POSTGRADUATE DEGREE

COURSE

M. Tech.

Electrical Engineering

(Power System)

University of Technology

Vatika Road, Jaipur Rajasthan

303903

UNIVERSITY OF TECHNOLOGY, JAIPUR

Program Outcomes (POs)

PO 1	Engineering Knowledge: Apply knowledge of mathematics, science, and Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering to solve numerical techniques problems.
PO 2	Problem Analysis: Identify, formulate, and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 3	Design/Development of Solutions: Design and develop Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering systems, components, or processes.
PO 4	Conduct Investigations: Conduct experiments and simulations to analyze Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 5	Modern Tool Usage: Use modern tools and software to analyze and solve Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering problems.
PO 6	The Engineer and Society: Apply Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions to societal problems.
PO 7	Environment and Sustainability: Understand the impact of Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering solutions on the environment.
PO 8	Ethics: Apply ethical principles to civil engineering practice.
PO 9	Individual and Team Work: Work effectively as an individual and in teams to solve civil engineering problems.
PO 10	Communication: Communicate Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering ideas and solutions effectively.
PO 11	Project Management: Manage civil engineering projects and resources effectively.
PO 12	Lifelong Learning: Engage in lifelong learning to stay current with Civil, Computer Science, Electronics & Communication, Electrical, Mechanical engineering developments.

Program Specific Outcomes (PSOs)

1. **PSO 1**: Analyze and design advanced power system components, including transmission lines, transformers, and substations, while ensuring system stability and reliability under various load conditions.
2. **PSO 2**: Demonstrate proficiency in using state-of-the-art simulation tools and software for power system analysis, planning, and optimization, including fault analysis, load flow studies, and power quality assessments.
3. **PSO 3**: Develop sustainable solutions for modern power systems by integrating renewable energy sources, energy storage systems, and smart grid technologies to enhance system resilience and efficiency.

Program Educational Objectives (PEOs)

1. **PEO 1**: Equip graduates with advanced knowledge in power system design, operation, and control, preparing them for leadership roles in the power and energy sector.
2. **PEO 2**: Foster the ability to apply theoretical knowledge to practical, real-world problems in power systems, focusing on sustainable energy solutions and environmental impact reduction.
3. **PEO 3**: Enable graduates to stay at the forefront of technological advancements in power systems by encouraging lifelong learning and the pursuit of professional certifications and higher studies.
4. **PEO 4**: Cultivate the skills to work in multidisciplinary teams, effectively communicate complex technical concepts, and lead power system projects with an emphasis on safety and ethical responsibility.

Course Overview and Objectives

The M. Tech in Power System provides an in-depth understanding of modern power systems, encompassing transmission, distribution, and generation aspects, with a focus on stability, optimization, and integration of renewable energy sources. The course aims to equip students with the skills to analyze and design complex power networks using advanced simulation tools, while addressing key challenges such as system reliability, grid modernization, and energy storage solutions. Through a combination of theoretical learning and practical application, the program prepares students to tackle real-world energy problems and contribute to the development of efficient, sustainable, and resilient power systems.

Scheme of

POSTGRADUATE DEGREE COURSE

M. Tech.

Electrical Engineering

(Power System)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, I Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Power System Analysis	5	0	0	3	25	100	125	5
2	Advanced Power Electronics	5	0	0	3	25	100	125	5
3	Power System Stability	5	0	0	3	25	100	125	5
4	Power Generation Sources	5	0	0	3	25	100	125	5
5	MATLAB Programming Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
***ETE:** End Term Exam, **IA:** Internal Assessment*
**: Not to be considered for award of division*

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Electric Drives & Their Control	5	0	0	3	25	100	125	5
2	Advanced Power System Protection	5	0	0	3	25	100	125	5
3	EHV AC/DC Transmission	5	0	0	3	25	100	125	5
4	Power System Planning & Reliability	5	0	0	3	25	100	125	5
5	Power System Modelling & Simulation Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
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UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	High Voltage Direct Current Transmission	5	0	0	3	25	100	125	5
2	Advanced Power System	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation-I	0	0	0		100	0	100	4
	Total	**10**	**0**	**0**		**240**	**260**	**500**	**20**

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ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
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UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, IV Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Dissertation-II	0	0	0		500	0	500	16
	Total					**500**	**0**	**500**	**16**

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UNIVERSITY OF TECHNOLOGY, JAIPUR

Syllabus of

POSTGRADUATE DEGREE COURSE

M. Tech.

Electrical Engineering

(Power System)

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, I Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Power System Analysis	5	0	0	3	25	100	125	5
2	Advanced Power Electronics	5	0	0	3	25	100	125	5
3	Power System Stability	5	0	0	3	25	100	125	5
4	Power Generation Sources	5	0	0	3	25	100	125	5
5	MATLAB Programming Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
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UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Power System)

