Hindi Seva Mandal's,

Shri Sant Gadge Baba

College of Engineering & Technology,

Near Z.T.C., Bhusawal, Dist. - Jalgaon (Maharashtra) Pin – 425203.

An Autonomous Institute

Accreditation by NAAC with A+ Grade

(Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere.)

www.ssgbcoet.com

Master of Technology (M. Tech) Electrical (Electrical Power System)

Programme curriculum

With effect from the Acedemic Year 2025-2026

2-year, 4 semester Full time Programme Choice Based Credit System (CBCS) and Grading System Outcome Based Education Pattern Aligned with National Educatin Policy (NEP) 2020

Structure and syllabus of
M. Tech. Electrical
(Electrical Power Systems)
With effect from the Academic Year 2025-2026

M. Tech. Electrical (Electrical Power Systems)

Program Educational Objectives:

1. To prepare graduates meet the challenges of modern society through viable engineering solutions.
2. To prepare graduates to develop economically viable cutting edge technology for local industry. Need.
3. To prepare graduates to inspire next generation graduates as successful engineer/ entrepreneur, scientist and researcher.

Program Outcomes:

1. Ability to apply knowledge of science, mathematics, and engineering principles for solving problems.
2. Ability to identify, formulate and solve electrical power system problems
3. Ability to understand and use different software tools in the domain of Power electronics, power system and control system simulations.
4. Ability to design and conduct experiments and analyze and interpret data.
5. Ability to coherently work in a multidisciplinary team.
6. Demonstrate sensitivity towards professional and ethical responsibility.
7. Ability to communicate effectively in writing as well as through public speaking.
8. Demonstrate ability to appreciate and engage in lifelong learning.
9. Demonstrated knowledge of contemporary issues.
10. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
11. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

PG First Year Structure 25-26 as per NEP 2020

Course Category	Category under NEP	Course Code	Course Title	Teaching Scheme			Marking Scheme				No. Of Credits
				L	T	P	CA	MSE	ESE	Total	
SEMESTER-I											
PCC	Programme Core	MTEE25PC101	Power System Modeling	03	-	-	20	20	60	100	03
PCC	Programme Core	MTEE 25PC102	Advanced Power Electronics	03	-	-	20	20	60	100	03
PEC	Programme Elective-I	MTEE 25PE103	**Programme Elective-I**	03	-	-	20	20	60	100	03
PEC	Programme Elective-II	MTEE 25PE104	**Programme Elective-II**	03	-	-	20	20	60	100	03
PCC	Programme Core	MTEE25PC105L	PG lab-I	-	-	04	50	0	0	50	02
ELC	Experiential Learning	MTEE25EL106	Seminar I	-	-	04	50	0	0	50	02
IKS	IKS	MTEE25 IK107	IKS Bucket	03	--	--	20	20	60	100	03
Audit	Ability Enhancement course	MTEE25AE108	YOGA for Stress Management	-	-	02	50	0	0	0	Audit
			Total	**15**	**--**	**10**	**250**	**100**	**300**	**650**	**20**
SEMESTER-II											
PCC	Programme Core	MTEE25PC201	Power System Dynamics and Control	03	--	-	20	20	60	100	03
PCC	Programme Core	MTEE25PC202	Advance Power System Protection	03	--	-	20	20	60	100	03
PEC	Programme Elective-III	MTEE25PE203	**Programme Elective-III**	03	--	-	20	20	60	100	03
RM	RM	MTEE25RM204	**Research Methodology and IPR**	03			20	20	60	100	03
OEC	Open Elective-I	MTEE25OE205	**Open Elective-I**	03	-	-	20	20	60	100	03
PCC	Programme Core	MTEE25PC206L	PG lab-II	-	-	04	50	0	0	50	02
ELC	Experiential Learning	MTEE25EL207P	Mini Project	-	-	04	50	0	0	50	02
Audit	Ability Enhancement course	MTEE25AE208	Disaster Management			02	50			50	01
			Total	**15**	**--**	**10**	**250**	**100**	**300**	**650**	**20**

Programme Elective-I MTEE25PE103	**Programme Elective-II** MTEE25PE104	**Programme Elective-III** MTEE25PE203	**Open Elective-I** MTEE25OE205
A. High Voltage Power Transmission.	A. Power System Planning and Reliability	A. Distributed generation and micro grid	A. Entrepreneurship
B. Advanced Topics in Power System.	B. Power Quality Assessment and Mitigation.	B. Smart Grid Design and Analysis	B. New Labor Codes of India
C. Electrical Transients in Power System	C. Advance Control System.	C. Power Sector Economics Restructuring & Regulation	C. Urban Utilities Planning: Water Supply, Sanitation and Drainage
D. Modern Optimisation Techniques in Power System.	D. AI Techniques in Power System	D. Energy Management and Auditing.	D. Environment and Development

SEMESTER-III											
Course Category	**Category under NEP**	**Course Code**	**Course Title**	**Teaching Scheme**			**Marking Scheme**				**No. Of Credits**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
OE	Open Elective-II	MTEE25OE301	**Open Elective-II**	03	-	-	20	20	60	100	03
MDM	Multidisciplinary Minor	MTEE25MD302	**Multidisciplinary Minor**	03	-	-	20	20	60	100	03
ELC	Experiential Learning	MTEE25EL303S	Seminar II	-	-	04	50	0	50	100	02
ELC	Experiential Learning	MTEE25EL304P	Project-I	-	-		100	0	100	200	12
			Total	**06**	**--**	**04**	**190**	**40**	**270**	**500**	**20**

SEMESTER-IV											
Course Category	**Category under NEP**	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**No. Of Credits**
				L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
ELC	Experiential Learning	MTEE25EL401P	Project-II	-	-	--	100	0	100	200	20
			Total	-	-	**--**	**100**	**0**	**100**	**200**	**20**

Credit Distribution

SEMI	SEMII	SEMIII	SEMIV	Total
20	20	20	20	80

Open Elective I (Bucket)

CouseCode	NPTEL Course	Credits	Name of Instructor	Host Institute	Link
MTEE25OE205A	Entrepreneurship	3	Prof. C. Bhaktavatsala Rao	IIT Madras	https://onlinecourses.nptel.ac.in/noc20_mg35/preview
MTEE25OE205B	New Labour Codes of India	3	Prof.K. D. Raju	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_lw05/preview
MTEE25OE205C	Urban Utilities Planning: Water Supply, Sanitation and Drainage	3	Prof. Debapratim Pandit	IIT Kharagpur	https://onlinecourses.nptel.ac.in/noc23_ar08/preview
MTEE25OE205D	Environment and Development	3	Prof. Ngamjahao Kipgen	IIT Guwahati	https://onlinecourses.nptel.ac.in/noc21_hs83/preview

Open Elective II (Bucket)

Couse Code	NPTEL Course	Credits	Name of Instructor	Host Institute	Link
MTEE25OE301A	Organizational Behaviour	3	Prof. M. P. Ganesh	IIT Hyderabad	OrganizationalBehaviour-Course(nptel.ac.in)
MTEE25OE301B	Business To Business Marketing (B2B)	3	Prof. J. K. Nayak	IIT Roorkee	BusinessToBusinessMarketing (B2B) -Course (nptel.ac.in)
MTEE25OE301C	Principles Of Economics	3	Prof. Sabuj Kumar Mandal	IIT Madras	PrinciplesOf Economics-Course(nptel.ac.in)
MTEE25OE301D	Student Psychology	3	Dr. S. Renukadevi	National Institute of Technical Teachers Training and Research, Chennai	https://onlinecourses.swayam2.ac.in/ntr19_ed23/preview

Multidisciplinary Minor bucket

Course Code	NPTEL Course	Credit s	Name of Instructor	Host Institute	Link
MTEE25MD302A	Components And Applications of Internet of Things	3	Dr. Sanjoy KumarParida	Indian Institute of Technology Patna	https://onlinecourses.swayam2.ac.in/arp20_ap 03/preview
MTEE25MD302B	Design Of Mechatronic Systems	3	Prof. Prasanna Gandhi	IITBombay	Design Of MechatronicSystems -Course(nptel.ac.in)
MTEE25MD302C	Ethical Hacking	3	Prof. Indranil Sengupta	IIT Kharagpur	Ethical Hacking - Course(nptel.ac.in)
MTEE25MD302D	Sustainable Power Generation Systems	3	Dr. Pankaj Kalita	IIT Guwahati	Sustainable PowerGenerationSystems-Course (nptel.ac.in)

IKS :- https://iksindia.org/courses-offered-by-iks-centers.php

Course Code	Course Name	Host Institute	Name of Instructor	E-Mails of the Instructors/ Links
MTEE25IK107A	Arogyasamskriti – Health Culture of Bharat	Amrita IKS Center for Ayurveda, Vyakrana and Darshana	Dr. Rammanohar P(PI) Dr. Manish Rajan Walvekar (Co-PI)	rammanohar@ay.amrita.edu r_manish@blr.amrita.edu
MTEE25IK107B	Indian Knowledge System in Science	IKS Centre in Jaina Mathematics School of Data Science and Forecasting Devi Ahilya University, Indore	Prof. Anupam Jain (PI) Prof. V.B. Gupta (Co-PI)	anupamjain3@rediffmail.com vbgupta.davv@gmail.com
MTEE25IK107C	Indian Knowledge System(IK): Humanities and Social Sciences	Indian Institute of Management Bangalore (IIMB), Chanakya University, Bangalore	Prof. B. Mahadevan, Dr. Vinayak Rajat Bhat, Dr. R Venkata Raghavan	https://onlinecourses.swayam2.ac.in/imb23_mg55/preview
MTEE25IK107D	Mathematics in India	IIT Madras Centre for Indian Knowledge Systems	Prof. Aditya Kolachana (PI) Co-PIs: 1. Dr.Arun Menon, 2. Dr. Manu Santhanam, 3. Dr. Sudarsan Padmanabha 4. Dr. Santosh Kumar Sahu, 5. Dr. Jyotirmaya Tripathy, 6. Dr. Rajesh Kumar	aditya@iitm.ac.in arunmenon@iitm.ac.in manus@iitm.ac.in sudarsanp@iitm.ac.in santosh@iitm.ac.in Jyotirmaya@iitm.ac.in

SEMESTER-I

Subject Name: POWER SYSTEM MODELLING Subject Code: MTEE25PC101

TEACHING SCHEME		EXAMINATION SCHEME		
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE
03	--	20	20	60

Course Description:

This course focuses on the mathematical modeling and analysis of key power system components for steady-state and dynamic performance studies. It covers synchronous machines, transformers, transmission lines, excitation systems, induction motors, and non-electrical elements such as turbines and governors. Emphasis is placed on modeling techniques, including Park's transformation, and simulation-based performance evaluation. Students will gain insights into excitation system configurations and their role in power system dynamics, and develop the skills to conduct steady-state and transient analyses using simulation tools.

Course Objectives:-

1	Understand characteristics and modeling techniques of power system components.
2	Study models of mechanical and non-electrical components involved in power system dynamics.
3	Analyze steady-state and transient performance of synchronous machines.
4	Understand structure and working of different excitation system configurations.
5	Develop and simulate excitation system models for dynamic.

Course Outcomes:-

CO1	**Formulate** mathematical models for various electrical power system components (e.g., transformers, transmission lines, induction motors) to represent their steady-state and dynamic behavior.
CO2	**Develop** and **evaluate** models of synchronous machines and associated non-electrical components (turbines, governors) for performance analysis under diverse operating conditions.
CO3	**Perform** steady-state and dynamic analysis of power systems by **conducting simulations** using appropriate software tools.
CO4	**Explain** the structure and operational principles of different synchronous machine excitation systems and their role in power system dynamics.
CO5	**Construct** and **simulate** excitation system models to investigate their impact on power system transient stability and voltage regulation.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Modeling of Power System Components: **[8Hours]**

The need for modeling of power system, different areas of power system analysis. Models of non-electrical components like boiler, steam & hydro- turbine & governor system. Transformer modeling such as auto-transformer, tap-changing & phase shifting transformer.

