SCHEME & SYLLABUS

(Choice Based Credit System)

for

M. TECH.

in

POWER SYSTEM

(w.e.f. Session 2019-20)

Program Code: EE-401

DEPARTMENT OF ELECTRICAL ENGINEERING

SCHOOL OF ENGINEERING

RIMT UNIVERSITY, MANDI GOBINDGARH, PUNJAB

TABLE OF CONTENTS

SECTION 1

Vision & Mission of the University

VISION

To become one of the most preferred learning places a centre of excellence to promote and nurture future leaders who would facilitate in desired change in the society

MISSION

M1: To impart teaching and learning through cutting edge technologies supported by the world class infrastructure

M2: To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values

SECTION 2

Vision and Mission of the Department

VISION

The Department of Electrical Engineering will provide programs of the high quality to produce world class competent engineers who can address challenges and are successfully involved in innovative research . It commits itself to impart the skills, knowledge and attitudes to create, interpret, apply and disseminate engineering to build better future for humankind.

MISSION

M1 :To create the environment that facilitates learning fundamentals of electrical engineering

M2: To impart the knowledge in Electrical Circuits, Power Systems electrical machines, power electronics non conventional energy

M3:Providing better understanding of the domain of study, including wider social issues, corporate social responsibility and ethical decision making.

M4:To ensure continuous interaction of the students through MOU's and collaborative research projects.

SECTION 3

About the Program

M.Tech Power Systems Engineering course is 2 year post graduate program that familiarizes students with processes of analyzing, developing, designing and evaluating high-end power system devices, for managing a variety of challenging projects and research work. .

Successful postgraduates of M. Tech. Power System course are hired in positions such as Energy Manager, Electrical Engineer, Test Engineer, Power System Engineer, Manufacturing Engineer, R&D Engineer, Researcher and Educator may also opt for PhD in Electrical Engineering etc

SECTION 4

Program Educational Objectives (PEOs), Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Programme Education Objectives

PEO1	The Post Graduates of Power Systems engineers will be able to take important roles in the corporate and public power sectors or conduct related research at academic and research institutions.
PEO.2	Apply their knowledge and skills in power system engineering while keeping practical limits in mind for the benefit of society as a whole.
PEO.3	Participate in life-long learning and professional growth through self-study, continuing education, or professional and doctorate studies.

PROGRAMME OUTCOMES (POs)

PO 1	Independently conduct research and development activities to tackle practical challenges.
PO 2	Ability to recognise, evaluate, and address current technical challenges in the field of power systems and to offer tactical solutions that meet safety, societal, cultural, and environmental requirements.
PO 3	Ability for continued pursuance of research and to design, develop and propose theoretical and practical methodologies towards research and development support for the Power System infrastructure.
PO 4	Willingness and aptitude to take on administrative problems, including the management of numerous interdisciplinary projects, and finish them in an effective manner while taking societal, environmental, economic, and financial considerations into account.
PO 5	An ability to write and present a substantial technical report/document
PO 6	Demonstrate knowledge of contemporary issues in the area of power system engineering
PO 7	Ability to articulate ideas clearly and communicate effectively orally and in writing with others, conforming to various national and international standards and practises for content recording and presentation.
PO8	Design advanced level power system, components, or processes to meet identified needs within economic, environmental and social constraints.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1:	Capability of using sophisticated technological expertise for modelling, analysing, and solving present difficulties in the power sector from a global perspective, as well as to undertake thorough and independent investigations on multifaceted challenging issues in the field of power systems
PSO2	Ability to employ and develop novel techniques for modelling, analysing, and resolving a variety of scientific problems relating to power systems, as well as to take on technical and administrative challenges like managing a variety of interdisciplinary projects, working in a team with shared goals to tackle challenges, and inspiring the group to adopt a multidisciplinary and collaborative strategy.

SECTION 5

Curriculum / Scheme with Examination Grading Scheme

SEMESTER WISE SUMMARY OF THE PROGRAMME: B.TECH. (ELECTRICAL ENGINEERING)

S. No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	16	500	16
2.	II	20	500	18
3	III	12	500	26
4	IV	-	100	20
	Total	**48**	**1600**	**80**

EXAMINATION GRADING SCHEME

Marks Percentage Range	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A^+	9	Excellent
60-69	A	8	Very Good
55-59	B^+	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Fail
0-39	F	0	Fail
ABSENT	AB	0	Fail

