

ANNA UNIVERSITY
NON-AUTONOMOUS COLLEGE
AFFILIATED TO ANNA UNIVERSITY
M.E., POWER SYSTEMS ENGINEERING
REGULATIONS 2025

PROGRAMME OUTCOMES (POs)

On successful completion of the programme, the graduate would have	
PO1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO2	An ability to write and present a substantial technical report / document.
PO3	Students should be able to demonstrate a degree of mastery in power systems engineering.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of Electrical and Electronics Engineering program, the student will have the following Program Specific Outcomes.	
PSO1	Get elevated as technically competent Power Engineer to cater the needs of Electrical Power Industry, Research and Educational Institutions. Pursue career in core service sector of power system industry with life long learning and professional ethics.
PSO2	Become an entrepreneur in modern restructured power systems, proficient in application software packages used in the Power System industry.



ANNA UNIVERSITY, CHENNAI

POST GRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E., Power Systems Engineering

Regulations: 2025

Abbreviations:

BS – Basic Science (Mathematics, Physics, Chemistry)	L –Laboratory Course
ES – Engineering Science (General (G), Programme Core (PC), Programme Elective (PE))	T – Theory
SD – Skill Development	LIT –Laboratory Integrated Theory
SL – Self Learning	PW – Project Work
OE – Open Elective	TCP –Total Contact Period(s)

Semester I

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	PS25101	Power System Dynamics	LIT	2	1	2	5	4	ES (PC)
2.	PS25102	Advanced Power System Analysis	LIT	2	1	2	5	4	ES (PC)
3.	PS25103	Advanced Power System Operation and Control	LIT	2	1	2	5	4	ES (PC)
4.	PX25C01	Analysis of Power Converters	LIT	3	0	2	5	4	ES (PC)
5.	PS25104	Power System Instrumentation	T	3	0	0	3	3	ES (PC)
6.	PS25105	Technical Seminar	-	0	0	2	2	1	SD
Total Credits							25	20	

Semester II

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		High Voltage DC Transmission	T	3	0	0	3	3	ES (PC)
2.		Advanced Power System Protection	LIT	3	0	2	5	4	ES (PC)
3.		Power System Restructuring and Pricing	T	3	0	0	3	3	ES (PC)
4.		Smart Power Grid Technologies	T	3	0	0	3	3	ES (PC)
5.		Programme Elective I	T	3	0	0	3	3	ES (PE)
6.		Industry Oriented Course I	---	1	0	0	1	1	SD
7.		Industrial Training	---	---	---	---	---	2	SD
8.		Self Learning Courses	--	--	-	--	--	1	SD
Total Credits							18	20	

Semester III

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Programme Elective II	T	3	0	0	3	3	ES (PE)
2.		Programme Elective III	T	3	0	0	3	3	ES (PE)
3.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
4.		Open Elective	--	3	0	0	3	3	-
5.		Industry Oriented Course II	---	1	0	0	1	1	SD
6.		Project Work I	---	0	0	12	12	6	SD
Total Credits							25	19	

Semester IV

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Project Work II	---	0	0	24	24	12	SD
Total Credits							24	12	

Programme Elective Courses (PE)

S. No.	Course Code	Course Title	Periods			Total Contact Periods	Credits
			L	T	P		
1.		Wind Energy Conversion systems	3	0	0	3	3
2.		Analysis of Electrical Machineries	3	0	0	3	3
3.		Inverter Based Renewable Energy systems	3	0	0	3	3
4.		Electric Vehicles and Power Management	3	0	0	3	3
5.		Energy Auditing and Management	3	0	0	3	3
6.		Electrical Distribution Systems	3	0	0	3	3
7.		IoT for Smart Energy Management Systems	3	0	0	3	3
8.		Power Quality	3	0	0	3	3
9.		System Theory	3	0	0	3	3
10.		Advanced Power System Dynamics	3	0	0	3	3
11.		Power System Planning and Reliability	3	0	0	3	3
12.		Distributed Generation and Micro-Grids	3	0	0	3	3
13.		Power System Transients	3	0	0	3	3
14.		Graph Theory applications to power system	3	0	0	3	3
15.		Design of Solar PV System	3	0	0	3	3
16.		Big Data Analytics in Power System	3	0	0	3	3
17.		FACTS	3	0	0	3	3
18.		Application of AI Techniques to Power System	3	0	0	3	3
19.		Cybersecurity of Smart Grids	3	0	0	3	3
20.		Grid Compliance studies for Inverter Based Resources	3	0	0	3	3
21.		Energy Storage Technologies	3	0	0	3	3