UNIT-II: Synchronous machine modeling **[8Hours]**

Model required for steady-state analysis. The development of model required for dynamic studies. The current & flux linkage models using Park's transformation leading to simulation as linear model.

UNIT-III: Analysis of synchronous machine modeling **[8Hours]**

Synchronous machine connected to an infinite bus, its simulation for steady- state condition.

UNIT-IV: Excitation systems **[7Hours]**

Simplified view of excitation control. Excitation configuration, primitive systems, Definitions of voltage response ratio & exciter voltage ratings.

UNIT-V: Excitation system modeling **[8Hours]**

Excitation control systems using dc generator exciter, alternator-rectifier, alternator SCR, and voltage regulators such as electro-mechanical and solid state. Modeling of excitation systems.

Reference books:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. R. Ramanujam, "Power System Dynamics: Analysis and Simulation", PHI Learning Pvt. Ltd., New Delhi, 2009.
3. B.M. Weedy and B.J. Cory, "Electric Power Systems", John Wiley & Sons, 4th Edition, 2002.
4. J. Duncan Glover and Mulukutla S. Sarma, "Power System Analysis and Design", Thomson Brooks/Cole, 3rd Edition, 2003

Subject Name: ADVANCED POWER ELECTRONICS
Subject Code: MTEE25PC102

TEACHING SCHEME		EXAMINATION SCHEME			CREDIT
TH(Hrs/Week)	**TU (Hrs/Week)**	**MSE**	**CA**	**ESE**	
03	**-**	**20**	**20**	**60**	**03**

Course Description:

This course provides an in-depth understanding of modern power semiconductor devices and advanced power electronic converters used in power system operation and control. It covers the configuration, characteristics, and operation of phase-controlled rectifiers, DC-DC converters, and inverters, including multilevel converter technologies. Emphasis is placed on device behavior, converter principles, and control techniques for efficient energy conversion.

Course Objectives:-

1	To understand configuration and characteristics of different power semiconductor devices used in power system operation and control.
2	To analyses principle of operation of various power converter used in power system operation.
3	To understand various advance power conversion techniques using power semiconductor devices.
4	To evaluate the performance and efficiency of power electronic systems under different loading and fault conditions.
5	To explore the design and control of multilevel converter systems for high-power applications.

Course Outcomes:-

CO1	**Explain** the configuration, characteristics, and switching behavior of various modern power semiconductor devices in power electronic circuits.
CO2	**Analyze** the operating principles, waveforms, and performance parameters of phase-controlled rectifiers, DC-DC converters, and inverters.
CO3	**Evaluate** advanced power conversion techniques and control strategies for improving efficiency and performance in power electronic systems.
CO4	**Apply** Pulse Width Modulation (PWM) techniques to control inverter performance, reduce harmonics, and optimize output characteristics.
CO5	**Design** and select appropriate multilevel converter configurations for high-power applications, considering efficiency and harmonic performance.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Overview of Switching Power Devices: **[8Hours]**

Solid State Power Semi-Conducting Devices: Review of the thyristors, TRIAC, GTO,BJT,MOSFET and other modern power devices(IGBT,SIT),characteristics ratings, commutation methods, protection and requirement of firing circuits.

UNIT-II: Phase Controlled Rectifiers: **[8Hours]**

Principle of phase-controlled converter operation- single phase full converter and semi converters- dual converters- three phase full and semi converters- reactive power- power factor improvements – extinction angle control- symmetrical angle control- PWM control- SPWM control.

UNIT-III: DC-DC Converters: **[8Hours]**

Study of Class:- A,B,C and D choppers; Non-isolated DC-DC converters: buck- boost-buck boost converters under continuous and discontinuous conduction operation. Isolated DC-DC converters: forward- fly-back- push-pull- half-bridge- and full-bridge converters. Relationship between I/P and O/P voltages-expression for filter inductor and capacitors.

UNIT-IV: Inverters: **[8Hours]**

Single-phaseandthree-phaseinverters-1200and1800modesofoperation-PWM techniques: single-multiple-and sinusoidal PWM techniques- selective harmonic elimination- space vector modulation-current source inverter- multi-level inverters- techniques for reduction of harmonics.

UNIT- V: Introduction to Multilevel Converters **[8Hours]**

Basic Characteristics, Multilevel DC/DC Converters, Multilevel Inverters, Control of Multilevel Inverters.

<u>Reference Books:</u>

1. M.H. Rashid, “Power Electronics: Circuits, Devices & Applications”, 4th Edition, PHI, 2017.
2. Dr. P.S. Bimbhra, “Power Electronics”, 7th Revised Edition, Khanna Publishers, 2022.
3. Ned Mohan, T.M. Undeland, and William P. Robbins, “Power Electronics: Converters, Applications”, 3rd Edition, John Wiley & Sons, 2009.
4. M.S. Jamil Asghar, “Power Electronics”, PHI Publications.
5. Branko L. Dokic, Branko Blanusa, “Power Electronics Converters and Regulators”, 3rd Edition, Springer.

Subject Name: High Voltage Power Transmission. Subject Code: MTEE25PE103A

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

- **Course Description:**

This course provides a comprehensive understanding of Extra High Voltage AC (EHVAC) and High Voltage DC (HVDC) transmission systems. It covers system configurations, voltage control, electromagnetic and electrostatic effects, transients in transmission lines, and protection methods. The course also addresses the design aspects, maintenance procedures, and HVDC transmission system configurations and switching operations.

Course Objectives:-

1	To understand the basic philosophy and engineering aspects of EHVAC transmission.
2	To study voltage gradient, electric fields, and their effects on transmission systems.
3	To analyze electromagnetic interference, audible noise, and radio interference in lines.
4	To understand transient phenomena in transmission systems and corresponding protection methods.
5	To understand the design principles, voltage control methods, and HVDC transmission configurations.

Course Outcomes:-

CO1	**Analyze** the fundamental engineering principles and configurations governing Extra High Voltage AC (EHVAC) transmission systems.
CO2	**Evaluate** the electrostatic and electromagnetic field effects, including voltage gradients and their implications for system performance, safety, and audible noise.
CO3	**Assess** various types of transients in high voltage transmission lines and **propose** suitable protection methods.
CO4	**Design** basic parameters and **apply** voltage control techniques for EHVAC and HVDC transmission systems.
CO5	**Compare and contrast** the configurations, operational principles, and control methods of different High Voltage DC (HVDC) transmission technologies for specific applications.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Engineering Aspects of EHV AC Transmission System [8Hours]

Principles, configuration, special features of high voltage AC lines, power transfer ability, reactive power compensation, audible noise, corona bundle conductors, electric field, right of way, clearances in a tower, phase to phase, phase to ground, phase to tower, factors to be considered, location of ground wire, angle of

protection, clearances, tower configuration. Principles of radio interference, origin of radio interference, method of propagation, factors to be considered in line design.

UNIT-II: Power System Transients [8 Hours]

Introduction, circuit closing transients, sudden symmetrical short circuit of alternator, recovery transients due to removal of short circuit, traveling waves on transmission lines, wave equation, surge impedance and wave velocity, specifications of traveling waves, reflection and refraction of waves, typical cases of line terminations , equivalent circuit for traveling wave studies, forked lines, reactive termination, successive reflections, Bewley lattice diagram, attenuation and distortion, arcing grounds, capacitance switching, current chopping, lightning phenomenon, over voltages due to lightning, line design based on direct strokes, protection of systems against surges, statistical aspects of insulation coordination.

UNIT-III: Other Issues [8 Hours]

Biological effects of electric field, safe values of electric field, requirements of transmission line, live line maintenance, basic principle, special tools and procedure, methods of voltage control, tap changing, shunt compensation, shunt rectors and shunt capacitors.

UNIT-IV: General Background [8 Hours]

EHV AC versus HVDC Transmission, power flow through HVDC link, equation for HVDC power flow, effect of delay angle and angle of advance, bridge connections, waveform of six pulse and twelve pulse bridge converter, commutation, phase control, angle of extinction, control of DC voltage, connections of three phase six pulse and twelve pulse converter bridges, voltage and current waveforms.

UNIT-V: HVDC Transmission [8 Hours]

Bipolar HVDC terminal, converter transformer connections, switching arrangements in DC yard for earth return to metallic return, HVDC switching system, switching arrangements in a bipolar HVDC terminal, sequence of switching operations, HVDC circuit breakers, DC current interruption, commutation principle, probable types and applications of HVDC circuit breakers, multi-terminal HVDC systems, parallel tapping, reversal of power, configurations and types of multi-terminal HVDC systems, commercial multi terminal systems.

Reference books:

1. An Introduction to High Voltage Engineering by Subir Ray, Prentice Hall of India.
2. Direct Current Transmission Vol-I, Kimbark E. W , Wiley Interscience
3. HVDC Transmission- Adamson C. Hingorani N. G.
4. EHV AC Transmission Rakosh Das Begamudre, New Age Publishers
5. HVAC and HVDC Transmission, Engineering and practice: S. Rao, Khanna Publisher, Delhi.
6. Electric Power Systems: B.M. Weddy and B.J. Cory, John Wiely and Sons
7. Power System Analysis and Design : J. Duncan Glover, Mulukutla S. Sarma,Thomson Brooks/cole/ Third Edition (2003)
8. Power System Analysis and Design, B.R. Gupta, S. Chand and Company (2004)

Subject Name: Advanced Topics in Power System. Subject Code: MTEE25PE103B

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course focuses on analyzing and enhancing power system stability and security in modern electric grids. It covers the classification of stability, modeling of synchronous machines, transient and voltage stability analysis, low-frequency oscillations, contingency analysis, and state estimation techniques to ensure reliable system operation under dynamic conditions.

Course Objectives:-

1	To study the stability and reliability of power systems.
2	To understand challenges in maintaining stability for complex and large-capacity units.
3	T o classify power system stability based on the nature of perturbation and evaluation time.
4	To analyze various types of power system stability using dynamic models.
5	To explore methods to improve system stability and prevent instability

Course Outcomes:-

CO1	**Classify and differentiate** power system stability types based on perturbation characteristics, evaluation time, and their economic implications in energy exchange.
CO2	**Analyze** the dynamic characteristics of synchronous alternators under various small and large disturbances to assess system stability.
CO3	**Apply** advanced power system analysis techniques to **solve** complex stability problems and **propose** methods for enhancing system stability.
CO4	**Analyze** voltage stability problems in power systems and **evaluate** methods for improving voltage stability in modern grids.
CO5	**Perform** contingency analysis for power system lines and **apply** appropriate techniques to mitigate their impact on system security and reliability.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: **[8 hours]**

Generation Control Loops, AVR Loop, Performance and Response, Automatic Generation Control of Single Area and Multi Area Systems, Static and Dynamic Response of AGC Loops, Economic Dispatch and AGC.

UNIT-II: **[8 hours]**

Transient Stability Problem, Modeling Of Synchronous Machine, Loads, Network, Excitation and Systems, Turbine And Governing Systems, Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis, Data For Transient Stability Studies, Transient Stability Enhancement Methods

UNIT-III: **[8 hours]**

Low Frequency Oscillations, Power System Model For Low Frequency Oscillation Studies, Improvement Of System Damping With Supplementary Excitation Control, Introduction To Sub Synchronous Resonance and Countermeasures.

UNIT-IV: **[8 Hours]**

Voltage Stability Problem, Real And Reactive Power Flow In Long Transmission Lines, Effect Of ULTC And Load Characteristics On Voltage Stability, Voltage Stability Limit, Voltage Stability Assessment Using PV Curves, Voltage Collapse Proximity Indices, Voltage Stability Improvement Methods.