Percentage Calculation: CGPA *10

FIRST SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks					Exam Duration (Hours)
Code	**Course Title**	**L**	**T**	**P**		**CWA**	**LWA**	**MTE**	**ETE**	**Total**	
MTEE101	Advance Power System Analysis & Design	3	1	0	4	16	-	24	60	100	3
MTEE102	Modern Control System	3	1	0	4	16	-	24	60	100	3
MTRM101	Research Methodology	3	1	0	4	16	-	24	60	100	3
MTEE108	Lab I (Power System software Lab)	0	0	4	2	-	60	-	40	100	2
MTEE181	Seminar	0	0	0	2	-	100	-	-	100	2
Total		**9**	**3**	**4**	**16**					**500**	

TOTAL CREDITS =16

SECOND SEMESTER:

COURSE		Contact Hours/Week			Credit	% of Total Marks					Exam Duration (Hours)
Code	Course Title	L	T	P		CWA	LWA	MTE	ETE	Total	
MTEE103	Power System operation and control	3	1	0	4	16	-	24	60	100	3
MTEE104	Advance Electrical Machines	3	1	0	4	16	-	24	60	100	3
MTEE105	Power Electronics Devices and controllers	3	1	0	4	16	-	24	60	100	3
MTEE109	Lab II (Simulation Lab)	0	0	4	2	-	60	-	40	100	
ELECTIVE-I		3	1	0	4	16	-	24	60	100	3
Total		**12**	**4**	**4**	**18**					**500**	

TOTAL CREDITS =18

THIRD SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks					Exam Duration (Hours)
Code	**Course Title**	**L**	**T**	**P**		**CWA**	**LWA**	**MTE**	**ETE**	**Total**	
MTEE106	Power System Dynamics & Stability	3	0	0	4	16	-	24	60	100	3
MTEE107	Modern Power System Protection	3	1	0	4	16	-	24	60	100	3
MTEE182	Pre Synopsis Seminar	0	0	0	4	16	-	24	60	100	3
MTEE183	Project	0	0	0	10	-	60	-	40	100	
ELECTIVE-II		3	1	0	4	16	-	24	60	100	3
Total		**9**	**3**	**0**	**26**					**500**	

TOTAL CREDITS =26

FOURTH SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks					Exam Duration (Hours)
Code	**Course Title**	**L**	**T**	**P**		**CWA**	**LWA**	**MTE**	**ETE**	**Total**	
MTEE190	**Dissertation**	0	0	0	20	-	-	-	-	100	

TOTAL CREDITS =20

LIST OF ELECTIVE SUBJECTS WITH RESPECTIVE SPECIALISATION:

Power System		
Elective I	MTEE140	Non-conventional energy resources
Elective II	MTEE141	Power System Reliability
Power Engineering		
Elective I	MTEE142	EHVAC & HVDC Transmission System
Elective II	MTEE143	Electric Traction System
Power Electronics		
Elective I	MTEE144	Solid State Power Controllers
Elective II	MTEE145	High Power Converters

TOTAL MARKS= 500+500+500 = 1500
TOTAL CREDITS= 20+18+8+10+10+14 = 80

First semester

SUBJECT TITLE: ADVANCED POWER SYSTEM ANALYSES AND DESIGN
SUBJECT CODE: MTEE101
SEMESTER: I
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objectives

The objective of the subject Advanced Power System Analysis and Design is:

- To aware the students to understand the Network modelling and conditioning of matrices for power system network.
- To provide a solid foundation in mathematical and engineering fundamentals required to solve the problems with the help of sequential techniques.
- To allow students discuss about system results and their testing in order to meet the load demand optimally and importance of reactive power control.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Load Flow:** Network modelling – Conditioning of Y Matrix – Load flow-Newton Raphson method- Decoupled – Fast decoupled Load flow -three-phase load flow.
UNIT-II	**DC Power Flow:** Single phase and three phase -AC-DC load flow - DC system model – Sequential Solution Techniques – Extension to Multiple and Multi-terminal DC systems – DC convergence tolerance – Test System and results.
UNIT-III	**Fault Studies:** Analysis of balanced and unbalanced three phase faults – fault calculations – Short circuit faults – open circuit faults. **System Optimization:** Strategy for two generator systems – generalized strategies – effect of transmission losses - Sensitivity of the objective function- Formulation of optimal power flow-solution by Gradient method-Newton's method.
UNIT-IV	**State Estimation:** Method of least squares – statistics – errors – estimates – test for bad data – structure and formation of Hessian matrix – power system state estimation.