Semester I

PS25101	Power System Dynamics	L	T	P	C
		2	1	2	4
Course Objective: To introduce the dynamic behavior of power systems under small and large disturbances. To model synchronous machines, exciters, and loads for dynamic studies. To analyze transient and small-signal stability in interconnected systems. To use modern simulation tools for dynamic performance analysis. To explore techniques for stability enhancement in practical power systems.					
Introduction to Power System Dynamics: Need for dynamic analysis in power systems- Stability concepts: steady-state, transient, small-signal, voltage, frequency- Mathematical preliminaries: nonlinear system behavior, equilibrium points, stability definitions- Review of numerical methods for stability studies. Activity: MATLAB/Python simulation of swing equation for a single machine connected to infinite bus (SMIB).					
Synchronous Machine Modeling: Classical model and its limitations- Park's transformation, d–q axis equations- Modeling of synchronous machines with and without damper windings- Turbine-governor and load modeling (static & dynamic). Activity: Build and simulate a synchronous machine model in MATLAB/Simulink.					
Excitation Systems: Excitation system requirements and IEEE models- Effect of excitation on power system stability- Static & dynamic load models. Activity: Simulate the AVR model					
Small Signal Stability Analysis: Small-signal stability of SMIB and multimachine systems-Damping and synchronizing torque concepts-Eigenvalue analysis and participation factors-Effect of Field circuit dynamics-Effect of AVR dynamics- Power System Stabilizers (PSS) design and application. Activity: Eigenvalue and participation factor analysis of SMIB system.					
Transient Stability: Transient stability studies – equal area criterion- Numerical integration methods: step-by-step, modified Euler, Runge-Kutta- Critical clearing time and angle- Stability enhancement methods: fast valving, braking resistors, high-speed excitation- Case studies with renewables and inverter-based systems. Activity: Transient stability simulation of a multi-machine system under fault conditions.					
Laboratory Practice: 1. Determination of synchronous machine parameters in SMIB system, Swing equation calculations in SMIB system under different conditions. 2. Simulation of steam turbine governor model, Simulation of hydraulic turbine governor model. 3. Simulation of DC, AC and IEEE excitation systems					

4. Simulation of small signal stability analysis of classical SMIB system,
5. Simulation of small signal stability analysis of SMIB system including field flux.
6. Simulation of modal and eigen value analysis in power system.
7. Simulation of small signal stability analysis in SMIB including AVR and PSS
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%
Assessment Methodology: Quiz (5%), Assignments (10%), Review of Question Papers (IES, GATE, SSC Questions) (20%), Projects (20%), Flipped Class (5%), Internal Examinations (40%).
References: 1. P. Kundur, Power System Stability and Control, McGraw Hill, 1994. 2. K.R. Padiyar, Power System Dynamics: Stability and Control, BS Publications, 2002. 3. P.M. Anderson & A.A. Fouad, Power System Control and Stability, IEEE Press. 4. Machowski, Bialek, Bumby, Power System Dynamics: Stability and Control, Wiley, 2020. 5. IEEE Committee Reports on Excitation Systems and Stabilizers. Web References 1. NPTEL – Power System Dynamics: https://nptel.ac.in/courses/108/101/108101127/ 2. MathWorks – Power System Stability Examples: 3. https://in.mathworks.com/help/phymod/sps/powersys/ref/powersystemstability.html 4. IEEE PES Resource Center: https://resourcecenter.ieee-pes.org 5. CIGRÉ Technical Publications: https://www.cigre.org/publications 6. PSCAD/DIGSILENT Tutorials: https://hvdc.ca/pscad/, https://www.digsilent.de/en/tutorials.html

	Description of CO	POs	PSO1	PSO2
CO1:	Ability to Explain the need and fundamentals of power system dynamics and stability.	PO1(3) PO2(1) PO3(3)	3	2
CO2:	Ability to Develop models of synchronous machines, exciters, and loads for system studies	PO1(3) PO2(1) PO3(3)	3	3
CO3:	Ability to Perform small-signal stability analysis using eigenvalue methods.	PO1(3) PO2(1) PO3(3)	3	2
CO4:	Ability to Evaluate transient stability and propose enhancement techniques.	PO1(3) PO2(2) PO3(3)	3	3
CO5:	Ability to Apply simulation tools for analyzing dynamic performance of power systems.	PO1(3) PO2(2) PO3(3)	3	2