UNIT-V: **[8 Hours]**

Contingency analysis ZBUS Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

Reference books:

1. Electric Energy System Theory: An Introduction.O.I. Elgard, .II Edition, McGraw Hill, New York, 1982.
2. Power Generation, Operation And Control., A.J. Wood, B.F. Wollenberg, .John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. Computer Modeling Of Electrical Power Systems.,J. Arrilaga, C.P. Arnold, B.J. Harker, Wiley, New York, 1983.
4. Power System Engineering, I.J. Nagrath, O.P. Kothari, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Electric Power System Dynamics,Yao-Nan-Yu,
6. Power System Stability andControl.P. Kundur McGraw Hill, New York, 1994.
7. 7 Power System Dynamics, Stability and Control, K.R. Padiyar Interline Publishing (P) Ltd., Bangalore, 1999.
8. Voltage Stability of Electric Power Systems.C. Van Custem, T. Vournas, Rlever Academic Press (U.K.), 1999.
9. Power System Analysis andDesign.B.R. Gupta, III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. Reactive Power Control in Electric Power Systems.T.J.E. Miller John Wiley and Sons, New York, 1982.

Subject Name: ELECTRICAL TRANSIENTS IN POWER SYSTEM.

Subject Code: MTEE25PE103C

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course covers the analysis of electrical transients in power systems caused by lightning, switching, and other disturbances. It includes the study of traveling waves, line parameters, modeling of overhead and underground cables, and computation of transients using digital tools such as EMTP. Students will learn how to evaluate system behavior under various transient conditions and apply modern computing tools for accurate system modeling and analysis.

Course Objectives:-

1	To understand the basic concepts of traveling wave phenomena and their behavior at line terminations.
2	To analyze the causes and effects of electrical transients such as lightning, switching, and temporary overvoltages in power systems.
3	To study and evaluate the parameters of overhead transmission lines and underground cables.
4	To model and analyze multiphase systems using transformations and assess ground return and skin effect.
5	To apply advanced digital computation tools such as EMTP for analyzing power system transients and modeling line parameters.

Course Outcomes:-

CO1	**Explain** the fundamental concepts of traveling wave phenomena and **analyze** their behavior at various line terminations in transmission systems.
CO2	**Analyze** the causes and effects of electrical transients, including lightning, switching operations, and temporary overvoltages, in power systems.
CO3	**Evaluate** system parameters and **develop** accurate analytical models for overhead transmission lines and underground cables.
CO4	**Apply** transformation techniques to **model and analyze** unbalanced or untransposed multiphase transmission systems, considering ground return and skin effects.
CO5	**Utilize** advanced digital computation tools, such as EMTP, to **simulate and compute** power system transients for effective planning and protection analysis.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I Review Of Travelling Wave Phenomena **[8 Hours]**

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion.

UNIT-II Lightning, Switching and Temporary Overvoltage **[8 Hours]**

Lightning over-voltages: interaction between lightning and power system ground wire voltage and voltage across insulator; switching overvoltage: Short line or kilometric fault, energizing transients-closing and re-closing of lines, methods of control; temporary over-voltages: line dropping, load rejection; voltage induced by fault; very fast transient overvoltage (VFTO).

UNIT-III Parameters and Modelling of Overhead Lines **[8 Hours]**

Review of line parameters for simple configurations: series resistance, inductance and shunt capacitance; bundle conductors: equivalent GMR and equivalent radius; modal propagation in transmission lines: modes on multiphase transposed transmission lines, α-β-0 transformation and symmetrical components transformation, modal impedances; analysis of modes on untransposed lines; effect of ground return and skin effect; transposition schemes.

UNIT IV - Parameters of Underground Cables **[8 Hours]**

Distinguishing features of underground cables: technical features, electrical parameters, overhead lines versus underground cables; cable types; series impedance and shunt admittance of single-core self-contained cables, impedance and admittance matrices for three phase system formed by three single-core self contained cables; approximate formulas for cable parameters.

UNIT-V Computation of Power System Transients - EMTP **[8 Hours]**

Digital computation of line parameters: why line parameter evaluation programs? salient features of tine; constructional features of that affect transmission line parameters; elimination of ground wires bundling of conductors; principle of digital computation of transients: features and capabilities of EMTP; steady state and time step solution modules: basic solution methods.

References Books:

1. Electrical Transients in Power System,Allan Greenwood Wiley & Sons Inc. New York, 1991.
2. Extra High Voltage AC Transmission Engineering,Rakosh Das Begamudre, (Second edition) Newage International (P) Ltd., New Delhi, 1990.
3. High Voltage Engineering, Naidu M S and Kamaraju V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. EMTP Theory Book, Hermann W. Dommel, second Edition, Microtran Power System Analysis
5. Corporation, Vancouver, British Columbia, Canada, May 1992, Last Update: April 1999. EMTP Literature from www.microtran.com.

Subject Name: MODERN OPTIMIZATION TECHNIQUES IN POWER SYSTEMS
Subject Code: MTEE25PE103D

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive overview of modern optimization techniques with a specific focus on their applications in power systems. It covers fundamental concepts, classification of optimization problems, and classical methods alongside advanced intelligent search methods. The syllabus delves into Evolutionary Computation Techniques (like Genetic Algorithms), Particle Swarm Optimization (PSO), and other advanced methods such as Simulated Annealing, Tabu Search, Ant Colony Optimization, and Bacteria Foraging Optimization. A significant portion is dedicated to Multi-Objective Optimization, including Pareto optimality and multi-objective evolutionary algorithms, all with practical relevance to power system operations like economic dispatch, unit commitment, optimal power flow, and reactive power control.

Course Objectives:-

1	To introduce fundamental concepts of optimization, classifications, and classical optimization techniques.
2	To familiarize students with the principles and applications of Evolutionary Computation Techniques.
3	To educate students on the theory and application of Particle Swarm Optimization for power system problems.
4	To explore advanced optimization methods and their utility in various power system scenarios.
5	To provide a comprehensive understanding of multi-objective optimization concepts and techniques for complex power system problems.

Course Outcomes:-

CO1	**Classify and Apply:** Classify various optimization problems and apply fundamental classical optimization techniques for problem-solving.
CO2	**Explain and Implement:** Explain the working principles of Evolutionary Algorithms (e.g., GA, ES, EP) and implement them for solving power system economic dispatch and unit commitment problems.
CO3	**Analyze and Develop:** Analyze Particle Swarm Optimization (PSO) principles and develop solutions for optimal power flow, reactive power control, and unit commitment problems using PSO.
CO4	**Utilize Advanced Methods:** Utilize advanced optimization methods such as Simulated Annealing, Tabu Search, Ant Colony Optimization, and Bacteria Foraging Optimization for relevant power system applications.
CO5	**Comprehend and Solve Multi-Objective Problems:** Comprehend the concept of Pareto optimality and apply multi-objective optimization techniques (e.g., MOGA, MOPSO) to solve complex power system problems like economic-emission dispatch.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT I - Fundamentals Of Optimization [8 Hours]

Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-Classical Optimization techniques (Linear and non linear programming, Quadratic programming, Mixed integer programming)-Intelligent Search methods (Optimization neural network, Evolutionary algorithms, Tabu search, Particle swarm optimization, Application of fuzzy set theory).

UNIT II - Evolutionary Computation Techniques [8 Hours]

Evolution in nature-Fundamentals of Evolutionary algorithms-Working Principles of Genetic Algorithm- Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation-Issues in GA implementation- GA based Economic Dispatch solution-Fuzzy Economic Dispatch including losses- Tabu search algorithm for unit commitment problem-GA for unit commitment-GA based Optimal power flow- GA based state estimation.

UNIT III - Particle Swarm Optimization [8 Hours]

Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues-Convergence issues- PSO based OPF problem and unit commitment-PSO for reactive power and voltage control-PSO for power system reliability and security.

UNIT IV - Advanced Optimiza Tion Methods [8 Hours]

Simulated annealing algorithm-Tabu search algorithm-SA and TS for unit commitment-Ant colony optimization- Bacteria Foraging optimization.

UNIT V - Multi Objective Optimization [7 Hours]

Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function-Economic Emission dispatch using MOGA-Multiobjective PSO (Dynamic neighbourhood PSO, Vector evaluated PSO) −Multiobjective OPF problem.

References Books:

1. D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2ndEdition, PHI learning private limited, 2010.
2. Kalyanmoy Deb, "Multi objective optimization using Evolutionary Algorithms" , John Wiley and Sons, 2008.
3. Kalyanmoy Deb, "Optimization for Engineering Design" ,Prentice hall of India first edition,1988.
4. Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen, "Evolutionary Algorithms for solving Multi Objective Problems, 2ndEdition, Springer, 2007.
5. Kwang Y.Lee,Mohammed A.El Sharkawi, "Modern heuristic optimization techniques John Wiley and Sons,2008.

Subject Name: POWER SYSTEM PLANNING AND RELIABILITY.

Subject Code: MTEE25PE104A

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive introduction to the planning and reliability aspects of electric power systems. It emphasizes the application of probability and reliability theory as tools for effective system design, operation, and long-term development. Students will learn load forecasting techniques, generation and transmission planning strategies, and methods for evaluating system reliability using modern analytical approaches such as Markov processes and FMEA. The course also covers availability, maintainability, and risk assessment practices critical to power system infrastructure.

Course Objectives:-

1	To use reliability theory as a tool for decision support for design, operation and planning of electric power system
2	To familiarize the students with various aspects of probability theory.
3	To acquaint the students with reliability and its concepts.
4	To introduce the students to methods of estimating the system reliability of simple and complex systems.
5	To understand the various aspects of Maintainability, Availability and FMEA procedure.

Course Outcomes:-

CO1	**Apply** probability and reliability theory as a decision support tool for the design, operation, and planning of electric power systems.
CO2	**Analyze** load forecasting techniques and various planning strategies for generation and transmission systems.
CO3	**Evaluate** the reliability of generation and transmission systems by **calculating** appropriate indices using probabilistic methods.
CO4	**Utilize** advanced analytical approaches, including Markov processes and recursive methods, to **assess** power system reliability and predict interruptions.
CO5	**Analyze** concepts of maintainability and availability, and **implement** Failure Mode and Effects Analysis (FMEA) for improved system reliability and risk management

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I Load Forecasting **[8Hours]**

Introduction, Factors affecting Load Forecasting, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non- Weather Forecasting, Weather Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting.

UNIT-II System Planning **[8 Hours]**

Introduction, Objectives & Factors affecting to System Planning, Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.

UNIT-III Reliability **[8 Hours]**

Reliability, Failure, Concepts of Probability, Evaluation Techniques (i) Markov Process (ii) Recursive Technique, Stochastic Prediction of Frequency and Duration of Long & Short Interruption, Adequacy of Reliability, Reliability Cost.

UNIT-IV Generation Planning and Reliability **[8 Hours]**

Objectives & Factors affecting Generation Planning, Generation Sources, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors Affecting Interconnection under Emergency Assistance.

UNIT-V Transmission Planning and Reliability **[8 Hours]**

Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.

References Books:

1. Modern Power System Planning - X. Wang & J.R. McDonald, McGraw Hill Book Company
2. Power System Planning - R.N. Sullivan, Tata McGraw Hill Publishing Company Ltd.
3. Electrical Power Distribution Engineering - T. Gonen, McGraw Hill Book Company
4. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication
5. Generation of Electrical Energy - B.R. Gupta, S. Chand Publications
6. Electrical Power Distribution A.S. Pabla Tata McGraw Hill Publishing Company Ltd.
7. Electricity Economics & Planning - T.W.Berrie, Peter Peregrinus Ltd., London

Subject Name: POWER QUALITY ASSESSMENT AND MITIGATION.

Subject Code: MTEE25PE104B

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive understanding of power quality issues in modern power systems. It focuses on the identification, assessment, and mitigation of problems such as harmonics, voltage sags, flickers, waveform distortions, and transient disturbances. Students will learn the importance of grounding, methods of voltage regulation, economic impacts of poor power quality, and the role of power quality monitoring tools and standards. The course equips learners with both theoretical knowledge and practical techniques to ensure system reliability and equipment protection in the presence of power quality disturbances.