Sub: Power System Analysis

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power System Components and Models**: Power generation (thermal, hydro, nuclear, renewable), synchronous generators and their equivalent circuit models, transmission lines (short, medium, and long-line models), line constants, transformer models in power systems.	07
3.	**Load Flow Analysis**: Introduction to load flow studies, Gauss-Seidel Method, Newton-Raphson Method, Fast Decoupled Method, load flow in practical systems.	07
4.	**Fault Analysis and Protection**: Types of faults (symmetrical and unsymmetrical), fault current calculation, protection systems (overcurrent, differential, and distance protection), protective relays, transformer protection, and coordination of protection systems.	08
5.	**Stability Analysis**: Power system stability (transient, dynamic, and voltage stability), transient stability (swing equation, methods for improvement), dynamic stability (small-signal analysis, eigenvalue methods), and voltage stability (causes and improvement methods).	07
6.	**Economic and Optimal Operation of Power Systems**: Optimal power flow, economic load dispatch (ELD), linear programming for optimization, unit commitment (formulation and solution methods).	08

Text/Reference Books:

1. **"Power System Analysis"** by John J. Grainger and William D. Stevenson
2. **"Power System Analysis and Design"** by J. Duncan Glover and Thomas Overbye
3. **"Modern Power System Analysis"** by D.P. Kothari and I.J. Nagrath
4. **"Power Systems Analysis"** by A.R. Bergen and Vijay Vittal
5. **"Electrical Power Systems"** by C.L. Wadhwa

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the basic concepts, objectives, and scope of power systems, including their components and operation.
CO2	Analyze the components of power systems such as generators, transmission lines, and transformers using appropriate models.
CO3	Perform load flow analysis using different methods (Gauss-Seidel, Newton-Raphson, and Fast Decoupled) for practical power systems.
CO4	Evaluate fault conditions, calculate fault currents, and understand protection systems and coordination in power systems.
CO5	Analyze power system stability, including transient, dynamic, and voltage stability, and explore methods for system improvement.

Course Description:

Power System Analysis focuses on the study of power generation, transmission, and distribution systems. It covers the modeling, analysis, and operation of key components such as generators, transformers, and transmission lines. The course includes load flow analysis, fault analysis, stability evaluation, and the integration of modern power system technologies.

Course Objectives:

1. To understand the fundamental concepts and scope of power systems, including key components and their operations.
2. To analyze the components of power systems, including generators, transformers, and transmission lines, using appropriate modeling techniques.
3. To perform load flow analysis using different methods such as Gauss-Seidel, Newton-Raphson, and Fast Decoupled methods.
4. To evaluate fault conditions and understand protection systems and coordination in power systems.
5. To study the stability of power systems and explore various methods to improve transient, dynamic, and voltage stability.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	-	-	-	1	-	1
CO2	3	1	3	3	1	-	-	-	-	-	-	-
CO3	2	2	-	2	-	-	-	-	-	-	-	2
CO4	2	1	3	2	2	-	-	-	-	-	-	1
CO5	3	2	-	3	3	-	-	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	2	2	1
CO3	-	-	-
CO4	-	2	3
CO5	3	2	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Power System)

Sub: Advanced Power Electronics

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power Semiconductor Devices**: Diodes, thyristors, MOSFETs, IGBTs, characteristics, switching characteristics, and thermal management of power devices.	07
3.	**DC-DC Converters**: Buck, Boost, Buck-Boost, Cuk, and Sepic converters, steady-state analysis, control techniques, and design considerations.	08
4.	**AC-DC Converters**: Controlled rectifiers, single-phase and three-phase converters, phase control, performance analysis, and harmonics in converters.	07
5.	**DC-AC Inverters**: Single-phase and three-phase inverters, voltage-source and current-source inverters, pulse-width modulation (PWM), control techniques, and applications.	08
6.	**Multilevel Inverters and Applications**: Types of multilevel inverters (Diode-clamped, flying capacitor, and cascaded H-Bridge), modulation techniques, and applications in high-power systems.	07

Text/Reference Books:

1. **"Power Electronics: Converters, Applications, and Design"** by Ned Mohan, Tore M. Undeland, William P. Robbins
2. **"Advanced Power Electronics Converters: PWM Converters Processing AC and DC Power"** by Ali Emadi
3. **"Power Electronics Handbook"** by Muhammad H. Rashid
4. **"Fundamentals of Power Electronics"** by Robert W. Erickson and Dragan Maksimovic
5. **"Power Electronics: Devices, Circuits, and Applications"** by Muhammad H. Rashid

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the basic concepts, objectives, and scope of power electronics and its applications.
CO2	Analyze the characteristics, switching behavior, and thermal management of power semiconductor devices like diodes, MOSFETs, and IGBTs.
CO3	Design and analyze DC-DC converters (Buck, Boost, Buck-Boost, Cuk, Sepic) with an understanding of control techniques and steady-state analysis.
CO4	Understand the operation and performance of AC-DC converters, including single-phase and three-phase converters, and phase control techniques.
CO5	Apply control techniques and modulation methods (PWM) for DC-AC inverters, including single-phase, three-phase, and multilevel inverter systems.

