu1VPDwdrRO_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/grlVqIYiMqQ?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/IDTSXFc9AcE?list=PLuv3GM6-gsE0WgB_q3tl2Gat_PEjQhF8o
UNIT- IV	Laplace Transform	https://youtu.be/TSkHT5solVM?list=PLuv3GM6-gsE0WgB_q3tl2Gat_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=nOr9Wa-CIRo&list=PLNdrDld4dxeVrRU4OmzVCR6UUgyRYMquI&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=PLNdrDld4dxeVrRU4OmzVCR6UUgyRYMquI&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=PLNdrDld4dxeVrRU4OmzVCR6UUgyRYMquI&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 and RL load.
6	To Study of SCR Commutation 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-dnzlV3ogoVFfaDTCr-N2b_TSBPEeBJdU&index=2&pp=iAQB
UNIT-II	Engineering & General Layout of Equipment's,	https://www.youtube.com/watch?v=s0xWtOLXH8&pp=yg-W5ASBQT1dFUiBTRUNUT1I6IFBvd2VyIHNIY3RvciBzdHJ1Y3R1cmUgaW4gZGlm
UNIT-III	Power sector structure in different states	https://www.youtube.com/watch?v=s0xWtOLXH8&pp=yg-W5ASBQT1dFUiBTRUNUT1I6IFBvd2VyIHNIY3RvciBzdHJ1Y3R1cmUgaW4gZGlm
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=PLbMVogVj5nJQoZqyLxx-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=VA0gk11C7qw&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=ygUpIFN0YXRlIGZlZWRIYWNrIGNvbnRyb2xsZXIeZGVzaWduOiAgbnB0ZWw%3D
UNIT-IV	Linearization of nonlinear systems.	https://www.youtube.com/watch?v=ozq9Qs75JQ0&pp=ygU0ICAgbnB0ZWwjaGFyYWN0ZXJpc3RpY3Mgb2Ygbm9ubGluZWVhIHN5c3RlbXMuICBucHRlbiA%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=PLp6ek2hDeoNBczPs_OoWYh4Siixdm20wQ
UNIT-II	Voltage Source Converters	https://www.youtube.com/watch?v=jsj0Vg8CTtE&pp=ygUiLCAGVm9sdGFnZSBtb3VyY2UgQ29udmVydGVycyBucHRlbA%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=ygU5cmVhY3RpdmUgcG93ZXIgaY29tcGVuc2F0aW9uIGluIHRyYW5zbWlzc2lvaW50ZW1zIG5wdGVs