Course Objectives:-

1	To understand various power quality issues, their causes, and effects on power systems and end-user equipment.
2	To study the effects of harmonics resulting from non-linear loads and their impact on system operation.
3	To learn the procedures and standards for assessing voltage sags, interruptions, flickers, and waveform distortions.
4	To understand various mitigation techniques such as filters, voltage compensators, and UPS systems for improving power quality.
5	To explore power quality monitoring tools, instrumentation, and data analysis techniques for diagnosing and resolving power quality problems.

Course Outcomes:-

CO1	**Identify and explain** various power quality issues, their causes, and effects on power systems and end-user equipment, referencing relevant IEEE standards.
CO2	**Analyze** the characteristics and impact of harmonics resulting from non-linear loads on system operation and equipment performance.
CO3	**Apply** appropriate mitigation techniques (e.g., UPS, filters, DVRs, active power filters) to reduce the adverse effects of power quality problems on systems and equipment.
CO4	**Perform** assessment procedures for voltage sags, interruptions, flickers, and waveform distortions, utilizing power quality monitoring tools and standards.
CO5	**Conduct** power quality monitoring using suitable instruments, **interpret** collected data, and **diagnose** sources of disturbances for system improvement.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I Introduction **[8 Hours]**

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159 such as transients, short and long duration voltage variations, interruptions, short and long voltagefluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding.

UNIT-II Flickers & transient voltage **[8 Hours]**

RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages

UNIT-III Voltage sag and interruptions **[8 Hours]**

Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag requirements for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions

UNIT-IV Waveform Distortion **[8 Hours]**

Definition of harmonics, interharmonics, subharmonics. Causes and effect of harmonics. Voltage versus current distortion. Overview of Fourier analysis. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non- characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. K-rated transformer. Principles for controlling harmonics. Reducing harmonic currents in loads. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Harmonic filtering, passive and active filters. Modifying the system frequency response. IEEE Harmonic standard 519-1992

UNIT-V Power Quality Monitoring **[8 Hours]**

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, d data collection and analysis. Selection of transducers. Harmonic monitoring, transient monitoring, event recording and flicker monitoring.

Reference Books:

1. Understanding power quality problems, voltage sag and interruptions - M. H. J. Bollen IEEE press, 2000, series on power engineering.
2. Electrical power system quality - Pogei G. Dugan, Mark F. McGranghan, Surya santoso, H. Wayne Beaty, second edition, McGraw Hill Pub.
3. Power system quality assessment - J. Arrillaga, M.R. Watson, S. Ghan, John Wiley and sons.

Subject Name: ADVANCED CONTROL SYSTEM Subject Code: MTEE25PE104C

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course aims to provide students with an in-depth understanding of advanced topics in control system engineering, including nonlinear, adaptive, and sliding mode control. It focuses on the analysis and design of control systems using both classical and modern approaches such as root locus, frequency response, and PID controllers. Students will explore eigenvalue/eigenvector sensitivities, controllability and observability matrices, nonlinear system behavior through phase plane and describing function methods, and Lyapunov's techniques for stability analysis. This course equips students with advanced tools and techniques for modeling, analyzing, and designing complex control systems.

Course Objectives:-

1	To help students understand the concepts of nonlinear control, adaptive control, and sliding mode control.
2	To study and apply classical control system design techniques such as root locus and frequency response methods.
3	To analyze system behavior using eigenvalue and eigenvector sensitivity analysis.
4	To investigate the controllability and observability structure of linear and multivariable systems.
5	To understand the behavior of nonlinear systems using phase-plane methods, describing functions, and Lyapunov stability analysis.

Course Outcomes:-

CO1	**Apply** various classical and modern control system design techniques, including PID controllers and compensation methods, for linear systems.
CO2	**Evaluate** the performance and sensitivity of linear systems using advanced methods like eigenvalue and eigenvector analysis.
CO3	**Analyze** the controllability and observability of multivariable systems by **utilizing** matrix methods.
CO4	**Interpret** and **predict** nonlinear system behavior using phase-plane trajectories and describing function techniques.
CO5	**Assess** the stability of nonlinear and time-varying systems by **implementing** Lyapunov's second method and other function construction methods

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: LEAD-LAG AND PID CONTROLLER DESIGN [8 Hours]

Control system design by root locus method-lead, lag and lead lag compensation. PI, PD and PID controllers design procedures and examples. Control system design by frequency response approach-lead, lag and lead lag compensation. PI, PD and PID controllers design procedures and examples.

UNIT- II: EIGEN VALUE AND EIGENVECTOR SENSITIVITIES IN LINEAR SYSTEM THEORY [8 Hours]

Continuous time systems: Introduction, first-order Eigen value sensitivities, first order eigenvector sensitivities, second-order Eigen value sensitivities, first order eigenvector sensitivities, second order Eigenvector sensitivities.

UNIT- III: MODE-CONTROLLABILITY MATRIX [8 Hours]

Distinct Eigen-values, confluent Eigen-values associated with single Jordan block, confluent Eigen-values associated with number of distinct Jordan blocks, confluent Eigen-values associated with a number of non-distinct Jordan block. Mode – Controllability structure of multivariable linear systems: Introduction, Distinct Eigenvalues, confluent Eigen-values associated with single Jordan block, confluent Eigenvalues associated with a number of non- distinct Jordan blocs.

UNIT- IV: OBSERVABILITY MATRICES [8 Hours]

Distinct Eigen-values, confluent Eigen-values, mode observability structure of multivariable linear systems: Introduction, Distinct Eigen-values, confluent Eigenvalues. Nonlinear systems: Common physical nonlinearities: the phase plane method – basic concept, singular points, construction of phase trajectories – Isocline and delta methods, Describing function – basic concept – derivation of describing functions – stability analysis by describing function method.

UNIT- V: LYAPUNOV STABILITY ANALYSIS [8 Hours]

Second method of Lyapunov, stability in the sense of Lyapunov, construction of Lyapunov functions – Krasovskii's and variable gradient methods, Lyapunov stability analysis of linear time varying systems.

<u>Reference Books:</u>

1. Advanced Control Systems B. N. Sarkar, PHI Learning Private Limited.
2. Advanced Control Theory, Somanath Majhi, Cengage Learning.
3. Control System Engineering – I J Nagarath, M. Gopal – New Age International – 3rdedition.
4. Control Systems – N K Sinha – New Age International – 3rd edition.

Subject Name: AI APPLICATIONS TO POWER SYSTEMS

Subject Code: MTEE25PE104D

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	**TU (Hrs/Week)**	**MSE**	**CA**	**ESE**	
03	**--**	**20**	**20**	**60**	**03**

Course Description:

This course introduces fundamental concepts of Artificial Intelligence (AI), encompassing problem characteristics, search techniques, and knowledge representation methods. It covers statistical reasoning, pattern recognition, and the design of classifiers. A core focus is on Artificial Neural Networks, exploring their architecture and learning paradigms. The course also delves into Expert Systems and their development, culminating in the practical application of these AI techniques to solve various problems in power systems, including load forecasting, load flow, and economic dispatch.

Course Objectives:-

1	To introduce fundamental concepts of Artificial Intelligence, including problem-solving, knowledge representation, and searching techniques.
2	To familiarize students with statistical reasoning methods and pattern recognition techniques, including classifier design and feature selection.
3	To educate students on the principles and applications of Artificial Neural Networks and various learning paradigms.
4	To provide an understanding of Expert Systems, their architecture, and building tools.
5	To enable students to comprehend and apply AI techniques for solving diverse power system problems.

Course Outcomes:-

CO1	Explain fundamental AI concepts, knowledge representation, and searching techniques.
CO2	Apply statistical reasoning and pattern recognition methodologies, including classifier design.
CO3	Design and analyze Artificial Neural Networks for various applications, including understanding supervised and unsupervised learning.
CO4	Develop rule-based systems and understand the architecture and tools for Expert Systems.
CO5	Implement and evaluate AI techniques to solve specific problems in power systems such as load forecasting and economic dispatch.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT- I: Introduction to AI: **[8 Hours]**

Definition, Applications, Components of an AI program; production system. Problem Characteristics. Overview of searching techniques. Knowledge representation: Knowledge representation issues; and overview. Representing knowledge using rules; procedural versus declarative knowledge. Logic programming, forward versus backward reasoning, matching. Control knowledge.

UNIT- II: Statistical Reasoning: **[8 Hours]**

Probability and Daye's theorem. Certainty factor and rule based systems. Baysian Networks, Dampster Shafer theorem. Semantic nets and frames, Scripts. Examples of knowledge based systems.

UNIT- III: Pattern Recognition: **[8 Hours]**

Introduction, automatic pattern recognition scheme. Design Concepts, Methodologies, Concepts of Classifier, concept of feature selection. Feature selection based on means and covariances. Statistical classifier design algorithms; increment-correction and LMSE algorithms. Applications.

UNIT- IV: Artificial Neural Networks: **[8 Hours]**

Biological Neuron, Neural Net, use of neural 'nets, applications, Perception, idea of single layer and multilayer neural nets, back propagation, Hopfield nets, supervised and unsupervised learning.

UNIT- V: Expert Systems: **[8 Hours]**

Introduction. Study of some popular expert systems, Expert System building tools and Shells, Design of Expert Systems

<u>Reference Books:</u>

1. Neural Networks, Fuzzy Logic & Genetic Algorithms,S.Rajasekaran and G.A.V.Pai,- PHI, New Delhi, 2003.
2. Computing Theory & Practice, P.D.Wasserman,Van Nostrand Reinhold, Neural- New York,1989.
3. Neural Network & Fuzzy System, Bart Kosko, Prentice Hall, 1992.
4. Fuzzy sets,Uncertainty and Information,G.J.Klir and T.A.Folger, PHI, Pvt.Ltd,1994.
5. Genetic Algorithms,D.E.Goldberg, Addison Wesley 1999.

Subject Name: PG lab-I Subject Code: MTEE25PC105L

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	**CA(PR)**	**ESE(PR)**	
04	**50**	**--**	**02**

Course Description

This postgraduate-level laboratory course is designed to provide hands-on experience with modeling, analysis, and simulation techniques relevant to modern power systems. The lab focuses on transformer and synchronous machine modeling, contingency analysis, transmission system components, and the impact of high-voltage systems on biological and environmental factors. Students will gain practical knowledge in applying theoretical concepts to analyze real-world scenarios using advanced tools and experimental setups.

Course Objectives:-

1	To model and analyze transformers and synchronous machines for power system applications.
2	To study excitation systems and their impact on synchronous machine dynamics.
3	To understand and simulate deterministic contingency analysis of transmission systems
4	To examine the environmental and biological effects of HVDC and EHV AC systems.
5	To investigate structural and loading aspects of transmission lines and substations under various physical conditions.

Course Outcomes:-

CO1	**Utilize** software or hardware-based tools to **model and simulate** transformers and synchronous machines for power system applications.
CO2	**Analyze** excitation systems and **develop** mathematical models to **evaluate** synchronous machine performance through practical exercises.
CO3	**Perform** deterministic contingency analysis for transmission systems using simulation tools and **assess** system stability under various fault conditions.
CO4	**Evaluate** the thermal, mechanical, and electrical loading on EHV/HVDC systems and **interpret** their effects on system components based on experimental or simulated data.
CO5	**Investigate** and **assess** the biological and environmental impact of HVDC/EHV systems, and **analyze** structural aspects of transmission towers through practical studies

- **Mapping of Course Outcome with Program Outcomes**

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

Experimental Set-up:

- MATLAB/Simulink for machine modeling, load flow, and stability analysis.
- Power World Simulator or ETAP for contingency and reliability studies.
- High-voltage lab kits for EHV effects and tower structure analysis.
- Power quality analyzers and digital recorders for harmonic studies.

SYLLABUS

List of Practicals to be performed

(Atleast 10 experiments should be performed from the following list)

List of experiments:

List of experiments:

Experiment 1: To study of transformer modeling.

Experiment 2: To study of Excitation modeling for synchronous machine.

Experiment 3: To study mathematical analysis of synchronous machine modeling.