Course Description:

Advanced Power Electronics delves into the design and analysis of power electronic systems used in modern energy conversion. It covers the operation of semiconductor devices such as diodes, MOSFETs, and IGBTs, as well as the design and control of DC-DC converters, AC-DC converters, and DC-AC inverters. Emphasis is placed on the use of advanced modulation techniques and system efficiency in renewable energy applications and power electronics integration.

Course Objectives:

1. To understand the fundamental concepts, applications, and significance of power electronics in modern systems.
2. To analyze the characteristics, switching behavior, and thermal management of power semiconductor devices, including diodes, MOSFETs, and IGBTs.
3. To design and analyze various DC-DC converters (Buck, Boost, Buck-Boost, Cuk, Sepic) with an understanding of control techniques and steady-state operations.
4. To explore the operation and performance of AC-DC converters, including single-phase and three-phase converters, with phase control techniques.
5. To apply control techniques and modulation methods, such as PWM, for the design and operation of DC-AC inverters, including single-phase, three-phase, and multilevel systems.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	-	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	2	2	-	-	-	-	2
CO5	3	3	3	3	3	2	2	-	-	2	2	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	-	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - I Semester: M. Tech. (Power System)

Sub: Power System Stability

Credit: 5 **Max. Marks**: 125 (IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power System Stability Concepts**: Types of stability (Transient, Dynamic, Voltage), stability limits, and the importance of stability in power system operation.	07
3.	**Transient Stability**: Swing equation, Equal Area Criterion, methods of improving transient stability, and numerical solutions for transient stability analysis.	08
4.	**Dynamic Stability**: Small-signal stability, linearization of power system equations, eigenvalue analysis, and analysis of damping in power system oscillations.	08
5.	**Voltage Stability**: Mechanisms of voltage instability, P-V and Q-V curves, methods for improving voltage stability, reactive power compensation techniques.	07
6.	**Stability Enhancement and Control Techniques**: Power system stabilizers (PSS), FACTS devices for stability enhancement (SVC, STATCOM, UPFC), and coordination of controllers.	07

Text/Reference Books:

1. **"Power System Stability and Control"** by Prabha Kundur
2. **"Power System Stability and Control"** by P. M. Anderson and A. A. Fouad
3. **"Power Systems Analysis"** by John J. Grainger and William D. Stevenson
4. **"Modern Power System Analysis"** by D.P. Kothari and I.J. Nagrath
5. **"Electrical Power Systems"** by C.L. Wadhwa

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the objective, scope, and expected outcomes of the course, providing a solid foundation for learning power system stability concepts.
CO2	Analyze the different types of power system stability (transient, dynamic, and voltage stability) and their importance in the operation of power systems.
CO3	Apply the swing equation and Equal Area Criterion to analyze transient stability and propose methods to improve system stability, including numerical solutions.
CO4	Evaluate small-signal stability and use eigenvalue analysis to assess damping and oscillation characteristics in power systems, understanding dynamic stability phenomena.
CO5	Investigate voltage stability mechanisms, utilize P-V and Q-V curves, and apply techniques like reactive power compensation for enhancing voltage stability.

Course Description:

Power System Stability focuses on understanding the stability of power systems under various operational conditions. The course covers transient, dynamic, and voltage stability, equipping students with the tools to analyze and improve system performance. Topics include swing equations, Equal Area Criterion, small-signal stability, eigenvalue analysis, and voltage stability mechanisms, with applications to enhance the reliability and efficiency of power systems.

Course Objectives:

1. To understand the objective, scope, and expected outcomes of the course, providing a foundation for power system stability concepts.
2. To analyze the different types of power system stability—transient, dynamic, and voltage stability—and their significance in power system operation.
3. To apply the swing equation and Equal Area Criterion for transient stability analysis and explore methods to improve system stability through numerical solutions.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	-	3	-	-	-	-	2	-	-
CO2	2	3	-	3	3	-	-	-	-	-	-	2
CO3	1	2	-	3	2	-	-	-	-	1	-	1
CO4	1	3	2	3	-	-	-	-	2	-	-	1
CO5	3	3	3	3	3	-	2	-	-	-	-	2

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	2	3	-
CO3	-	-	1
CO4	-	3	2
CO5	3	-	3

1st Year - I Semester: M. Tech. (Power System)

Sub: Power Generation Sources

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Conventional Power Generation**: Thermal power plants (coal, gas), nuclear power plants, steam cycles, efficiency analysis, and environmental considerations.	07
3.	**Hydropower Generation**: Types of hydropower plants (run-of-river, storage, pumped storage), efficiency, design considerations, and environmental impact of hydropower.	07
4.	**Renewable Energy Sources**: Solar energy (photovoltaic, solar thermal), wind energy, geothermal energy, biomass energy, and their integration into power systems.	08
5.	**Distributed Generation and Microgrids**: Concepts of distributed generation, microgrids, advantages, and challenges, integration of renewable sources, and storage systems.	08
6.	**Future Trends in Power Generation**: Fusion power, advanced nuclear reactors, ocean energy (tidal and wave power), and emerging technologies in power generation.	07