Course Outcomes: After studying this subject students may be able

CO1	MTEE-101.1	Basic knowledge representation of power system components and gain knowledge of symmetrical component
CO2	MTEE-101.2	Understand fault classification and analyse symmetrical and asymmetrical faults in a power network.
CO3	MTEE-101.3	Use load flow strategies to operate and design the power system.
C04	MTEE-101.4	Simulate and design various types of strategies in order to achieve optimal power system performance

Recommended Books:

1. Grainger, J.J. and Stevenson, W.D. Power System Analysis Tata McGraw hill, New Delhi.
2. Arrillaga, J and Arnold, C.P., Computer analysis of power systems, John Wiley and Sons, New York.
3. Pai, M.A., Computer Techniques in Power System Analysis, Tata McGraw hill, New Delhi.

SUBJECT TITLE: MODERN CONTROL THEORY

SUBJECT CODE: MTEE102
SEMESTER: I
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Modern Control Theory is:

- To aware the students to understand the Economic operation of power system.
- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.

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Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Mathematical Preliminaries:** Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.
UNIT-II	**State Variable Analysis:** Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and its properties. General concept of controllability,– Controllability tests for Continuous-Time Invariant Systems – general concept of Observability- observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model.
UNIT-III	**Non Linear Systems:** Introduction – Non Linear Systems - Types of Non-Linearties – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function–describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions. Introduction to phase plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.
UNIT-IV	**Stability Analysis:** Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reduced order. **Optimal Control:** Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of

	variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator.

Course Outcomes: After study this subject student will be able

CO1	MTEE-101.1	Develop dynamic system state space models
CO2	MTEE-101.2	Demonstrate the fundamental ideas of control, such as controllability, observability, poles and zeros, and stability.
CO3	MTEE-101.3	Create full-state control systems.
C04	MTEE-101.4	Design a state estimator.

Recommended Books:

1. Modern Control System Theory by M. Gopal – New Age International
2. Modern Control Engineering by Ogata. K – Prentice Hall
3. Control Systems Engineering by I.J. Nagarath and M. Gopal, New Age International (P) Ltd.
4. Digital Control and State Variable Methods – by M. Gopal, Tata Mc Graw-Hill Companies.

SUBJECT TITLE: Lab I (POWER SYSTEM SOFTWARE LAB)

SUBJECT CODE: MTEE108
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	4	2

Internal Assessment: 60
End Term Exam: 40

Course objectives

1. To give students a practical knowledge about all types of digital circuits.
2. To give students a working knowledge to connect digital circuits and verify their truth tables.
3. To give students acknowledge about integrated circuits of different combinational and sequential circuits.

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	Design of transmission systems for given power and distance.
EXP-2	Short circuit calculations and calculations of circuit breaker ratings for a power system network.
EXP-3	Design of substations
EXP-4	Design of distribution systems
EXP-5	Y-bus formation
EXP-6	Z-bus formulation
EXP-7	Load flow analysis by Gauss-Seidal method
EXP-8	Load flow analysis by Newton Raphson method
EXP-9	Fault analysis for line-to-line (L-L), Line-to-Ground (L-G) etc
EXP-10	Design of underground cabling system for substation.
EXP-11	To obtain power system stability on High Voltage Alternating current (HVAC) system with the help of Flexible Alternating Current Transmission Systems (FACTS) devices.
EXP-12	Optimal Capacitor placement on a system having variable reactive power and low voltage profile. 13.
EXP-13	To obtain relay co-ordination on a power system.

EXP-14	To obtain optimal generator pricing on hydro-thermal and renewable energy systems

Course Outcomes : After completing the subject, the student will able to

CO1	MTEE-108.1	Demonstrate problem-solving expertise of power system analysis methods.
CO2	MTEE-108.2	Explore the underlying principles and methodologies underpinning power system network analysis utilising software tools.
CO3	MTEE-108.3	Analyse various sorts of short-circuit failures that can arise in power systems
C04	MTEE-108.4	Formulate & identify solutions to problems relevant to power system using software tools.

Note: At least ten experiments should be performed in semester.

SECOND SEMESTER

SUBJECT TITLE: POWER SYSTEM OPERATION AND CONTROL

SUBJECT CODE: MTEE103
SEMESTER: II
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Power System Operation and Control is:

- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.
- To allow students discuss about thermal and hydro power plants operation in meeting the load demand optimally and importance of reactive power control.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Introduction to Power Generation Units:** Characteristics and its variations, **Economic Operation of Power Systems:** Fuel consumption, Characteristics of thermal unit, Incremental fuel rate and their approximation, minimum and maximum power generation limits
UNIT-II	**Economic Dispatch:** Economic dispatch problem with and without transmission line losses, Unit Commitment and solution methods. Hydrothermal scheduling: fixed-head and variable head, Short- term and Long-term.
UNIT-III	**Power System Control:** Power system control factors, interconnected operation, tie-line operations, Reactive power requirements, during peak and off peak hours, Elementary ideas of load frequency and voltage, reactive power control; block diagrams of P-f and Q-V controllers, ALFC control, Static and Dynamic performance characteristics of automatic load frequency control (ALFC) and automatic voltage regulator (AVR) controllers, Excitation systems.
UNIT-IV	**Power System Security:** Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method and linear programming. **Power flow analysis in AC/DC systems:** General, modelling of DC links, solution of DC load flow, discussion, per unit system for DC quantities, solution techniques of AC-DC power flow equations.