Experiment 4: To study deterministic contingency analysis of transmission system

Experiment 5: To study the mathematical analysis of a discrete state, continuous transition maker process

Experiment 6: To study the biological effects of HVDCCC and EHV AC on human being, plants, and animals.

Experiment 7: to study Towers for transmission line and substation Structure.

Experiment 8: To study the thermal, electrical, and mechanical loading Effects on EHV system.

Experiment 9: To study Load forecasting using statistical techniques.

Experiment 10: To study Harmonic analysis using FFT and filter design (passive/active).

Experiment 11: To study Voltage stability assessment using PV/QV curves.

Experiment 12: To study Real-time fault analysis using MATLAB/ETAP.

Experiment 13: To study Power quality assessment using analyzers and data loggers.

Experiment 14: To study Reliability analysis of a power network using Markov/recursive techniques.

Experiment 15: To study advanced fault location techniques in transmission and distribution networks using impedance-based and traveling wave methods.

Resources for reference (if any)

1. Textbooks: Kundur's Power System Stability, Greenwoods Transients, IEEE 519, EMTP Manuals

Subject Name: Seminar I Subject Code: MTEE25EL106

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	CA(PR)	ESE(PR)	
04	50	--	02

Course Description

This course develops essential analytical and practical skills. Students will **research and critically analyze recent technical topics**, drawing from their undergraduate and postgraduate studies. Key activities include **developing high-quality technical reports** and **delivering professional oral presentations**, enhancing both written and verbal communication. This seminar fosters independent learning and prepares students to effectively convey complex engineering information.

Course Objectives:-

1	**Analyze:** To enable students to critically analyze recent technical topics by synthesizing knowledge from undergraduate courses and current interests.
2	**Apply:** To provide students with the opportunity to apply theoretical knowledge to practical scenarios through in-depth study of selected technical subjects.
3	**Create:** To guide students in developing well-structured and comprehensive technical reports that effectively communicate complex information.
4	**Evaluate:** To foster students' ability to critically evaluate and present their research findings in a clear, concise, and engaging manner.
5	**Communicate:** To enhance students' oral communication skills through formal seminar presentations and interactive discussions.

Course Outcomes:-

CO1	**(Analyze):** Systematically analyze recent advancements and relevant technical topics from their chosen field, integrating concepts from their undergraduate studies and current academic interests.
CO2	**(Create):** Construct a high-quality technical report, demonstrating proficiency in scientific writing, proper citation, and logical organization of complex technical information.
CO3	**(Apply):** Effectively apply research methodologies to gather, synthesize, and interpret information from diverse technical sources for their chosen seminar topic.
CO4	**(Evaluate):** Critically evaluate their own research findings and effectively address questions and feedback during the seminar presentation.
CO5	**(Communicate):** Deliver a professional and engaging oral presentation on their chosen technical topic, utilizing appropriate visual aids and demonstrating strong communication skills.

- **Mapping of Course Outcome with Program Outcomes**

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

A candidate is required to develop report writing skills by studying recent technical topics based on knowledge of undergraduate courses and topics studied in the first/ second semester of his/ her interest and develop presentation skills through seminar.

Subject Name: YOGA FOR STRESS MANAGEMENT Subject Code: 251MTEEAE108

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	CA(PR)	ESE(PR)	
02	50	--	01

Course Description:

This course is designed to provide students with a holistic understanding of stress and the transformative role of yoga in managing it. Integrating perspectives from both modern science and ancient Indian wisdom, the course explores the physiological, psychological, and spiritual dimensions of stress. Students will learn and practice various yoga techniques—including asanas, pranayama, relaxation methods, and meditation—that foster resilience, emotional balance, and mental clarity.

The curriculum draws insights from classical yogic texts such as the **Patanjali Yoga Sutras** and the **Bhagavad Gita**, offering a philosophical foundation for stress transformation. It also emphasizes modern tools such as stress assessment methods, diet and sleep management, and evidence-based research on yoga's effectiveness. Through practical modules, participants will develop life-enhancing skills to integrate mindfulness, physical health, and emotional well-being into their daily lives.

Course Objectives:-

1	Understand the physiological and psychological aspects of stress and its impact on overall well-being
2	Learn and practice specific yoga postures, breathing exercises, and relaxation techniques to alleviate stress.
3	Explore the connection between mindfulness, meditation, and stress reduction, fostering mental clarity.
4	Discover holistic practices that promote better sleep, nutrition, and overall lifestyle habits for stress management.
5	Develop practical skills to manage stress in daily life, enhancing resilience and promoting emotional balance.

Course Outcomes:-

CO1	**Recognize** the physiological and psychological signs and sources of stress, and **explain** its impact on overall well-being.
CO2	**Demonstrate proficiency** in a variety of yoga techniques, including postures (asanas), breathing exercises (pranayama), and relaxation methods, to effectively manage stress.
CO3	**Practice** mindfulness and meditation techniques to **cultivate** calmness, reduce anxiety, and enhance mental clarity and emotional balance.
CO4	**Integrate** healthy habits inspired by yogic principles into daily life to **foster** improved sleep, nutrition, and holistic self-care routines.
CO5	**Develop** practical strategies and resilience to **effectively cope with and navigate** stress in various life situations, promoting overall harmony and well-being.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT I

Introduction to Yoga for Stress Management - 1

Introduction to Yoga for Stress Management - 2 Stress according to Western perspective Stress Eastern Perspective Developmental process: Western and Eastern Perspective Stress Hazards and Yoga

UNIT II

Meeting the challenges of Stress - 1

Meeting the challenges of Stress – 2 Introduction to Stress Physiology, Stress, Appetite and Dietary management- Modern and Yogic perspective Sleep and Stress: understanding the relationship for effective management of stress.

UNIT III

Stress Assessment methods- a valuable tool toward stress management, Role of Yoga in prevention and management of stress related disorders – a summary of research evidence,

Concept of stress and its management - perspectives from Patanjali Yoga, Sutra - Part 1

Concept of stress and its management - perspectives from Patanjali Yoga Sutra - Part 2

Concept of stress and its management -perspectives from Patanjali Yoga Sutra - Part 3

UNIT IV

Concept of stress and its management - perspectives from Bhagavad Gita - Part 1

Concept of stress and its management - perspectives from Bhagavad Gita - Part 2

Concept of stress and its management - perspectives from Bhagavad Gita - Part 3

UNIT V

Bio-Psycho-Socio-Spiritual model of stress management Yoga practices for Stress Management Breathing practices – 1 Hands in and out breathing, Hands stretch breathing, Ankle stretch breathing Breathing practices – 2 Dog Breathing, Rabbit breathing, Tiger breathing, Sashankasana breathing Breathing practices – 3 Bhujangasana breathing, Ardha Shalabhasana breathing (alternate legs), Straight leg raising (alternate legs), Straight leg raising (both legs), Sethubandhasana lumbar stretch, Instant Relaxation Technique (IRT)

Loosening Practices – 1 Shoulder Rotation, Side bending, standing twist, Hip rotation, Thigh strengthening Loosening practices – 2 Chakki chalan, Bhunamasana Chalana, Alternative toe touching Loosening practices – 3 Side leg raising, Pavana muktasana kriya: Wind releasing pose movements, Quick Relaxation Technique (QRT)

Textbooks / References:

1. H R Nagendra and R Nagarathna. Yoga for Promotion of Positive Health. Swami Vivekananda Yoga Prakashana. 2011.
2. Contrada, R., & Baum, A. (Eds.). The handbook of stress science: Biology, psychology, and health. Springer Publishing Company. 2010
3. Al'Absi, M. (Ed.). Stress and addiction: Biological and psychological mechanisms. Elsevier.
4. Van den Bergh, O. Principles, and practice of stress management. Guilford Publications.
5. Swami Muktibodhananda, Hatha Yoga Pradipika, Bihar Scool of Yoga, 1998
6. Swami Satyananda Saraswati, Four Chapters on Freedom, Bihar Scool of Yoga, 1975
7. Swami Tapasyananda, Srimad Bhagavat Gita, Sri Ramakrishna Math, 2012

SEMESTER-II

Subject Name: POWER SYSTEM DYNAMICS AND CONTROL

Subject Code: MTEE25PC201

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course introduces students to the dynamic behavior of power systems, focusing on small-signal and transient stability. It provides a deep understanding of synchronous machine modeling, dynamic simulations, and system response under various operating conditions. Students will learn analytical techniques for studying power system stability using classical and modern control theory, including eigenvalue analysis and state-space modeling. Emphasis is also placed on practical stability enhancement methods such as excitation control systems and Power System Stabilizers (PSS). Through theoretical and simulation-based learning, the course aims to equip students with the skills needed for dynamic stability assessment and control in modern power systems.

Course Objectives:-

1	To review the fundamentals of dynamic systems in the context of power system operation.
2	To understand the nature of small-signal and transient stability problems in power systems
3	To identify and analyze factors affecting power system stability.
4	To apply mathematical and analytical techniques for small-signal and transient stability studies.
5	To study the implementation and effectiveness of power system stabilizers and excitation control systems.

Course Outcomes:-

CO1	**Develop and utilize** various models of synchronous machines for power system dynamic analysis.
CO2	**Analyze** the dynamic performance of a Single Machine Infinite Bus (SMIB) system under various operating conditions and disturbances.
CO3	**Explain** the philosophy and **assess** the applications of Power System Stabilizers (PSS) and excitation control systems.
CO4	**Perform** small-signal stability analysis for power systems, evaluating the impact of controllers on system performance.
CO5	**Apply** various techniques to **enhance** power system small-signal stability and dynamic performance.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Dynamics of Synchronous Generator Connected To Infinite Bus [7 Hours]

Review of Classical Methods System model, states of operation and system security, steady state stability, transient stability, simple representation of excitation control. System model, synchronous machine model, calculation of Initial conditions, system simulation, other machine models, inclusion of SVC model.

UNIT-II: Analysis of Single and Multi-Machine System [7 Hours]

Small signal analysis, applications of Routh-Hurwitz criterion, analysis of Synchronizing and damping torque, state equation for small signal model Simplified model, improved model of the system for linear load, Inclusion of dynamics of load and SVC, introduction to analysis of large power system.

UNIT III: Power System Stabilizers [7Hours]

Basic concepts of control signals in PSS, structure and tuning, field implementation and operating experiences, example of PSS design and application, future trends.

UNIT-IV: Signal Stability Analysis without Controllers [7 Hours]

Classification of Stability, Basic Concepts and Definitions: Rotor angle stability, The Stability Phenomena. Fundamental Concepts of Stability of Dynamic Systems: Statespace representation, stability of dynamic system, Linearization, Eigen properties of the state matrix: Eigen values and eigenvectors, modal matrices, Eigen value and stability, mode shape and participation factor. Single-Machine Infinite Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example, Effects of Field Circuit Dynamics: synchronous machine, network and linearized system equations, block diagram representation with K-constants; expression for Kconstants (no derivation), effect of field flux variation on system stability: analysis with numerical example.

UNIT-V: Small-Signal Stability Analysis with Controllers [7 Hours]

Effects Of Excitation System: Equations with definitions of appropriate Kconstants and simple thyristor excitation system and AVR, block diagram with the excitation system, analysis of effect of AVR on synchronizing and damping components using a numerical example, Power System Stabilizer: Block diagram with AVR and PSS, Illustration of principle of PSS application with numerical example, Block diagram of PSS with description, system state matrix including PSS, analysis of stability with numerical example.