Text/Reference Books:

1. **"Power Generation, Operation, and Control"** by Allen J. Wood and Bruce F. Wollenberg
2. **"Electric Power Generation, Transmission, and Distribution"** by Leonard L. Grigsby
3. **"Renewable Energy: Power for a Sustainable Future"** by Godfrey Boyle
4. **"Introduction to Renewable Energy"** by Vaughn Nelson
5. **"Energy Systems Engineering: Evaluation and Implementation"** by Francis Vanek and Louis Albright

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the objectives, scope, and expected outcomes of power generation systems.
CO2	Analyze and evaluate the efficiency, design, and environmental impact of conventional power generation systems.
CO3	Comprehend the working principles, types, and design considerations of hydropower generation systems.
CO4	Explore various renewable energy sources and their integration into power systems for sustainable generation.
CO5	Investigate emerging trends in power generation, including advanced technologies like fusion power and ocean energy.

Course Description:

Power Generation Sources introduces students to the various methods of generating electricity, covering conventional and renewable energy systems. The course explores the efficiency, design, and environmental impacts of traditional power generation systems, such as thermal and nuclear, as well as the working principles and considerations in hydropower. Emphasis is also placed on the integration of renewable energy sources and emerging trends in power generation technologies.

Course Objectives:

1. To understand the objectives, scope, and expected outcomes of different power generation systems.
2. To analyze and evaluate the efficiency, design, and environmental impacts of conventional power generation systems, such as thermal, nuclear, and gas-based plants.
3. To comprehend the working principles, types, and design considerations for hydropower generation systems.
4. To explore various renewable energy sources (solar, wind, biomass, etc.) and their integration into existing power systems for sustainable energy generation.
5. To investigate emerging trends and advanced technologies in power generation, including fusion power, ocean energy, and next-generation energy solutions.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	-	-	-	-	-	-	-
CO2	2	3	-	3	3	-	-	-	-	-	-	3
CO3	1	3	3	3	2	-	-	-	-	-	-	2
CO4	1	3	2	3	-	-	-	-	2	-	-	1
CO5	3	3	3	3	3	-	2	-	-	-	-	2

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	2	-	-
CO2	3	3	-
CO3	-	-	1
CO4	2	3	3
CO5	3	-	3

1st Year - I Semester: M. Tech. (Power System)

Lab: MATLAB Programming Lab

Credit: 2 **Max. Marks**: 100(IA:60, ETE:40)

0L+0T+4P

Experiment No.	Description
1	Introduction of MATLAB environment, matrix operations, array manipulation, and built-in functions.
2	Implementation the Fourier Transform (FT), Fast Fourier Transform (FFT), and digital filters in MATLAB.
3	Using MATLAB for solving electrical circuit problems, including mesh and nodal analysis.
4	Analyzing AC circuits with MATLAB, using phasor analysis and transient response simulations.
5	Designing and analyzing control systems using MATLAB’s Control System Toolbox (e.g., transfer function modeling, stability analysis, and controller design).
6	Solving power system load flow problems using MATLAB, including methods like Newton-Raphson and Gauss-Seidel.
7	Modeling and simulating electrical machines (motors, generators) and drives in MATLAB.
8	Developing state-space models for electrical systems, including modeling of RLC circuits and electrical systems with dynamic behavior.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 1st Year, II Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	Electric Drives & Their Control	5	0	0	3	25	100	125	5
2	Advanced Power System Protection	5	0	0	3	25	100	125	5
3	EHV AC/DC Transmission	5	0	0	3	25	100	125	5
4	Power System Planning & Reliability	5	0	0	3	25	100	125	5
5	Power System Modelling & Simulation Lab	0	0	4		60	40	100	2
	Total	**20**	**0**	**4**		**160**	**440**	**600**	**22**

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1st Year - II Semester: M. Tech. (Power System)

Sub: Electric Drives & Their Control

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Basic Components of Electric Drives**: Electric motor types (DC, induction, synchronous), power electronic converters, control strategies, and feedback systems.	07
3.	**DC Motor Drives**: Characteristics and modeling of DC motors, control techniques (Armature control, Field control, and Armature-Field control), speed control methods, and applications.	07
4.	**Induction Motor Drives**: Performance characteristics of induction motors, speed control methods (V/f control, vector control, direct torque control), and applications.	07
5.	**Synchronous Motor Drives**: Synchronous motor characteristics, methods of starting and control (V/f control, constant power control, vector control), and applications in industrial drives.	08
6.	**Control of Electric Drives**: Open-loop and closed-loop control systems, speed control using power electronic converters, digital controllers (PI, PID), adaptive control, and modern control strategies for electric drives.	08

Text/Reference Books:

1. **"Electric Drives: Concepts and Applications"** by Vedam Subrahmaniam
2. **"Electric Motor Drives: Modeling, Analysis, and Control"** by R. Krishnan
3. **"Modern Power Electronics and AC Drives"** by Bimal K. Bose
4. **"Power Electronics and Electric Drives"** by S.K. Pillai
5. **"Control of Electric Drives"** by Werner Leonhard

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the basic concepts, objectives, and scope of electric drive systems.
CO2	Analyze and evaluate the performance of various electric motor types and associated control strategies, including feedback systems.
CO3	Apply control techniques and speed control methods for DC motor drives in practical applications.
CO4	Design and implement speed control methods for induction motor drives, including V/f control, vector control, and direct torque control.
CO5	Implement advanced control strategies, including digital controllers (PI, PID), adaptive control, and modern techniques, for efficient operation of electric drives.