Course Outcomes:

After study this subject, the student will able:

CO1	MTEE-103.1	Understand the operation and control of power systems
CO2	MTEE-103.2	Distribute the load between thermal plants as cheaply as possible.
CO3	MTEE-103.3	Explain the necessity of power system security and voltage stability.
C04	MTEE-103.4	Estimate the system's state using the weighted least squares method.

Recommended Books:

1. Dhillon J.S., Kothari D.P., *Power System Optimisation*, Prentice Hall India.
2. Kundur P, "*Power System Stability and Control*", Tata McGraw Hill.
3. Murthy, P.S.R., "*Power System Operation and Control*", Tata McGraw Hill.

SUBJECT TITLE: ADVANCE ELECTRICAL MACHINES
SUBJECT CODE: MTEE104

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)

Program Name: M. Tech. Power System
Program Code: EE-401

SEMESTER: II
CONTACT HOURS/WEEK:

3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Advance Electrical Machines is:

- To prepare students to perform the analysis of any electromechanical system
- To provide a mathematical and engineering fundamentals knowledge required to solve the problems of steady state and transient analysis of electrical machines.
- To empower students to understand the working of electrical equipment used in everyday life.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**POLYPHASE SYNCHRONOUS MACHINES**: Mathematical: Basic Synchronous machine parameters, Voltage, Flux linkage and inductance relations, Park's transformation – its physical concept, equations of performance **BALANCED STEADY STATE ANALYSIS**: Phasor equations and phasor diagrams, Power-angle characteristics, cylindrical rotor and Salient pole machines, Short circuit ratio
UNIT-II	**TRANSIENT ANALYSIS:** Three phase short-circuits, Armature and field transients, Transient torque, Sudden reactive loading and Unloading. Transient Analysis - a qualitative approach, Reactance and Time – Constants from equivalent circuits, Measurement of Reactance, Transient Power – angle characteristics.**SYNCHRONOUS – MACHINE DYNAMICS:** The basic electromechanical equation, Linearized Analysis, Large Angular/oscillation, Non-linear analysis.
UNIT-III	**TRANSFORMERS:** Multi-Circuit Transformers: General theory, Equivalent circuits, Three winding transformer as a multi-circuit transformers, Determination of parameters. **EXCITATION PHENOMENA IN TRANSFORMERS:** Harmonics in Single – phase transformers, Harmonics in three-phase transformers, Disadvantages of harmonics, Suppression of harmonics.
UNIT-IV	**TRANSFORMER TRANSIENTS:** In-rush current phenomena, Qualitative approach, Analytical approach, In-rush current in 3-phase transformers. **UNBALANCED OPERATION OF THREE-PHASE TRANSFORMERS:** Single-phase load on three-phase transformers, Single – Phasing in 3-phase transformers, Effect of using tertiary winding.

Course Outcomes: After study this subject student may be able:

CO1	MTEE-104.1	Analyse the operation of any electrical machine under loaded and unloaded conditions using a mathematical model.
CO2	MTEE-104.2	Examine the design, operation, and performance of single-phase induction motors and special machines.
CO3	MTEE-104.3	Determine the D.C. motor's performance equation under various load conditions and analyse the braking system.
C04	MTEE-104.4	Create an output equation for an AC machine and construct the stator and rotor for an induction machine.

Recommended Books:

1. Bimbra, P.S., Generalized theory of electrical Machines, Khanna Publications
2. Draper A, Electrical Machines, Longman London.
3. MIT Staff , Magnetic Circuits and Transformer..