PS25102	Advanced Power System Analysis	L	T	P	C
		2	1	2	4
Course Objective: This course aims ● To enable the students to analyse the mathematical representation of power system components and solution techniques and generalise the power flow analysis using various methods. ● To infer the knowledge of the different types of faults and its calculation using computer method and mathematical model. ● To know the concept of numerical integration methods to analyse power system transient stability.					
Solution Techniques: Sparse matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity, Flexible packed storage scheme for storing matrix as compact arrays, Factorization by Bifactorization and Gauss elimination methods, Repeat solution using left and right factors and L and U matrices. Activity: Group Discussion on Gauss Elimination Method					
Power Flow Analysis: Fast decoupled power flow method, Sensitivity factors for P-V bus adjustment, Net interchange power control in multi-area power flow analysis: ATC, assessment of available transfer capability (ATC) using repeated power flow method, Continuation power flow method - Contingency analysis. Activity: Quiz: Available transfer capability					
Optimal Power Flow : Problem statement - Solution of optimal power flow (OPF), The gradient method, Newton's method, linear sensitivity analysis; LP methods with real power variables only, LP method with AC power flow variables and detailed cost functions, security constrained optimal power flow - Interior point algorithm - Bus Incremental costs. Activity: Quiz: Interior Point Algorithm					
Short Circuit Analysis : Fault calculations using sequence networks for different types of faults, Bus impedance matrix (ZBUS) construction using building algorithm for lines with mutual coupling, Simple numerical problems, Computer method for fault analysis using ZBUS and sequence components, Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase domain using Thevenin's equivalent and ZBUS matrix for different faults. Activity: Group Discussion on Computer method for fault analysis.					
Transient Stability Analysis : Introduction, numerical integration methods: Euler and fourth order Runge, Kutta methods, algorithm for simulation of SMIB and multi-machine					

system with classical synchronous machine model, Factors influencing transient stability, numerical stability and implicit integration methods.

Activity: Group Discussion on Factors influencing transient stability

Laboratory Exercises:

1. Simulation of large scale power system to determine the voltage magnitudes and phase angles at different points in the system.
2. Simulation of Load flow study of a power transmission network.
3. Simulation of Load flow study of a radial distribution network.
4. Simulation of large scale power system to perform Short Circuit studies according to IEC 60909, ANSI, and GOST standards.
5. Simulation of large scale power system to assess the system's transient ability to maintain synchronism after disturbances.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (10%), Review of Question Papers (IES, GATE, SSC Questions) (20%), Projects (20%), Flipped Class (5%), Internal Examinations (40%).

References:

1. Grainger, J.D., "Power System Analysis", Tata McGraw Hill Publishing Company, 2016.
2. Kusic, C.L., "Computer Aided Power System Analysis", Tata McGraw Hill Publishing Company, Reprint 2017.
3. Pai, M. A., "Computer Techniques in Power System Analysis", TMH Publishing Company, Reprint 2015.
4. Stagg, G. W. and Elabadi, A. H., "Computer Methods in Power System Analysis" McGraw Hill, Reprint 2016.
5. Wood, A.J. and Wollenberg, B.F., "Power Generation, Operation and Control", John Wiley and Sons, 2015.
6. Singh L.P., "Advanced power system analysis and dynamics", 3rd Ed., Wiley eastern, New Delhi, 2015.

	Description of CO	PO	PSO1	PSO2
CO1	Analyze large-scale power systems using advanced computational methods and algorithms	PO1(3) PO2(1) PO3(3)	3	2
CO2	Apply advanced methods for steady-state power system analysis under symmetrical and unsymmetrical faults	PO1(3) PO2(1) PO3(3)	3	2
CO3	Formulate and solve equations for AC, DC, and optimal power flow	PO1(3) PO2(1) PO3(3)	3	3

CO4	Utilize modern simulation tools for short-circuit, load flow, and optimal power flow studies	PO1(3) PO2(2) PO3(3)	3	3
CO5	Evaluate the transient stability of power systems under disturbances	PO1(3) PO2(2) PO3(3)	3	2