Course Description:

The course on Electric Drives & Their Control provides an in-depth understanding of electric drive systems and their applications in various industries. Students will explore the fundamental concepts of electric drives, analyze different electric motor types, and evaluate their performance in control systems. The course focuses on control techniques, including speed regulation and feedback systems, for DC and induction motor drives.

Course Objectives:

1. To understand the objectives, scope, and applications of power generation systems in electric drives.
2. To gain a solid understanding of electric drive systems, including motor types and their control methods.
3. To analyze and evaluate the performance of different electric motors and associated control strategies, including feedback systems.
4. To apply control techniques for DC motor drives, focusing on speed control methods in practical scenarios.
5. To design and implement speed control methods for induction motor drives, including V/f control, vector control, and direct torque control.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	3	2	1	-	-	-	-	-	-	1
CO2	1	2	-	2	-	-	-	1	-	-	-	2
CO3	2	1	3	3	-	-	-	-	1	-	2	2
CO4	3	2	3	2	2	-	-	-	2	2	-	-
CO5	2	3	2	3	1	2	1	-	-	-	-	1

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	-	2	-
CO2	2	3	-
CO3	1	2	2
CO4	3	3	3
CO5	3	3	3

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Power System)

Sub: Advanced Power System Protection

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power System Protection Fundamentals**: Protection concepts, protection schemes for transmission lines, transformers, generators, and buses; fault types, fault analysis, and protection coordination.	07
3.	**Relays and Protective Devices**: Electromechanical relays, solid-state relays, digital relays, and their characteristics, relay operating principles, relay settings, and coordination.	07
4.	**Distance Protection**: Distance relay principles, impedance, reactance, and Mho relays, characteristic impedance diagrams, protection of transmission lines using distance relays, settings, and coordination.	08
5.	**Differential Protection**: Transformer and generator differential protection, principle of operation, CT saturation and errors, and adaptive differential protection schemes.	08
6.	**Protection of Power System Components and Smart Grids**: Protection of generators, transformers, and buses in power systems, microgrids, smart grids, and their protection schemes, integration of renewable energy sources.	07

Text/Reference Books:

1. **"Power System Protection and Switchgear"** by B. Ravindranath and M. Chander
2. **"Modern Power System Protection"** by S. S. R. A. Babu and A. G. S. R. Murthy
3. **"Power System Protection: Principles and Applications"** by Paul M. Anderson
4. **"Protection of Electricity Distribution Networks"** by M. A. L. Dufour
5. **"Power System Protection and Control"** by M. S. N. Murthy

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the basic concepts, objectives, scope, and outcomes of power system protection.
CO2	Analyze fault types, perform fault analysis, and apply protection schemes to transmission lines, transformers, generators, and buses.
CO3	Evaluate and implement various relay types (electromechanical, solid-state, digital) and their operational principles for system protection.
CO4	Apply distance protection principles to transmission lines, including impedance and reactance relays, and coordinate relay settings.
CO5	Design and implement differential protection schemes for transformers, generators, and other components in power systems, including adaptive protection methods.

Course Description:

The course on Advanced Power System Protection focuses on the principles and techniques for protecting power systems from faults and disturbances. Students will explore various protection schemes for transmission lines, transformers, generators, and other components. The course covers fault analysis, relay operation, distance protection, and differential protection methods, equipping students with the skills to design and implement protection systems in complex power networks.

Course Objectives:

1. To understand the basic concepts, objectives, and outcomes of power system protection.
2. To analyze fault types and apply appropriate protection schemes for transmission lines, transformers, generators, and buses.
3. To evaluate and implement various relay types, including electromechanical, solid-state, and digital relays, and understand their operational principles.
4. To apply distance protection principles to transmission lines and coordinate relay settings effectively.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	1	2	-	-	-	-	-	-	1	-
CO2	2	3	-	1	-	3	-	1	-	3	-	-
CO3	2	-	3	-	-	3	2	-	2	-	2	-
CO4	3	1	2	-	-	1	-	-	2	3	1	2
CO5	1	3	2	3	3	2	2	2	-	3	3	2

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	-	-	1
CO2	2	2	2
CO3	3	-	-
CO4	2	-	-
CO5	3	1	-

UNIVERSITY OF TECHNOLOGY, JAIPUR

1st Year - II Semester: M. Tech. (Power System)