SUBJECT TITLE: POWER ELECTRONICS DEVICES AND CONTROLLERS

SUBJECT CODE: MTEE105
SEMESTER: II
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Power Electronics Devices and Controllers is:

- To aware the students to understand the importance of power electronics devices.
- To provide a solid foundation in mathematical and engineering fundamentals required to control the electrical drives with the help of power electronics devices.
- To allow students discuss about device operation in order to meet the optimum performance with their operating characteristics.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**REVIEW OF SEMICONDUCTOR DEVICES:** Conduction Process in semiconductors, pn Junction, Charge control description, Avalanche breakdown, Power diodes, Thyristors, Gate Turn Off Thyristor (GTO), VI characteristics, Dynamic characteristics, ratings, protection, heat transfer by conduction, radiation and convection, heat sink design, driving circuits
UNIT-II	**POWER MOSFET AND IGBT:** Basic structure, I-V Characteristic, Physics of device operation, switching characteristics, operating limitation and safe operating area. **EMERGING DEVICES AND CIRCUITS:** Power junction Field effect transistor (FET), Integrated Gate-Commutated Thyristor (IGCT), Field Control Thyristor, Metal oxide semiconductor (MOS) Control Thyristor etc. Power ICs, new semiconductor materials.
UNIT-III	**SNUBBER CIRCUITS:** Types of Snubber circuits, needs of Snubber circuit with diode, thyristor and transistors, Turn-off Snubber, over voltage snubber, turn on snubber, Snubber for bridge circuit configurations, GTO Snubber circuit.
UNIT-IV	**GATE AND BASIC DRIVE CIRCUITS**: Design Consideration, De-coupled drive circuits, Electrically isolated drive circuits, cascade connected drive circuits, Power device protection in drive circuits, circuit layout considerations.

Course Outcomes:

After study this subject student may be able:

CO1	MTEE-105.1	Identify and apply power semiconductor devices in a variety of applications.
CO2	MTEE-105.2	Use various SCR protection and commutating circuits.
CO3	MTEE-105.3	Construct a model of control equipment in order to achieve long-term performance of power electronics devices.
C04	MTEE-105.4	Test power electronic circuits used in various domestic and industrial applications.

Recommended Books:

1. Rashid M.H., Power Electronics - Circuits, Devices and Applications, PHI, India
2. Finney D., The Power Thyristor and its Applications, McGraw Hill, New York.
3. Lander C. W. Power Electronics, McGraw Hill Book Co., U.K

SUBJECT TITLE: NON- CONVENTIONAL ENERGY RESOURCES
SUBJECT CODE: MTEE140
SEMESTER: II
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Objective and outcome of course:

The objective of the subject Non- Conventional Energy Sources is:

- To aware the students to understand the need and growth of alternative energy sources.
- To allow students discuss about renewable and non-renewable sources of energy in order to meet the load demand optimally and importance of reactive power control.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**INTRODUCTION:** Limitation of conventional energy sources, need and growth of alternative energy source, basic scheme and application of direct energy conservation.**MHD GENERATORS:** Basic principles, gaseous, conduction and hall effect, generator and motor effect, different types of Magneto-Hydro-Dynamic (MHD) generator, types of MHD material, conversion effectiveness, analysis of constant area MHD generator, practical MHD generator, application and economic aspects
UNIT-II	**THERMO-ELECTRIC GENERATORS:** Thermoelectric effects, Seeback effect, Peltier effect, Thomson effect, thermoelectric converters, figures of merit, properties of thermoelectric material, brief description of the construction of thermoelectric generators, application and economic aspect.
UNIT-III	**PHOTOVOLTAIC EFFECT AND SOLAR ENERGY:** Photovoltaic effect, different types of photovoltaic cells, cell fabrication, characteristics of photovoltaic cells, conversion efficiency, solar batteries, application, solar radiation analysis, solar energy in India, solar collectors, solar furnaces and applications.
UNIT-IV	**FUEL CELLS:** Principle of action, Gibb's free energy, general description of fuel cells, types, construction, operational characteristics and application.**MISCELLANEOUS SOURCES:** Geothermal system, hydro-electric plants, wind power, tidal energy, Bio-mass energy

Course Outcomes: After study this subject student may be able:

CO1	MTEE-140.1	Explain the generation of electricity from several non-conventional energy

		sources, as well as practical understanding of fuel cell types.
CO2	MTEE-114.2	Investigate fuel cell and magneto hydrodynamics technologies.
CO3	MTEE-140.3	To carry out field projects in the areas of solar thermal, solar PV, wind, biomass, ocean energy, geothermal, and so on.
C04	MTEE-140.4	Examine the utilisation of wind energy, solar energy, biomass energy, geothermal energy, and ocean energy

Recommended Books:

1. Rai, G.D., *Non Conventional Energy Sources*, Khanna Publishers.
2. Chakrabarti A., Soni M. L., Gupta P. V. and Bhatnagar U. S., *Power System Engineering*, Dhanpat Rai and Co.
3. Gupta B. R., *Generation of Electrical Energy*, S. Chand.
4. *Simon , Christopher A., Alternate Source of Energy*, Rowman and LittleField Publishers Inc.
5. *Venikov, V.A. and Putyain, E.V., Introduction to Energy Technology*, Mir Publishers.