References Books:

1. Power System Dynamics and Stability, P. W. Sauer and M. A. Pai, Stipes Publishing Co, 2007
2. Dynamic Models for Steam and Hydro Turbines in Power System Studies,IEEE Committee Report, IEEE Trans., Vol.PAS-92, pp 1904-1915, November/December, 1973. on Turbine-Governor Model.
3. Power System Dynamics Analysis and Simulation, R.Ramunujam,PHI Learning Private Limited, New Delhi, 2009
4. Power System Stability and Control, P. Kundur,McGraw-Hill, 1993

Subject Name: ADVANCE POWER SYSTEM PROTECTION

Subject Code: MTEE25PC202

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	**TU (Hrs/Week)**	**MSE**	**CA**	**ESE**	
03	**--**	**20**	**20**	**60**	**03**

Course Description:

This course provides a comprehensive study of modern power system protection techniques, with a focus on static and digital relays. It covers the operating principles, design, and application of various protective relays such as overcurrent, differential, distance, and microprocessor-based relays. The course also introduces advanced topics including multi-input comparators, power swing detection, and relay coordination during system disturbances. Students will learn how to analyze and design reliable protection systems for power networks using both analog and digital signal processing approaches, ensuring system stability and security under fault conditions.

Course Objectives:-

1	To understand the philosophy and application of various relays used in modern power system protection.
2	To explore digital and microprocessor-based relaying techniques for fault detection and isolation.
3	To analyze static relay components including amplitude and phase comparators.
4	To study protection schemes against faults, distance measurement techniques, and power swings
5	To apply logical and algorithmic methods for the implementation of protective relays using digital computers.

Course Outcomes:-

CO1	**Explain** the philosophy and **differentiate** the application of various protective relays used in modern power systems.
CO2	**Analyze** the basic principles of digital and microprocessor-based relaying techniques for fault detection and isolation.
CO3	**Implement and analyze** static relay logic, including amplitude and phase comparators, for specific protection functions.
CO4	**Evaluate** distance relay performance under various dynamic conditions, including power swings.
CO5	**Design and simulate** microprocessor-based protective relays using flowchart/block diagram approaches and logical/algorithmic methods.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Static Relays **[7 Hours]**

Advantages of static relays-Basic construction of static relays-Level detectors- Replica impedance – Mixing circuits-General equation for two input phase and amplitude comparators- Duality between amplitude and phase comparators.

AMPLITUDE COMPARATORS: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.

UNIT-II: Phase Comparators **[7 Hours]**

Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators. STATIC OVER CURRENT RELAYS: Instantaneous overcurrent relay-Time over-current relaysbasic principles – definite time and Inverse definite time over-current relays.

UNIT-III: Static Differential Relays **[7 Hours]**

Analysis of Static Differential Relays –Static Relay schemes –Duo bias transformer differential protection –Harmonic restraint relay.

STATIC DISTANCE RELAYS: Static impedance- Reactance–MHO and angle impedance relay sampling comparator –realization of reactance and MHO relay using sampling comparator.

UNIT-IV: Multi-Input Comparators **[7 Hours]**

Conic section characteristics-Three input amplitude comparator –Hybrid comparator-switched distance schemes –Poly phase distance schemes- phase fault scheme –three phase scheme –combined and ground fault scheme.

POWER SWINGS: Effect of power swings on the performance of distance relays –Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

UNIT-V: Microprocessor Based Protective Relays **[7 Hours]**

(Block diagram and flowchart approach only)-Over current relays–impedance relays-directional relay-reactance relay .Generalized mathematical expressions for distance relays-measurement of resistance and reactance –MHO and offset MHO relays-Realization of MHO characteristics-Realization of offset MHO characteristics -Basic principle of Digital computer relaying.

<u>References Books:</u>

1. Power system protection and Switch gear ,Badri Ram and D.N.Vishwakarma, "TMH publication New Delhi 1995.
2. Static relays, T.S.Madhava Rao, TMH publication, second edition 1989.
3. Protection and Switchgear, Bhavesh Bhalja, R. P. Mahesheari, Nilesh G hothani, Oxford University Press.
4. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International

Subject Name: DISTRIBUTED GENERATION AND MICRO GRID

Subject Code: MTEE25PE203A

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive understanding of Distributed Generation (DG) systems and microgrid technologies. It explores the integration of renewable energy sources such as solar PV, wind, and fuel cells into the existing power grid. Students will learn about the challenges and standards associated with DG, the technical requirements for grid integration, and the impact on power system stability, reliability, and quality. The course also delves into the design, operation, and control of microgrids, addressing power electronics interfaces, communication infrastructure, islanding detection, and power quality management. It aims to equip future power engineers with the skills and knowledge needed to effectively implement and operate distributed energy systems in modern smart grids.

Course Objectives:-

1	To understand the role of microgrids in addressing utility objectives and energy sustainability.
2	To explore and evaluate renewable energy sources suitable for distributed generation systems.
3	To learn about the standards, regulations, and operational challenges associated with DG and grid interconnection.
4	To gain knowledge on microgrid architecture, control strategies, and operational modes.
5	To analyze power quality, protection, and economic considerations in microgrid and smart grid environments.

Course Outcomes:-

CO1	**Analyze** the role of renewable energy sources and their suitability for Distributed Generation (DG) systems.
CO2	**Explain** the fundamental philosophy and principles of Distributed Generation, including its benefits and challenges.
CO3	**Assess** the various technical and operational issues associated with DG integration into the existing power grid, including standards and regulations.
CO4	**Describe** the architecture, control strategies, and operational modes of microgrids, including power quality management.
CO5	**Evaluate** power quality issues, economic aspects, and stability of microgrids within the context of smart grid technologies.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT I – INTRODUCTION **[7 Hours]**

Conventional power generation: advantages and disadvantages, Energy crises, Nonconventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

UNIT II – DISTRIBUTED GENERATIONS (DG) **[7 Hours]**

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

UNIT III – IMPACT OF GRID INTEGRATION **[7 Hours]**

Requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

UNIT IV- MICROGRIDS **[7 Hours]**

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

UNIT V- POWER QUALITY ISSUES IN MICROGRIDS **[7 Hours]**

Power quality issues in microgrids- Modelling and Stability analysis of Microgrid, regulatory standards, Microgrid economics, Introduction to smart microgrids.

References Books:

1. Power Switching Converters: Medium and High Power, Dorin Neacsu, CRC Press, Taylor & Francis, 2006.
2. Solar Photo Voltaics, Chetan Singh Solanki, PHI learning Pvt. Ltd., New Delhi,2009.
3. Wind Energy Explained, theory design and applications,J.F. Manwell, J.G. McGowan Wiley publication,2002.
4. Biomass Regenerable Energy,D. D. Hall and R. P. Grover, John Wiley, New York, 1987.
5. Renewable Energy Resources, John Twidell and Tony Weir, Tyalor and Francis Publications, 2005.

Subject Name: SMART GRID DESIGN AND ANALYSIS

Subject Code: MTEE25PE203B

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	**TU (Hrs/Week)**	**MSE**	**CA**	**ESE**	
03	**--**	**20**	**20**	**60**	**03**

Course Description:

This course provides an in-depth study of smart grid systems, focusing on their design, architecture, performance, and integration with modern technologies. It explores the transition from traditional power systems to intelligent, flexible, and responsive smart grids. Topics include smart grid functions, architecture, communication technologies, metering infrastructure, performance analysis using load flow studies, and stability tools specific to smart grids. The course also emphasizes the integration of renewable energy sources (RES), energy storage systems, and wide-area monitoring through PMUs and WAMS. It prepares students to solve real-world challenges in building, analyzing, and operating next-generation power systems.

Course Objectives:-

1	To understand the essential functions and design philosophy of modern smart grids.
2	To explore smart grid architectures, market structures, and stakeholder roles.
3	To study communication protocols, monitoring tools, and advanced metering infrastructure.
4	To apply load flow and contingency analysis tools specific to smart grid operation.
5	To evaluate stability assessment tools and energy management strategies in smart grids.

Course Outcomes:-

CO1	**Explain** the essential functions and design philosophy of modern smart grids, including their architecture and market structures.
CO2	**Analyze** various smart grid communication technologies, monitoring tools, and advanced metering infrastructure.
CO3	**Apply** load flow and contingency analysis tools to **assess** the performance of smart grid designs.
CO4	**Evaluate** the stability of smart grids using specialized tools and **propose** energy management strategies.
CO5	**Analyze** the technical aspects of integrating renewable energy sources (RES) and energy storage systems into smart grids.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Introduction to Smart Grid **[7 Hours]**

What is Smart Grid? Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Comparison of Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid.

UNIT-II: Smart Grid Architectural Designs **[7 Hours]**

Smart grid – power system enhancement – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Measures - Representative Architecture - Functions of Smart Grid Components-Wholesale energy market in smart grid- smart vehicles in smart grid.

UNIT-III: Smart Grid Communications and Measurement Technology **[7 Hours]**

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS)- Advanced metering infrastructure- GIS and Google Mapping Tools.

UNIT-IV: Performance Analysis Tools For Smart Grid Design **[7 Hours]**

Introduction to Load Flow Studies - Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Fl ow Methods - Load Flow State of the Art: Classical, Extended Formulations, and Algorithms –Load flow for smart grid design-Contingencies studies for smart grid.

UNIT-V: Stability Analysis Tools For Smart Grid **[7 Hours]**

Voltage Stability Analysis Tools- Voltage Stability Assessment Techniques- Voltage Stability Indexing-Application and Implementation Plan of Voltage Stability in smart grid-Angle stability assessment in smart grid-Approach of smart grid to State Estimation-Energy management in smart grid.

<u>References Books:-</u>

1. Smart Grid: Fundamentals of design and analysis, James Momoh John Wiley & sons Inc, IEEE press 2012.
2. Smart Grid: Technology and Applications,Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, John Wiley & sons inc, 2012.
3. Smart Grid: Integrating Renewable, Distributed & Efficient Energy,Fereidoon P. Sioshansi, Academic Press, 2012.
4. The smart grid: Enabling energy efficiency and demand response,Clark W.Gellings, Fairmont Press Inc, 2009.

Subject Name: POWER SECTOR ECONOMICS RESTRUCTURING & REGULATION
Subject Code: MTEE25PE203C

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive overview of the Indian power sector with a focus on economic, policy, and regulatory aspects. It introduces students to the structure, challenges, and evolution of power sector institutions, including reforms driven by the Electricity Act 2003. The course covers core economic concepts such as tariff design, pricing strategies, investment appraisal, and cost analysis. It also emphasizes the regulatory framework and power market mechanisms such as competition, trading models, and restructuring strategies. Additionally, students will explore global case studies, electricity market pricing strategies, and non-price issues like service quality and environmental considerations. This course equips students with the analytical and policy tools necessary to contribute to the development and reform of modern power systems.

Course Objectives:-

1	To introduce students to the structure and key institutions of the Indian power sector.
2	To provide an understanding of economic concepts and regulatory mechanisms related to power sector planning and pricing.
3	To explore the framework and rationale behind power sector restructuring and market reforms.
4	To analyze power tariff principles, structures, and their impact on different consumer categories.
5	To study electricity market pricing methods and associated non-price issues like service quality and sustainability

Course Outcomes:-

CO1	**Explain** the structure, roles, and challenges of the Indian power sector institutions and their evolution.
CO2	**Apply** key economic principles and regulatory processes to power sector planning, investment, and pricing decisions.
CO3	**Analyze** various power tariff models and **evaluate** their suitability across different consumer categories and load patterns.
CO4	**Assess** the concepts, rationale, and benefits of power sector restructuring and electricity market reforms.
CO5	**Evaluate** pricing mechanisms in electricity markets and **address** non-price issues such as quality of supply, environmental impact, and social implications.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Power Sector in India **[7 Hours]**

Introduction to various institutions in an Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues challenges before the Indian power sector, Salient features of Electricity act 2003, various national policies and guidelines under this act.

UNIT-II: Power sector economics and regulation **[7 Hours]**

Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return , methods of calculations of Internal Rate of Return (IRR) and Net Present Value (NPV) of project, Short term and long term marginal costs, Different financing options for the power sector. Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

UNIT-III: Power Tariff **[7 Hours]**

Different tariff principles (marginal cost, cost to serve, average cost), Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns etc.

UNIT-IV: Power sector restructuring and market reform **[7 Hours]**

Different industry structures and ownership models Competition in the electricity sector- conditions, barriers, different types, benefits and challenges etc. Different market and trading models arrangements, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, ancillary service market, transmission market, Forward and real time markets, market power.