PS25103	Advanced Power System Operation and Control	L	T	P	C
		2	1	2	4
Course Objective: To impart the knowledge on various operational and control activities as applied to the power system, articulate the economic nuances and modern control techniques & estimate the states of the power system under normal and abnormal conditions.					
Real Power and Frequency Control : Fundamentals of speed governing mechanism and modelling: Speed-load characteristics, Load sharing between two synchronous machines in parallel, LFC of single/multi-area systems- Static and dynamic analysis, economic dispatch, tie-line control, state-variable model. Activities: Tutorial on ALFC for single and two area systems, load sharing between two synchronous generators					
Reactive Power and Voltage Control: Reactive power production/absorption, AVR, shunt/series compensation, Methods of Voltage Control , synchronous condensers, static VAR systems, Modeling of reactive compensating devices, Application of tap changing transformers to transmission systems, Distribution system voltage regulation, Modeling of transformer ULTC control systems. Activities: Tutorial on AVR with conventional controllers, series and shunt compensation in Power System transmission lines.					
Unit Commitment and Economic Dispatch: Statement of Unit Commitment (UC) problem, constraints, Priority List, Dynamic Programming, Lagrangian relaxation, Forward DP approach method- Economic dispatch problem with losses, Lambda-iteration, Gradient method, piecewise linear cost, two generator system, coordination equations, Incremental losses and penalty factors, Hydro Thermal Scheduling using DP. Activities: Tutorial on UC and ED problems using methods listed above					
Modern Control of Power Systems: System operating states, contingency analysis, linear sensitivity factors, Line Outage Sensitivity Factor, Generation Outage Sensitivity Factor, Analysis of multiple contingencies, corrective controls, Energy Control Centre, SCADA system, EMS functions. Activities: Tutorial on Contingency Analysis for simple power networks					
State Estimation: Maximum likelihood Weighted Least Squares Estimation: Concepts, Matrix formulation, Example for Weighted Least Squares state estimation, state estimation of an AC network, Estimation by Orthogonal Decomposition algorithm, Detection and Identification of Bad Measurements, observability, pseudo-measurements, PMU applications. Activities: Tutorial on State estimation of AC network with PMU.					

Laboratory Exercises:

1. Simulation of ALFC for single and two area systems
2. Simulation of AVR with conventional controllers, series and shunt compensation in Power System transmission lines
3. Simulation of UC and ED problems using methods listed above
4. Contingency Analysis for simple power networks
5. Simulation of State estimation of an AC network

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Assignments (10%), Review of Question Papers (IES, GATE, SSC Questions) (20%), Projects (20%), Flipped Class (5%), Internal Examinations (40%).

References

1. Wood, A. J., & Wollenberg, B. F. (2016). Power generation, operation, and control. John Wiley and Sons.
2. Kundur, P. (2008). Power system stability and control (5th reprint). Tata McGraw Hill.
3. Elgerd, O. I. (2002). Electric energy system theory: An introduction. Tata McGraw Hill.
4. Kothari, D. P., & Nagrath, I. J. (2003). Modern power system analysis (4th ed.). Tata McGraw Hill Publishing Company Limited.
5. Grigsby, L. L. (2001). The electric power engineering handbook. CRC Press & IEEE Press.

	Description of CO	PO	PSO1	PSO2
CO1	Identify the operational activities of power systems under normal operating conditions	PO1(2) PO2(1) PO3(3)	3	2
CO2	Summarize the control activities of power systems under both normal and abnormal operating conditions	PO1(2) PO2(1) PO3(3)	3	2
CO3	Analyze the economic aspects and cost optimization of power system operation	PO1(3) PO2(2) PO3(3)	3	3
CO4	Illustrate and apply modern control techniques in power system operation	PO1(3) PO2(2) PO3(3)	3	3
CO5	Evaluate the operating states of the power system under normal and abnormal conditions	PO1(3) PO2(2) PO3(3)	3	3