Sub: EHV AC/DC Transmission

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Fundamentals of EHV Transmission**: Transmission line parameters, Line constants (inductance, capacitance), Voltage and current distribution in EHV transmission lines, Surge impedance loading (SIL), and Electrostatic field analysis.	07
3.	**EHV AC Transmission**: General aspects of EHV AC transmission, Voltage regulation, Reactive power compensation, Line voltage drop and its calculation, Series and shunt compensation, and Transformer and reactor applications in EHV transmission.	08
4.	**EHV DC Transmission**: Basic concepts of HVDC transmission, Types of HVDC systems (monopolar, bipolar, back-to-back), Advantages and limitations of HVDC transmission, Converter stations, and HVDC control and protection.	07
5.	**Converter and Inverter Circuits for HVDC Transmission**: Thyristor-based converter and inverter circuits, Power control in HVDC systems, Harmonics in HVDC transmission, and Filters for harmonics reduction.	08
6.	**System Control and Stability in EHV AC/DC Transmission**: System stability, Power flow control, EHV AC/DC system interactions, Stability analysis, and Voltage stability in EHV AC and HVDC systems, and Power flow optimization.	07

Text/Reference Books:

1. **"High Voltage Direct Current (HVDC) Transmission Systems Technology Review Paper"** by K.R. Padiyar
2. **"EHV-AC and DC Transmission"** by S.R. Bhide and S. S. Shukla
3. **"High Voltage Engineering"** by M.S. Naidu and V. Kamaraju
4. **"Power Transmission and Distribution"** by S. L. Uppal

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the fundamental principles of EHV transmission, including line parameters, surge impedance loading, and electrostatic field analysis.
CO2	Analyze and apply concepts related to EHV AC transmission, including voltage regulation, reactive power compensation, and compensation methods.
CO3	Demonstrate an understanding of HVDC transmission systems, including types, advantages, limitations, and basic operation of converter stations.
CO4	Explain and analyze thyristor-based converter and inverter circuits for HVDC transmission, including power control and harmonic reduction methods.
CO5	Evaluate system control and stability in EHV AC/DC transmission systems, with an emphasis on power flow control, system interactions, and stability analysis.

Course Description:

The course on EHV AC/DC Transmission provides an in-depth understanding of the principles and applications of Extra High Voltage (EHV) systems for power transmission. Students will explore the fundamentals of EHV AC transmission, voltage regulation, and reactive power compensation. The course also covers HVDC systems, converter/inverter circuits, power control methods, and system stability, equipping students with the necessary skills to analyze and optimize transmission systems.

Course Objectives:

1. To understand the fundamental principles of EHV transmission, including line parameters, surge impedance loading, and electrostatic field analysis.
2. To analyze and apply concepts related to EHV AC transmission, focusing on voltage regulation, reactive power compensation, and compensation methods.
3. To demonstrate an understanding of HVDC transmission systems, including types, advantages, limitations, and basic operation of converter stations.
4. To explain and analyze thyristor-based converter and inverter circuits for HVDC transmission, including power control and harmonic reduction methods.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	2	3	3	-	2	-	-	-	-	-	-	3
CO3	1	2	3	3	3	-	-	2	-	-	2	-
CO4	2	3	3	2	3	2	-	-	-	-	-	3
CO5	1	1	3	3	3	2	2	-	-	-	-	-

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	-	-	-
CO2	3	2	-
CO3	2	3	3
CO4	1	3	3
CO5	3	3	3

1st Year - II Semester: M. Tech. (Power System)

Sub: Power System Planning & Reliability

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power System Planning**: Overview of power system planning, forecasting demand, planning for generation and transmission, load flow studies, integration of renewable energy sources, and network expansion.	07
3.	**Generation Planning**: Optimal generation capacity planning, reserve margin, reliability of generation, and economic considerations in power generation planning.	07
4.	**Transmission Planning**: Optimal transmission network planning, expansion of transmission systems, contingency planning, power flow studies, and voltage stability.	07
5.	**Reliability of Power Systems**: Reliability concepts in power systems, probabilistic modeling of generation and transmission systems, system reliability indices (e.g., SAIDI, SAIFI), and methods to evaluate system reliability.	08
6.	**Reliability Evaluation Techniques and Optimization**: Monte Carlo simulation, analytical methods for reliability evaluation, optimization techniques for system design, and reliability-based design of power systems.	08

Text/Reference Books:

1. **"Power System Planning"** by Hadi Saadat
2. **"Reliability Evaluation of Power Systems"** by Roy Billinton and Ronald N. Allan
3. **"Power System Reliability Evaluation"** by T. M. S. S. Rao
4. **"Power System Engineering"** by S. S. Vadhera
5. **"Modern Power System Planning"** by X. Wang and G. A. K. L. Chang

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Analyze the principles and objectives of power system planning, including forecasting demand, generation and transmission planning, and integration of renewable energy.
CO2	Evaluate optimal generation capacity planning, reserve margin, and economic considerations for reliable power generation.
CO3	Apply methods for optimal transmission network planning, including contingency planning, power flow studies, and voltage stability.
CO4	Understand the concepts of system reliability in power systems and evaluate system reliability using indices like SAIDI and SAIFI.
CO5	Use Monte Carlo simulation, analytical methods, and optimization techniques to evaluate and design reliable power systems.