SUBJECT TITLE: EHVAC & HVDC TRANSMISSION SYSTEM
SUBJECT CODE: MTEE142
SEMESTER: II
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject EHVAC & HVDC Transmission System is:

- To give the depth knowledge of the configuration and working of HVDC & AC systems.
- To allow the students to apply knowledge of steady state and transient limit in design of EHV Ac transmission

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**Overview** Comparison of EHV AC and DC transmission, description of DC transmission systems, modern trends in AC and DC transmission. **EHV AC Systems** Limitations of extra-long AC transmission, Voltage profile and voltage gradient of conductor, Electrostatic field of transmission line, Reactive Power planning and control, travelling and standing waves, EHV cable transmission system.
UNIT-II	**Static VAR System** Reactive VAR requirements, Static VAR systems, SVC in power systems, design concepts and analysis for system dynamic performance, voltage support, damping and reactive support. **HVDC System** Converter configurations and their characteristics, DC link control, converter control characteristics; Mono-polar operation, converter with and without overlap, smoothing reactors, transients in DC line, converter faults and protection, HVDC Breakers.
UNIT-III	**Corona and Interference** Corona and corona loss due to EHV AC and HVDC, Radio and TV interference due to EHV AC and HVDC systems, methods to reduce noise, radio and TV interference. **Harmonic Filters** Generation of harmonics, Design of AC filters, DC filters.
UNIT-IV	**Power Flow Analysis in AC/DC Systems** Component models, solution of DC load flow, per unit system for DC quantities, solution techniques of AC-DC power flow equations, Parallel operation of HVDC/AC systems, Multi terminal systems.

Course Outcomes: After study this subject student may be able:

CO1	MTEE-142.1	To demonstrate knowledge on EHVAC & HVDC transmission systems and operation of static converters and analysis.
CO2	MTEE-142.2	To analyze various static converters in EHVAC & HVDC system and filters.
CO3	MTEE-142.3	Explain Functions of various components in HVDC station.
C04	MTEE-142.4	Synthesize controllers for Voltage Source Converters based HVDC under DC fault conditions

Recommended Books:

1. Kimbark E., Direct Current Transmission, Vol-I, John-Wiley and sons, NY
2. Begamudre R.D., EHV AC Transmission Engineering, Wiley Eastern Press
3. Padiyar K.R., HVDC Power Transmission Systems, Wiley Eastern Ltd., New Delhi.
4. Arrillaga J., HVDC Transmission, IEE Press, London

SUBJECT TITLE: LAB II (SIMULATION LAB)
SUBJECT CODE: MTEE109
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	4	2

Internal Assessment: 60
End Term Exam: 40

Course objectives

1. To give students a practical knowledge about all types of digital circuits.
2. To give students a working knowledge to connect digital circuits and verify their truth tables.
3. To give students acknowledge about integrated circuits of different combinational and sequential circuits.

LIST OF EXPERIMENTS

Sr. No	Contents
EXP-1	Introduction to MATLAB
EXP-2	Working with Matrices
EXP-3	Relational and Logical Operations
EXP-4	Plotting Function
EXP-5	Transfer function for poles and zeros
EXP-6	Zeros and poles from transfer function
EXP-7	Step response of a transfer function
EXP-8	Impulse response of a transfer function
EXP-9	Ramp response of a transfer function
EXP-10	Time domain analysis of second order system
EXP-11	Root locus from transfer function
EXP-12	Bode plot from transfer function
EXP-13	Transfer function from state model.
EXP-14	State model from transfer function

Course Outcomes After completing the course the student will able to

CO1	MTEE-109.1	Understand the basic concepts of MATLAB coding.
CO2	MTEE-109.2	Do fault analysis modelling and coding (for 3 to 6 bus) and test the findings using MATLAB for the following faults various circumstances like LG Fault , LLG Fault , LL Fault , and 3-Phase Fault .
CO3	MTEE-109.3	Analyse the situations that leading to system overloading, conduct overload security analysis, obtain results for a particular problem using MATLAB, and do transient stability study of a specific network using MATLAB Software.
C04	MTEE-109.4	Applying the Lagrange Multiplier approach, optimise a power system network for economic load dispatch.

Note: At least ten experiments should be performed in semester.