PX25C01	Analysis of Power Converters	L 3	T 0	P 2	C 4
Course Objectives: • To provide a comprehensive understanding of the operation, design, and control of hard switched and soft switched power electronic converters. • To analyse and evaluate the performance of single-phase and three-phase power converters under various load conditions. • To enhance practical skills through laboratory experiments that reinforce theoretical concepts and provide exposure to real-world converter operation and analysis.					
Single-Phase Controlled Rectifiers: Semi and fully controlled rectifiers with R, RL, and RLE loads. Freewheeling diode effects: Continuous and discontinuous conduction modes. Inversion operation; Dual converter operation. PWM rectifiers. Performance parameters: Harmonics, ripple, distortion, power factor. Effect of source inductance. Practical: Simulation and Experimentation of single-phase half and fully controlled converters. / Gate drivers and firing circuits for single phase rectifiers./ Waveform analysis under various load conditions./ Input power factor and harmonic analysis.					
Three-Phase Controlled Rectifiers: Three-phase semi and fully controlled rectifiers with R, RL, RLE loads. Freewheeling diode, inversion operation, continuous/discontinuous modes. Multi-pulse (6 and 12 pulse) and dual converters. Effect of source inductance and commutation overlap. Performance parameters Practical: Simulation and Experimentation of three-phase line-commutated converters.					
DC-DC Converters: Non-isolated topologies: Buck, Boost, Buck-Boost, Cuk. Isolated topologies: Single and multiple switch converters. Operation in CCM and DCM; Synchronous and interleaved converters. Practical: Design and testing of driver circuits for DC-DC converters (totem pole/transformer based/boot strap/opto coupler based)					
DC-AC Inverters: Single-phase and three-phase VSI and CSI; 120° and 180° conduction modes. PWM techniques: Sine PWM, Space Vector PWM, 60° PWM, Third harmonic PWM. Multilevel inverters: Diode-clamped, flying capacitor, cascaded H-bridge. Voltage control methods and harmonic elimination. Filter design and device selection.					
Practical: Simulation and analysis of single phase and three-phase inverters / Generation of PWM pulses with different modulation techniques/ Harmonic spectrum and THD analysis.					

AC-AC Converters: AC voltage controllers: Single-phase and three-phase with R, RL loads. Phase angle control and integral cycle control. Working principle of Resonant converters: ZVS, ZCS, quasi, and multi-resonant types. Practical: Simulation and Experimentation of AC voltage regulators / Simulation and experimentation of resonant converters
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%
Assessment Methodology: Quiz (5%), Assignments (10%), Review of Question Papers (IES, GATE, SSC Questions) (20%), Projects (20%), Flipped Class (5%), Internal Examinations (40%).
References: 1. Rashid, M. H. (2017). <i>Power electronics: Circuits, devices and applications</i> (4th ed.). Prentice Hall India. 2. Bose, B. K. (2003). <i>Modern power electronics and AC drives</i> (2nd ed.). Pearson Education. 3. Umanand, L. (2010). <i>Power electronics: Essentials & applications</i> (1st ed.). Wiley. 4. Mohan, N., Undeland, T. M., & Robbins, W. P. (2007). <i>Power electronics: Converters, applications and design</i> (3rd ed.). John Wiley and Sons. 5. Bimbhra, P. S. (2022). <i>Power electronics</i> (7th ed.). Khanna Publishers.
E-resources: 1. https://onlinecourses.nptel.ac.in/noc24_ee88/preview.

	Description of CO	PO	PSO1	PSO2
CO1	Analyze the operation and performance of single-phase and three-phase rectifiers under various load conditions.	PO1(3) PO3(3)	3	2
CO2	Design and evaluate isolated and non-isolated DC-DC converter topologies for specific applications.	PO1(2) PO3(2)	3	3
CO3	Implement PWM techniques in single and three-phase inverters and assess performance.	PO1(3) PO3(2)	3	3
CO4	Examine and compare multilevel inverters and resonant converter architectures for high-power applications.	PO1(3) PO2(2) PO3(2)	3	1
CO5	Conduct experiments and simulations to validate theoretical concepts and evaluate real-time converter behaviour.	PO1(3) PO2(2) PO3(3)	3	3