Course Description

The **Power System Planning & Reliability** course provides an in-depth understanding of the methods and tools used for planning and evaluating the reliability of power systems. It covers topics such as generation and transmission planning, demand forecasting, system reliability indices, and the integration of renewable energy sources. Students will also explore advanced techniques like Monte Carlo simulations, optimization methods, and power flow studies for designing resilient and efficient power systems.

Course Objectives

- **Understand Power System Planning**: Gain knowledge of demand forecasting, generation planning, transmission network design, and renewable energy integration.
- **Evaluate System Reliability**: Learn to assess the reliability of power systems using key reliability indices like SAIDI and SAIFI.
- **Apply Optimization Techniques**: Use methods such as Monte Carlo simulations and analytical approaches for designing optimal and reliable power systems.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1	-	2	-	-	-	-	-	2
CO2	3	1	2	3	-	-	-	-	-	-	-	-
CO3	3	2	-	2	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	-	-	-	-	-	-	1
CO5	3	2	3	3	3	-	-	-	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	-	3	-
CO3	2	3	-
CO4	3	3	3
CO5	3	3	3

1st Year - I Semester: M. Tech. (Power System)

Sub: Power System Modelling & Simulation Lab

Credit: 2 **Max. Marks**: 100(IA:60, ETE:40)

0L+0T+4P

Experiment No.	Description
1	Simulating generators, transformers, and transmission lines in MATLAB/Simulink.
2	Perform load flow studies to determine voltage profiles, real and reactive power flows.
3	Simulation of symmetrical and unsymmetrical faults (e.g., three-phase faults, line-to-line faults).
4	Simulate the transient stability of a power system using the swing equation and other related methods.
5	Implement algorithms for optimal generation dispatch and system operation.
6	Study the effects of Flexible AC Transmission Systems (FACTS) devices like STATCOM, SVC.
7	Simulate protection schemes, including overcurrent, differential, and distance relays.
8	Design and simulate a high-voltage direct current (HVDC) transmission system.
9	Model and simulate the integration of wind and solar power generation into the grid, analyzing their impacts on stability and power flow.

UNIVERSITY OF TECHNOLOGY, JAIPUR
Scheme and Syllabus
M.Tech 2nd Year, III Sem: Power System

Teaching and Examination Scheme
ACADEMIC SESSION 2023-2024

S. No.	Course Name	Contact Hours per Week			Marks				Cr
		L	T	P	Exam Hrs	IA	ETE	Total	
1	High Voltage Direct Current Transmission	5	0	0	3	25	100	125	5
2	Advanced Power System	5	0	0	3	25	100	125	5
3	Seminar	0	0	0		90	60	150	6
4	Dissertation-I	0	0	0		100	0	100	4
	Total	**10**				**240**	**260**	**500**	**20**

L: *Lecture,* ***T:*** *Tutorial,* ***P:*** *Practical,* ***Cr:*** *Credits*
ETE: *End Term Exam,* ***IA:*** *Internal Assessment*
**: Not to be considered for award of division*

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2nd Year - III Semester: M. Tech. (Power System)

Sub: High Voltage Direct Current (HVDC) Transmission

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Fundamentals of HVDC Transmission**: Basic concepts of HVDC systems, advantages of HVDC over HVAC, types of HVDC systems, components of HVDC systems, converter stations, and their role in HVDC transmission.	08
3.	**HVDC Converter Stations**: Converter configurations (monopolar, bipolar), converter control methods (voltage control, power control, current control), harmonic elimination techniques, and converter station design considerations.	07
4.	**Control of HVDC Systems**: Voltage control, power control, and current control methods; reactive power control, stability considerations, and control of HVDC systems during steady-state and dynamic conditions.	08
5.	**Analysis of HVDC Systems**: DC line voltage drop, voltage regulation, power flow analysis, and steady-state performance analysis. Transient analysis during faults, control strategies during faults, and fault location techniques.	07
6.	**HVDC System Applications and Planning**: Long-distance HVDC transmission, integration with AC systems, economic benefits of HVDC, planning considerations, reliability, and safety of HVDC systems.	07

Text/Reference Books:

1. **"High Voltage Direct Current (HVDC) Transmission"** by K.R. Padiyar
2. **"HVDC Power Transmission Systems Technology and System Integration"** by S. Kamakshaiah and L. K. L. S. Rao
3. **"Power Transmission and Distribution"** by A. S. Pabla
4. **"High Voltage Engineering"** by C.L. Wadhwa
5. **"HVDC Transmission Systems"** by Jyoti K. Gupta

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the fundamentals of HVDC systems, including their advantages over HVAC systems, types, and components.
CO2	Gain knowledge of HVDC converter station configurations, control methods, and harmonic elimination techniques.
CO3	Learn the control mechanisms of HVDC systems, including voltage, power, current, and reactive power control methods.
CO4	Analyze the steady-state and transient performance of HVDC systems, including voltage regulation, power flow, and fault analysis.
CO5	Evaluate the applications, economic benefits, and planning considerations for long-distance HVDC transmission and integration with AC systems.