Third Semester

SUBJECT TITLE: POWER SYSTEM DYNAMICS & STABILITY

SUBJECT CODE: MTEE106
SEMESTER: III
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Power System Dynamics & Stability is:

- To study the model of synchronous machines and stability studies of synchronous machines.
- To study the solution method of transient stability and the effect of different excitation systems.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**OVERVIEW:** Angular Stability, Transient stability, steady state stability, dynamic stability, Small Signal, Voltage Stability **MODELING OF POWER SYSTEM COMPONENTS**: Generators (Non-linear and linear models using d-q transformation, power capability curve); Excitation System (IEEE standard models); Turbine and Speed governing System; Loads (Induction motors and composite loads).
UNIT-II	**TRANSIENT STABILITY ANALYSIS:** Single Machine - Infinite Bus System; Equal Area Criterion; Multi-machine Stability; Network Reduction and Numerical Integration Methods; Methods of Improvement
UNIT-III	**SMALL SIGNAL STABILITY ANALYSIS**: Eigen Value and Participation Factor Analysis; Single machine - Infinite Bus and Multi machine Simulation; Effect of Excitation System and AVR; Improvement of Damping - Power System Stabilizer and SVS supplementary controls. **SUB SYNCHRONOUS OSCILLATIONS:** Sub Synchronous Resonance (SSR) Phenomenon; Counter measures to SSR problems
UNIT-IV	**VOLTAGE STABILITY:** P-V and Q-V curves, Impact of Load and Tap-changer Dynamics; Static Analysis, Sensitivity and Continuation Methods; Dynamic Simulation, Introduction to Bifurcation Analysis; Proximity Indices, Methods to enhance Stability Margin

Course Outcomes:
After study this subject student may be able:

CO1	MTEE-106.1	Understand the fundamental idea of stability as well as the features of power system dynamics under various pressures.
CO2	MTEE-106.2	Learn how to model synchronous machines and conduct synchronous machine stability investigations.
CO3	MTEE-106.3	Analyse the power system's stability using various numerical methodologies.
C04	MTEE-106.4	Demonstrate the effect of different excitation systems in power systems.

Recommended Books:

1. Kundur P, Power System Stability and Control, McGraw Hill.
2. Taylor C.W., Power System Voltage Stability, McGraw Hill.
3. Anderson P.M. and Foud A. A., Power System Control and Stability, IEEE Press.
4. Kimbark E., Power System Stability, Vol. I, II & III, IEEE Press.

SUBJECT TITLE: MODERN POWER SYSTEM PROTECTION

SUBJECT CODE: MTEE107
SEMESTER: III
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Modern Power System Protection is:

- To make Student able to appreciate the importance of comparators.
- To give knowledge of various types of transmission line protection techniques.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**EQUIPMENT PROTECTION** Types of transformers – Phasor diagram for a three – Phase transformer Equivalent circuit of transformer – Types of faults in transformers- Over – current protection Percentage Differential Protection of Transformers - Inrush phenomenon-High resistance Ground Faults in Transformers – Inter turn faults in transformers - Incipient faults in transformers - Phenomenon of over-fluxing in transformers - Transformer protection application chart Electrical circuit of the generator –Various faults and abnormal operating conditions-rotor fault –Abnormal operating conditions
UNIT-II	**DISTANCE AND CARRIER PROTECTION OF TRANSMISSION LINES** Introduction to distance relay – Simple impedance relay – Reactance relay – mho relays comparison of distance relay – Distance protection of a three – Phase line-reasons for inaccuracy of distance relay reach - Various options for a carrier –Coupling and trapping the carrier into the desired line section - Unit type carrier aided directional comparison relaying – Carrier aided distance schemes for acceleration of zone II.
UNIT-III	**BUSBAR PROTECTION** Introduction – Differential protection of bus bars-external and internal fault - Actual behaviours of a protective CT - Circuit model of a saturated CT - External fault with one CT saturation: need for high impedance – Minimum internal fault that can be detected by the high – Stability ratio of high impedance bus bar differential scheme - Supervisory relay-protection of three – Phase bus bars-.
UNIT-IV	**NUMERICAL PROTECTION** Introduction – Block diagram of numerical relay - Sampling theorem Correlation with a reference wave – Least error squared (LES) technique - Digital filtering-numerical over - Current protection – Numerical transformer differential protection-Numerical distance protection of transmission line

Course Outcomes: After Study this subject, student may be able:

CO1	MTEE-107.1	Acquire knowledge of evolution of digital relays from electromechanical relays, performance and operating characteristics of digital protection.
CO2	MTEE-107.2	Understand the formulas for interpolation, numerical differentiation, curve fitting, smoothing, and the least square method.
CO3	MTEE-107.3	Develop the conceptual framework of digital protection and signal conditioning.
C04	MTEE-107.4	Understand the mathematical foundations of security algorithms, finite difference approaches, sinusoidal wave-based algorithms, and sample and first derivative algorithms.