UNIT-V: Electricity Markets Pricing and Non-price issues **[7 Hours]**

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices, Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, environmental and social considerations) Global experience with electricity reforms in different countries.

References Books:

1. Regulation in infrastructure SeNices: Progress and the way forward - TERI, 2001
2. Paper "The real challenges in Power sector Restructuring: Instilling Public Control Through TApn, Prayas Energy Group, Energy for Sustainable Development, September 2001, www.DravaSDune.org
3. Privatization or Democratization The Key to the Crises in the ElectricitySector - The Case of Maharashtra 2002, www.prayaspune.org
4. Maharashtra Electricity Regulatory Commission.
   Regulations and Orders – www.mercindia.com
5. Various publications, reports and presentations by Prayas, Energy Group, Pune
6. Central Electricity Regulatory Commission, Regulations and Orders - www.cercind.ora
7. Electricity Act 2003 and National Policies - www.Dowermin.nic.in
8. Sally Hunt, "Making Competition Work in Electricityn, 2002, John Wiley Inc.
9. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy.
10. Market Operations in Electric Power Systems Forecasting, Scheduling and Risk Management.

Subject Name: ENERGY MANAGEMENT AND AUDITING

Subject Code: MTEE25PE203D

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a comprehensive understanding of energy management and auditing principles, covering definitions, types of audits, and the process of establishing energy management programs. It delves into energy cost analysis, load management techniques, and economic evaluation models. Key topics include energy-efficient motors, advanced metering for energy management, and optimized lighting systems. The course concludes with an in-depth analysis of economic aspects such as depreciation methods, life cycle costing, and the feasibility of cogeneration projects.

Course Objectives:-

1	To introduce the fundamental principles, definitions, and types of energy audits, along with the process of establishing an energy management program.
2	To familiarize students with energy cost analysis, load management techniques, and economic models for evaluating energy projects.
3	To educate students on the characteristics and energy efficiency aspects of electric motors and other major electrical equipment.
4	To provide an understanding of metering techniques and lighting systems for effective energy management.
5	To enable students to perform economic analysis of energy efficiency measures and evaluate cogeneration feasibility.

Course Outcomes:-

CO1	Explain the basic principles of energy audit, its types, and the methodology for establishing an energy management program.
CO2	Analyze energy cost structures, apply load management techniques, and perform economic evaluations of energy-related projects.
CO3	Evaluate the energy efficiency of electric motors and other electrical equipment, identifying potential for energy savings.
CO4	Utilize various metering techniques for energy management and optimize lighting systems for energy conservation.
CO5	Perform comprehensive economic analysis using depreciation methods, life cycle costing, and evaluate the feasibility of cogeneration projects.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT-I: Basic Principles of Energy Audit **[7 Hours]**

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit Need for energy management – energy basics – designing and starting an energy management program – energy audit process Need for energy management – energy basics – designing and starting an energy management program – energy accounting – energy monitoring, targeting and reporting-

UNIT II – Energy Cost and Load Management **[7 Hours]**

Important concepts in an economic analysis – economic models – time value of money –utility rate structures – cost of electricity – loss evaluation. Load management: demand control techniques – utility monitoring and control system-HVAC and energy management – economic justification.

UNIT-III: Energy Efficient Motors **[7 Hours]**

Energy efficient motors , factors affecting efficiency, loss distribution , constructional details, characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit applications to Systems and equipment such as : electric motors – transformers and reactors – capacitors and synchronous machines.

UNIT-IV Metering For Energy Management **[7 Hours]**

Relationships between parameters – Units of measure – typical cost factors – utility meters – timing of meter disc for kilowatt measurement – demand meters – paralleling of current transformers – instrument transformer burdens – multitasking solid-state meters – metering location vs. requirements – metering techniques and practical examples.

UNIT-V Lighting Systems And Cogeneration **[7 Hours]**

Concept of lighting systems – the task and the working space – light sources – ballasts – luminaries – lighting controls – optimizing lighting energy – power factor and effect of harmonics on power quality – cost analysis techniques – lighting and energy standards. Cogeneration: forms of cogeneration – feasibility of cogeneration – electrical interconnection.

Reference Books:-

1. Energy Efficiency for Engineers and Technologists,Eastop T.D and Croft D.R, Logman Scientific & Technical, 1990.
2. Industrial Energy Conservation , Reay D.A., first edition, Pergamon Press, 1977 .
3. IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4. Handbook on Energy Audits and Management,Amit K. Tyagi, TERI, 2003.
5. Guide to Energy Management, Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, Fifth Edition, The Fairmont Press, Inc., 2006.

Subject Name: RESEARCH METHODOLOGY & IPR

Subject Code: MTEE25RM204

TEACHING SCHEME		EXAMINATION SCHEME			CREDITS
TH(Hrs/Week)	TU (Hrs/Week)	MSE	CA	ESE	
03	--	20	20	60	03

Course Description:

This course provides a foundational understanding of the research process, from initial conceptualization to the final report. It covers key topics such as defining research problems and hypotheses, designing effective research studies, selecting appropriate sampling techniques, and applying methods for data collection and analysis. The course also addresses the ethical considerations inherent in conducting research.

Course Objectives:-

1	To introduce students to the fundamental principles, types, and importance of research methodology.
2	To equip students with the skills to identify a research problem, conduct a comprehensive literature review, and formulate a testable hypothesis.
3	To enable students to design and structure a research study, selecting the most appropriate research design for their objectives.
4	To teach students various sampling techniques and methods for collecting, analyzing, and interpreting both primary and secondary data.
5	To guide students in preparing and presenting a well-structured research report while adhering to ethical standards.

Course Outcomes:-

CO1	Differentiate between various types of research and articulate the ethical responsibilities of a researcher.
CO2	Formulate a clear research problem, conduct a literature review, and develop a sound research hypothesis.
CO3	Select and justify an appropriate research design for a given study and formulate a suitable sampling strategy.
CO4	Apply various data collection and analysis techniques to interpret research findings effectively.
CO5	Construct a well-structured research report and present research results clearly and concisely.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT I: **[8 Hours]**

Introduction to Research, Meaning and Objectives of Research, Motivation and Utility of Research, Characteristics of Good Research, Types of Research, Research Process, Ethics in Research.

UNIT II: **[8 Hours]**

Formulating the Research Problem and Hypothesis, Identification of Research Problem, Defining the Research Problem, Literature Review, Hypothesis Formulation.

Unit III: **[8 Hours]**

Research Design, Concept and Importance of Research Design, Features of a Good Research, Types of Research.

Unit IV: **[8 Hours]**

Sampling Concepts of Population, Sample, and Sampling Frame, Sampling Error and Sample Size: Characteristics of a Good Sample, Sampling Techniques.

Unit V: **[8 Hours]**

Data Collection Types and Sources of Data, Methods of Primary Data Collection, Data Collection Instruments, Data Analysis, Research Report Writing and Presentation.

References Books

1. Creswell, J. W. (Year of latest edition). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications.
2. Booth, W. C., Colomb, G. G., & Williams, J. M. (Year of latest edition). The Craft of Research. University of Chicago Press.
3. Kothari, C. R. (Year of latest edition). Research Methodology: Methods and Techniques. New Age International.
4. Kumar, R. (Year of latest edition). Research Methodology: A Step-by-Step Guide for Beginners. Sage Publications.
5. Bryman, A. (Year of latest edition). Social Research Methods. Oxford University Press.
6. Field, A. (Year of latest edition). Discovering Statistics Using [Software Name, e.g., SPSS, R, SAS]. Sage Publications.

Subject Name: PG lab-II　　　　　　　　Subject Code: MTEE25PC206

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	CA(PR)	ESE(PR)	
04	50	--	02

Course Description

This laboratory course is designed to provide practical exposure to the operation, control, and simulation of key power electronic converters and devices. Through hands-on experiments and software-based design, students will explore rectifiers, inverters, DC-DC converters, and multi-level converter architectures. The lab emphasizes both hardware-based implementation and simulation techniques using MATLAB/Simulink, enabling students to understand circuit behavior under various loads and conditions. The course also includes advanced topics such as cascaded multilevel inverters and switching converter designs to support real-world energy conversion applications in power systems and electric drives.

Course Objectives:-

1	To study the working principles of basic power electronic circuits like rectifiers, inverters, and converters.
2	To design and simulate different AC–DC, DC–DC, and DC–AC converters using MATLAB/Simulink.
3	To analyze the performance of converters with resistive and inductive loads.
4	To understand the behavior of multilevel and advanced topologies used in modern power electronics.
5	To develop circuit analysis and troubleshooting skills using both hardware and software platforms

Course Outcomes:-

CO1	Understand and operate single-phase controlled and uncontrolled rectifiers with various loads.
CO2	Simulate and analyze the performance of AC voltage controllers and inverters.
CO3	Design and implement buck, boost, and buck-boost converters and study their performance characteristics.
CO4	Model and simulate advanced converter topologies such as multilevel inverters and cascaded H-bridge systems
CO5	Develop proficiency in using simulation tools and hardware kits for validating theoretical designs.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

Course Outcome (CO)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2		2						1	
CO2	3	2	3	2						3	
CO3	3	3	2	3						3	
C04	3	3	3	2				1	2	3	1
C05	2	2	3	3				1		3	

Experimental Set-up:

Category	Details
Software Tools	MATLAB/Simulink, PSIM, LTspice, Multisim
Hardware Kits	Single-phase and three-phase power electronics trainer kits, rectifier/inverter/converter boards
Measurement Tools	Oscilloscope, DSO, Multimeter, Tachometer, Power Analyzer
Control Tools	Microcontroller/DSP-based PWM generator (e.g., Arduino, DSP TMS320F28335)
Components	Thyristors, MOSFETs, IGBTs, resistive/inductive loads, filters, isolation transformers

List of Practicals to be performed

(Atleast 10 experiments should be performed from the following list)

List of experiments:

Experiment 1: To study single phase full wave-controlled rectifier with Resistive Inductive (RL) load.

Experiment 2: To study Single-phase AC voltage controller with Resistive(R) & Resistive Inductive (RL) loads.

Experiment 3: To study Single Phase Diode Bridge Rectifier with R load and capacitance filter

Experiment 4: To study Single Phase Series Inverter with Resistive(R) & Resistive Inductive (RL) loads.

Experiment 5: Design and Simulation of single phase and three phase semi-converter**.**

Experiment 6: Design and Simulation of buck-boost converter.

Experiment 7: Design and simulation of 4 level DC-DC converter.

Experiment 8: Design and simulation of Cascaded H-bridge p-level inverter.

Experiment 9: To study three-phase full-wave rectifier with RL load using simulation.

Experiment 10: Design and simulation of boost converter with feedback control.

Experiment 11: Implementation and testing of PWM inverter using microcontroller or DSP kit.

Experiment 12: Analysis and simulation of flying capacitor-based multilevel inverter.

Experiment 13: To study the design and simulation of a Modular Multilevel Converter (MMC) for HVDC applications.

Experiment 14: Implementation and testing of a Space Vector Pulse Width Modulation (SVPWM) scheme for a three-phase inverter using a microcontroller or DSP kit.

Experiment 15: To study the design and simulation of a Z-source inverter for voltage boost and sag mitigation.

- **Resources for reference (if any)**
- **Online Learning Platforms & Tutorials**

1. **NPTEL Online Courses**
   - "Power Electronics" by Prof. M. Madhusudhan Rao (IIT Kharagpur)
   - "Advanced Power Electronics and Control" by Prof. S. Jain (IIT Roorkee)
2. **Texas Instruments – Power Management Tutorials**
   - https://training.ti.com/power-management

3. **MathWorks Documentation and Examples**
    - https://www.mathworks.com/help/physmod/sps/index.html
4. **All About Circuits & Electronics Tutorials**
    - https://www.allaboutcircuits.com

- ## Simulation Tools

1. **MATLAB/Simulink (Simscape Electrical Toolbox)**
    - For designing and simulating power electronics systems, control strategies, and wavefor m analysis.
2. **PSIM**
    - A powerful simulation environment specifically for power electronics and motor drives.
3. **LTspice**
    - Free, lightweight simulator from Analog Devices useful for fast circuit prototyping.
4. **PSpice / Multisim**
    - Widely used for low-level electronic circuit simulation and testing waveforms under various loading.