Course Description

This course provides a comprehensive understanding of High Voltage Direct Current (HVDC) transmission systems, focusing on their components, configurations, and control mechanisms. It covers the advantages of HVDC over HVAC systems, their application in long-distance power transmission, and the integration of HVDC systems with AC grids. The course also includes the study of steady-state and transient performance, economic benefits, and planning considerations.

Course Objectives

- To understand the fundamentals, advantages, and types of HVDC systems.
- To explore HVDC converter station configurations, control methods, and harmonic elimination techniques.
- To study the control mechanisms of HVDC systems, including voltage, current, power, and reactive power control methods.
- To analyze the steady-state and transient performance of HVDC systems, including fault analysis and power flow.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)
3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	-	-	2	-	-	-	-	2
CO2	-	-	2	3	2	-	-	-	-	2	-	-
CO3	3	-	-	3	1	-	-	-	1	-	-	1
CO4	-	3	3	3	1	3	2	-	1	-	-	3
CO5	-	2	-	-	-	3	2	3	-	-	-	3

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	3	1	-
CO2	2	1	-
CO3	-	2	1
CO4	-	2	3
CO5	-	1	3

2nd Year - III Semester: M. Tech. (Power System)

Sub: Advanced Power System

Credit: 5 **Max. Marks**: 125(IA:25, ETE:100)

5L+0T+0P **End Term Exam**: 3 Hours

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction: Objective, Scope, and Outcome of the Course**	01
2.	**Power System Stability**: Types of stability (transient, dynamic, voltage), swing equation, transient stability analysis, methods for improving stability, small signal stability, voltage stability and methods of improvement.	07
3.	**Power System Dynamics**: Modeling of power system components (generators, turbines, and exciters), state-space representation, system response, dynamic stability analysis, damping and oscillations.	07
4.	**Power System Operation and Control**: Economic dispatch, load forecasting, optimal power flow, security-constrained economic dispatch, unit commitment, and coordination of control.	08
5.	**Power System Protection**: Relay coordination, fault analysis, protective relaying schemes for transmission lines, generators, transformers, and busbars, digital protection systems.	08
6.	**Smart Grids and Modern Power Systems**: Introduction to smart grids, components of smart grids, energy management systems, demand-side management, integration of renewable energy sources, advanced metering, and communication technologies in power systems.	07

Text/Reference Books:

1. **"Power System Stability and Control"** by Prabha Kundur
2. **"Power Systems Analysis"** by John J. Grainger and William D. Stevenson
3. **"Advanced Power System Analysis and Dynamics"** by L.P. Singh
4. **"Modern Power System Analysis"** by D.P. Kothari and I.J. Nagrath
5. **"Smart Grid: Fundamentals of Design and Analysis"** by James A. Momoh

Course Outcomes (COs)

S.No.	Course Outcome (CO)
CO1	Understand the objectives, scope, and outcomes of the course, and recognize the significance of power system stability.
CO2	Analyze different types of power system stability (transient, dynamic, voltage) and apply methods for improving stability.
CO3	Model power system components (generators, turbines, exciters) and analyze their dynamic behavior using state-space representation.
CO4	Demonstrate knowledge in power system operation and control, including economic dispatch, load forecasting, and optimal power flow.
CO5	Understand the protection mechanisms in power systems, including relay coordination, fault analysis, and protective relaying schemes.

Course Description

This course covers advanced concepts in power system stability, operation, and control. It focuses on analyzing different types of power system stability, modeling key components like generators and turbines, and studying power system operation, including economic dispatch and optimal power flow. The course also explores protection mechanisms, including relay coordination and fault analysis, to ensure system reliability and efficiency.

Course Objectives

- To understand the significance of power system stability and its types (transient, dynamic, and voltage).
- To analyze and improve power system stability using appropriate methods and techniques.
- To model power system components (e.g., generators, turbines, exciters) and analyze their dynamic behavior.
- To gain knowledge in power system operation and control, including economic dispatch and optimal power flow.

Mapping Table

The mapping table uses a scale of 1 to 3 to indicate the level of correlation between COs and POs/PSOs, where:

1. Slight (Low)
2. Moderate (Medium)

3. Substantial (High)

CO-PO Mapping

Course Outcomes (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	1	-	-	-	-	1	-
CO2	3	3	1	2	-	2	-	-	-	-	-	-
CO3	3	2	2	3	2	-	-	-	1	-	-	-
CO4	3	2	-	3	-	-	-	-	-	-	-	-
CO5	1	2	2	2	3	1	2	-	-	-	-	1

CO-PSO Mapping

Course Outcomes (CO)	PSO1	PSO2	PSO3
CO1	2	2	-
CO2	-	3	2
CO3	2	3	-
CO4	2	1	3
CO5	3	3	-