Recommended Books:

1. Y.G. Paithankar and S.R Bhide, “Fundamentals of Power System Protection”, Prentice-Hall of India,
2. P.Kundur “Power System Stability and Control”, McGraw-Hill, ,
3. . Badri Ram and D.N. Vishwakarma “Power System Protection and Switchgear”, Tata McGraw- Hill Publishing Company.

SUBJECT TITLE: ELECTRIC TRACTION SYSTEM
SUBJECT CODE: MTEE143

SEMESTER: III
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Electric Traction System is:

- To provide the students the fundamental concepts of drives and types of drives used in traction
- To train the students with a good engineering breadth so as to analyze the accessing techniques for braking system implementation in traction

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**INTRODUCTION**: Definitions, Classification and symbolization of electric vehicles on land. The general structure of an electric drive system, Concept of electrical drives, Basic features of industrial drives, review of operating and starting characteristics of different types of electric motors for various drives (AC and DC motors).
UNIT-II	**THEORETICAL FOUNDATION**: Movement of a convoy, the equation of motion of the convoy, making the thrust, making braking force, Drag the convoy, Principles of construction diagrams walk.
UNIT-III	**DRIVE MOTOR UNIT**: Electric traction motors (DC motors, induction motors, synchronous motors with electromagnetic excitation, as permanent magnet motors, linear motors) and electric drive systems specific electric traction. Units powered engines nip DC (possible solutions; engine control unit).
UNIT-IV	**DRIVES SPECIFICATION**: Estimation of rating and heating of motors, load equalization (Fly wheel effect), drives for particular services, units powered motors in AC line contact (possible solutions, engine control units), Diesel Electric units (specific problems, possible solutions, engine control units), specific aspects of electrical drive systems for high-speed trains.

Course Outcomes: After study this subject student may be able:

CO1	MTEE-143.1	Demonstrate Express working of Electric Drives and Design Electric Traction.
CO2	MTEE-143.2	To differentiate services of traction system based on speed time curve.
CO3	MTEE-143.3	To Control different types of traction motors and use various traction system auxiliaries.
C04	MTEE-143.4	To explain the distribution system of a traction system.

Recommended Books:

1. Tripathy S. C., *Electric Energy Utilization and Conservation*, Tata McGraw Hill
2. Taylor E.O., *Utilization of Electric Energy*, Orient Blackswan
3. Hughes Austin, *Electric Motors and Drives: Fundamentals, Types and Applications*, Newnes,
4. Partab H., *Modern Electric Traction,* Dhanpat Rai
5. De N.K. and Sen P.K., *Electric Drives*, PHI publication
6. Berde M.S., *Electric Motor Drives*, Khanna Publishers
7. Gupta J.B., Utilization of Electric Power and Electric Traction, S.K. Kataria and Sons

SUBJECT TITLE: POWER SYSTEM RELIABILITY
SUBJECT CODE: MTEE141
SEMESTER: III
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3 Hrs

Course Objective

The objective of the subject Power System Reliability is:

- To able to get the basic understanding of network modelling and reliability and Markov chains.
- To understand Reliability analysis of generation systems and decomposition techniques.

Contents of Syllabus:

Sr. No	Contents
UNIT-I	**PROBABILITY AND RELIABILITY:** Review of probability concepts, probability distributions, applications of binomial distribution to engineering problems, probability distribution in reliability evaluation, reliability indices, network modelling and evaluation of simple and complex networks, system reliability evaluation using probability distributions, frequency and load duration techniques, key indices of power system reliability and their calculations.
UNIT-II	**GENERATION SYSTEM RELIABILITY EVALUATION:** Concept of loss of load probability (LOLP), Energy demand, EDNS (Energy demand not served), Evaluation of these indices for isolated systems, generation system, reliability analysis using the frequency and duration techniques.
UNIT-III	**TRANSMISSION SYSTEM RELIABILITY EVALUATION:** Evaluation of LOLP and EDNS, indices for an isolated transmission system, interconnected system reliability, bulk power system reliability.
UNIT-IV	**DISTRIBUTION SYSTEM RELIABILITY EVALUATION**: Reliability analysis of radial systems with switching.

Course Outcomes: After study this subject student may be able to

CO1	MTEE-141.1	Know about reliability analysis applied to power systems.
CO2	MTEE-141.2	Understand Markov Chains and application to power systems.
CO3	MTEE-141.3	U se the concepts of reliability index computation to help with system planning analytical exercises.
C04	MTEE-141.4	Model the power system in terms of supply reliability

Recommended Books:

1. Billinton R., Power System Reliability Calculation, MIT Press, USA.
2. Endreyni, Reliability Modeling in Electric Power System, John Wiley, New York