PS25104	Power System Instrumentation	L	T	P	C
		3	0	0	3
Course Objective: This course aims • To provide a comprehensive understanding of instrumentation used in power generation, transmission, and distribution systems. • It focuses on measurements, SCADA, substation and distribution automation, and energy management. • Emphasis is also placed on modern control techniques and data acquisition systems for efficient and reliable power system operation.					
Fundamentals of Power System Instrumentation: Measurement and error analysis - Objective and philosophy of power system instrumentation - Measurement of large currents, high voltages, torque, and speed, Standard specifications for instrumentation - Introduction to data acquisition systems in power systems.					
Activities: Group Discussion: Why standard specifications are important in measurement, students discuss in pairs or small groups.					
SCADA and Communication in Power Systems: SCADA architecture, components and applications - Data transmission and telemetry - PLC equipment and computer control of power systems - Communication protocols: IEC 60870, IEC 61850 - Man-Machine Interface (HMI) Activities: Simulation Exercise: Use a SCADA simulation tool (or online demo) where students can observe data from a virtual substation. Quiz / Concept Check: Short quiz on SCADA terminology, communication protocols, and PLC equipment.					
Power Plant Instrumentation: Instrumentation diagram and Measurement of electrical parameters of thermal and nuclear power plants, Temperature, pressure, flow, and level sensors, Monitoring systems, measurement and control of combustion, Turbine monitoring and control: speed, vibration, shell temperature monitoring, radiation detection instruments, process sensors for nuclear power plants, Data acquisition systems in generating stations. Activities: Case Study Discussion: Review an example of radiation detection in nuclear plants and its significance for safety. Plant Visit or Virtual Tour: If possible, arrange a site visit to a thermal/nuclear plant, or watch a virtual tour, followed by a reflection discussion.					
Substation Instrumentation: Sub-station automation, requirements, control aspects in substations, feeder automation, consumer side automation, reliability, GPIB programmable test instruments - microprocessor / microcontroller based GPIB controllers Activities: Research Paper Review Activity: “Read one recent paper related to Substation Instrumentation and write a short note about why it is important, and how it relates to what you learned in class.”					

Distribution Automation: Concepts of automation in distribution networks, Automation Switching Control, Management Information Systems (MIS), Remote Terminal Units, communication method for data transfer, Consumer Information Service (CIS), Graphical Information Systems (GIS), Automatic Meter Reading (AMR), Remote control load management.

Activities: Diagram Practice: Students draw a basic layout of a distribution automation system and label key components.
Case Study: Review an example of MIS or GIS in a real utility and discuss its benefits.

Energy Management Techniques and Instruments: Need for energy management in power systems, Demand side management (DSM), DSM planning, DSM Techniques, Load management as a DSM strategy, energy conservation, tariff options for DSM, Energy audit, instruments for energy audit, Energy audit for generation, distribution and utilization systems.

Activities: Demonstration Session: Show actual instruments used for energy audits (power analyzers, thermal cameras, etc.) through a video or live demonstration.
Mini Project: Students create a basic energy audit outline for a site (e.g., campus building), including equipment and data required.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Assignments (10%), Review of Question Papers (IES, GATE, SSC Questions) (20%), Projects (20%), Flipped Class (5%), Internal Examinations (40%).

References:

1. Liptak, B. G. (1973). *Instrumentation in process industries* (Vols. I & II). Chilton Book Co.
2. Sherry, A. (1971). *Modern power station practice* (Vol. 6: Instrumentation, controls and testing). Pergamon Press.
3. Pabla, A. S. (2004). *Electric power distribution*. Tata McGraw Hill.
4. Mahalanabis, A. K., Kothari, D. P., & Ahson, S. I. (1988). *Computer aided power system analysis and control*. Tata McGraw Hill.
5. Murphy, W. R., & McKay, G. (1982). *Energy management*. Butterworths Publications.
6. Turner, W. C. (1982). *Energy management handbook*. John Wiley and Sons.
7. National Programme on Technology Enhanced Learning (NPTEL). (n.d.). *Course on power system protection* [Video lecture]. <https://nptel.ac.in/courses/108105088>

Description of CO		PO	PSO1	PSO2
CO1:	Understand measurement principles, error analysis, and data acquisition techniques in power systems	PO1(2) PO2(1) PO3(3)	3	2
CO2:	Explain SCADA systems, communication protocols, and control methods in power networks	PO1(2) PO2(1) PO3(3)	3	3
CO3:	Describe advanced instrumentation techniques in thermal and nuclear power plants	PO1(2) PO2(1) PO3(3)	3	2
CO4:	Analyze substation and distribution automation systems for enhanced control and reliability	PO1(3) PO2(2) PO3(3)	3	3
CO5:	Apply energy management strategies and auditing tools for efficient and sustainable power system operation	PO1(3) PO2(2) PO3(3)	3	3