- ## Resource Books for PG Lab – II (Power Electronics Laboratory)

1. **Power Electronics: Circuits, Devices and Applications**
    - Muhammad H. Rashid, 4th Edition, Pearson Education
    - Covers rectifiers, inverters, choppers, and simulation methods with practical circuit examples.
2. **Power Electronics**
    - P.S. Bimbhra, Khanna Publishers
    - Detailed treatment of thyristor-based converters, inverter operations, and lab-relevant hardware setups.
3. **Modern Power Electronics and AC Drives**
    - Bimal K. Bose, Pearson Education
    - Focuses on advanced drive systems and multilevel inverters, including PWM control strategies.
4. **Power Electronics: Converters, Applications, and Design**
    - Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, John Wiley & Sons
    - Provides analytical and design techniques relevant for simulation and testing in lab environments.
5. **Fundamentals of Power Electronics**
    - Robert W. Erickson, Dragan Maksimović, Springer
    - Core reference for DC–DC converters including buck, boost, buck-boost, and feedback control design.
6. **Power Electronics Handbook**
    - Edited by Muhammad H. Rashid, Academic Press
    - A comprehensive reference on devices, circuits, control, simulation, and industrial applications.
7. **Digital Control of High-Frequency Switched-Mode Power Converters**
    - Riccardo Tonelli, Springer
    - Useful for students working on microcontroller/DSP-based power converters and PWM control techniques.
8. **Simulation of Power Electronic Circuits Using MATLAB & Simulink**
    - Mahesh Patil, Alpha Science International
    - Ideal for learning modeling, simulation, and result analysis of experiments using MATLAB tools.

Subject Name: MINI PROJECT Subject Code: MTEE25EL207P

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	CA(PR)	ESE(PR)	
04	50	--	02

Course Description

Project work based on signal analysis, signal conditioning, state of art, professional software acquaintance like MATALAB, ETAP, PSCAD, PSIM similar work.

Course Objectives:-

1	To enable students to identify and formulate an engineering problem related to signal analysis or conditioning.
2	To provide hands-on experience in selecting and utilizing professional software tools (e.g., MATLAB, ETAP, PSCAD, PSIM) for simulation and analysis.
3	To guide students in designing and implementing a solution for the identified project problem.
4	To foster the ability to analyze and interpret the results obtained from project work and simulations.
5	To develop effective technical communication and presentation skills through project report preparation and demonstrations.

Course Outcomes:-

CO1	Students will be able to **identify, formulate, and define a problem** in the domain of signal analysis or conditioning for a mini-project.
CO2	Students will be able to **select and effectively use relevant professional software tools** (e.g., MATLAB, ETAP, PSCAD, PSIM) to simulate and analyze their project work.
CO3	Students will be able to **design and implement a practical solution or system** for the chosen mini-project problem.
CO4	Students will be able to **analyze, interpret, and validate the results** obtained from their project's simulations and implementations.
CO5	Students will be able to **prepare a comprehensive technical report and present their project work** effectively, demonstrating strong communication skills.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

Subject Name: DISASTER MANAGEMENT   Subject Code: MTEE25AE208

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	**CA(PR)**	**ESE(PR)**	
02	**50**	**--**	**1**

Course Description

This course provides an in-depth understanding of disasters, their causes, and impacts. It explores the distinction between hazards and disasters, categorizes natural and man-made disasters, and examines their repercussions on life, property, and the environment. Students will learn about disaster-prone zones in India, the role of monitoring and preparedness, and the use of technology in disaster management. The course also covers risk assessment, mitigation strategies, and global cooperation in disaster response, with a special focus on India's mitigation programs and community participation.

Course Objectives:-

1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4	Critically understand the strengths and weaknesses of disaster management approaches.
5	Planning and programming in different countries, particularly their home country or the countries they work in.

Course Outcomes:-

CO1	Capacity to integrate knowledge and to analyze, evaluate and manage the different public health aspects of disaster events at a local and global levels, even when limited information is available.
CO2	Capacity to describe, analyze and evaluate the environmental, social, cultural, economic, legal and organizational aspects influencing vulnerabilities and capacities to face disasters.
CO3	Capacity to work theoretically and practically in the processes of disaster management (disaster risk reduction, response, and recovery) and relate their interconnections, particularly in the field of the Public Health aspects of the disasters.
CO4	Capacity to manage the Public Health aspects of the disasters.
CO5	Capacity to obtain, analyze, and communicate information on risks, relief needs and lessons learned from earlier disasters in order to formulate strategies for mitigation in future scenarios with the ability to clearly present and discuss their conclusions and the knowledge and arguments behind them.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

UNIT I: **[7 Hours]**

Introduction: Disaster: Definition, Factors and Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II: **[7 Hours]**

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human & Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease & Epidemics, War And Conflicts.

UNIT III: **[7 Hours]**

Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone To Floods & Droughts, Landslides and Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV: **[7 Hours]**

Disaster Preparedness and Management: Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V: **[7 Hours]**

Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co- Operation in Risk Assessment & Warning, People's Participation in Risk Assessment. Strategies for Survival. Concept & Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

<u>Reference Books:</u>

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal bookCompany
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, NewDelhi.
1. Goel S. L. , Disaster Administration And Management Text And Case Studies" , Deep & Deep Publication Pvt. Ltd., NewDelhi.

SEMESTER-III

Subject Name: Seminar II Subject Code: MTEE25EL303S

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	CA(PR)	ESE(PR)	
04	50	50	02

Course Description

This course develops essential analytical and practical skills. Students will research and critically analyze recent technical topics, drawing from their undergraduate and postgraduate studies. Key activities include developing high-quality technical reports and delivering professional oral presentations, enhancing both written and verbal communication. This seminar fosters independent learning and prepares students to effectively convey complex engineering information.

Course Objectives:-

1	**Analyze:** To enable students to critically analyze recent technical topics by synthesizing knowledge from undergraduate courses and current interests.
2	**Apply:** To provide students with the opportunity to apply theoretical knowledge to practical scenarios through in-depth study of selected technical subjects.
3	**Create:** To guide students in developing well-structured and comprehensive technical reports that effectively communicate complex information.
4	**Evaluate:** To foster students' ability to critically evaluate and present their research findings in a clear, concise, and engaging manner.
5	**Communicate:** To enhance students' oral communication skills through formal seminar presentations and interactive discussions.

Course Outcomes:-

CO1	**(Analyze):** Systematically analyze recent advancements and relevant technical topics from their chosen field, integrating concepts from their undergraduate studies and current academic interests.
CO2	**(Create):** Construct a high-quality technical report, demonstrating proficiency in scientific writing, proper citation, and logical organization of complex technical information.
CO3	**(Apply):** Effectively apply research methodologies to gather, synthesize, and interpret information from diverse technical sources for their chosen seminar topic.
CO4	**(Evaluate):** Critically evaluate their own research findings and effectively address questions and feedback during the seminar presentation.
CO5	**(Communicate):** Deliver a professional and engaging oral presentation on their chosen technical topic, utilizing appropriate visual aids and demonstrating strong communication skills.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

A candidate is required to develop report writing skills by studying recent technical topics based on knowledge of undergraduate courses and topics studied in the first/ second semester of his/ her interest and develop presentation skills through seminar.

Subject Name: PROJECT PHASE - I Subject Code: MTEE25EL304P

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	**CA(PR)**	**ESE(PR)**	
--	100	100	20

Course Description: Experiential Learning (Project-I)

This course is the foundational phase of a student's major project work. It guides students in applying their engineering knowledge to address real-world problems in industry or society. Key activities include identifying a relevant work area, conducting a thorough literature survey, formulating a clear problem statement, and defining the project's aims, objectives, and probable solution methodologies. Students will document their initial findings and future work in a comprehensive Project Phase-I report and present their progress.

Course Objectives:-

1	**Analyze:** To enable students to critically analyze real-world problems and identify suitable areas for engineering intervention within industry or society.
2	**Research:** To guide students in conducting comprehensive literature surveys to understand existing knowledge, identify research gaps, and validate problem significance.
3	**Formulate:** To develop students' ability to clearly and concisely formulate a well-defined engineering problem statement based on their analysis and literature review.
4	**Design:** To train students in defining the specific aims and measurable objectives of a project, along with outlining probable solution methodologies.
5	**Document:** To facilitate the development of skills in preparing a detailed and comprehensive technical report (Project Phase-I), documenting the problem formulation, literature survey, and proposed methodology.

Course Outcomes:-

CO1	**(Analyze):** Systematically identify a relevant area of work and conduct a detailed literature survey to understand the existing state-of-the-art and identify research gaps.
CO2	**(Formulate):** Accurately formulate a well-defined and concise problem statement that clearly articulates the challenge to be addressed.
CO3	**(Design):** Clearly define the specific aims and measurable objectives of the project, along with outlining appropriate and probable solution methodologies.
CO4	**(Communicate):** Effectively present the formulated problem, aims, objectives, and methodologies to an audience, demonstrating strong oral communication skills.
CO5	**(Create):** Produce a comprehensive Project Phase-I report, meticulously documenting the literature review, problem statement, project aims, objectives, and proposed methodologies.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

The candidate who has presented will now formulate an appropriate problem statement for topic selected and define the aim and objectives along with then probable methodologies useful for the solution for the problem statement at the end of semester he/ she will make a comprehensive project Phase-I report in detail and make the presentations along with the future work towards fulfillment of the Project Phase-I.

SEMESTER-IV

Subject Name: PROJECT PHASE - II   Subject Code: MTEE25EL401P

TEACHING SCHEME	EXAMINATION SCHEME		CREDIT
PR(Hrs/Week)	**CA(PR)**	**ESE(PR)**	
--	**100**	**100**	**20**

Course Description: Experiential Learning (Project-I)

This culminating course represents the final stage of the Master's project. Building on the problem formulation and initial methodologies developed in Project Phase-I, students will design, develop, and rigorously test their proposed system or solution. The emphasis is on analyzing the performance of the developed system, documenting the entire research process in a comprehensive final report, and disseminating findings through a research paper and/or final presentation. This phase consolidates all acquired engineering knowledge and skills to deliver a complete, impactful, and academically sound project.

Course Objectives:-

1	**Create:** To enable students to design, develop, and implement an engineering solution or system based on their formulated problem.
2	**Evaluate:** To guide students in systematically testing, validating, and critically evaluating the performance of their developed system against defined objectives.
3	**Analyze:** To train students in analyzing and interpreting experimental/simulation results to draw valid conclusions and identify system limitations.
4	**Document:** To facilitate the development of skills in preparing a comprehensive, high-quality technical report that meticulously documents the entire project work.
5	**Communicate:** To empower students to effectively disseminate their research findings to the academic and professional community through a research publication and/or final oral defense.

Course Outcomes:-

CO1	**(Create):** Design, develop, and successfully implement an engineering solution or system that effectively addresses the identified problem.
CO2	**(Evaluate):** Rigorously test and validate the developed system, critically evaluating its performance and functionalities against predefined criteria.
CO3	**(Analyze):** Analyze and interpret complex experimental or simulation data, drawing meaningful conclusions about the system's behavior and performance.
CO4	**(Create):** Produce a complete and professionally written project report, showcasing comprehensive documentation of the entire research, design, implementation, and analysis.
CO5	**(Communicate):** Effectively present and publish the research findings, contributing to the body of knowledge in their specific domain.

Mapping of Course Outcome with Program Outcomes

CO-PO Mapping Table (with Strength of Correlation: 3-High, 2-Medium, 1-Low):

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

Based on the total work carried out in semester III and satisfactory performance, a candidate will be allowed to prepare the Project report for the final submission and evaluation.