Proposed Structure of M. Tech Electrical Engineering (Power Systems)
(2023-24)

Semester I			**Total Duration: 24 hrs/week Total Marks:500 Total Credits: 20**						
Subjects	**Teaching Scheme (Hrs) Hrs./Week**		**Examination Scheme (Marks)**						**Credits**
	L	**P**	**Theory**	**Internal Assessment**	**TW**	**PR**	**Oral**	**Total**	
Power System Modeling	04	--	50	50	-	--	--	100	04
Energy Audit &Power Quality Issues	04	--	50	50	-	--	--	100	04
Power system planning & reliability	04	--	50	50	--	--	--	100	04
Open Elective - I	04	--	50	50	--	--	--	100	04
Lab Practice - I	--	04	--	--	25	--	25	50	02
Lab Practice - II	--	04	--	--	25	--	25	50	02
	16	**8**	**200**	**200**	**50**	--	**50**	**500**	**20**

Semester II			**Total Duration: 24hrs/week Total Marks :500 Total Credits: 20**						
Subjects	**Teaching Scheme (Hrs) Hrs./Week**		**Examination Scheme (Marks)**						**Credits**
	L	**P**	**Theory**	**Internal Assessment**	**TW**	**PR**	**Oral**	**Total**	
Power System Dynamics & Stability	04	--	50	50	--	--	--	100	04
Advanced Power Electronics & Drives	04	--	50	50	--	--	--	100	04
Distributed Generation	04	--	50	50	--	--	--	100	04
Open Elective - II	04	--	50	50	--	--	--	100	04
Lab Practice - I	--	04	--	--	25	--	25	50	02
Lab Practice - II	--	04	--	--	25	--	25	50	02
Total	**16**	**8**	**200**	**200**	**50**	--	**50**	**500**	**20**

Semester III									Total Duration: 08hrs/week Total Marks :250 Total Credits: 20
Subjects	**Teaching Scheme (Hrs) Hrs./Week**		**Examination Scheme (Marks)**						**Credits**
	L	**P**	**Theory**	**Internal Assessment**	**TW**	**PR**	**Oral**	**Total**	
Seminar	--	02	--	--	50	--	50	100	05
Dissertation Stage - I	--	06	--	--	100	--	50	150	15
Total	**--**	**08**	**--**	**--**	**150**	**--**	**100**	**250**	**20**

Semester IV									Total Duration: 08hrs/week Total Marks :250 Total Credits: 20
Subjects	**Teaching Scheme (Hrs) Hrs./Week**		**Examination Scheme (Marks)**						**Credits**
	L	**P**	**Theory**	**Internal Assessment**	**TW**	**PR**	**Oral**	**Total**	
Dissertation Stage - II	--	08	--	--	150	--	100	250	20
Total	**--**	**08**	**--**	**--**	**150**	--	**100**	**250**	**20**

<u>List of Self Learning Courses, Department Electives and Open Elective</u>

Elective - I	Elective - II
Demand response & demand side management	Power Sector Restructuring & Deregulation
FACTS & HVDC	Smart Grid
Energy Storage Systems	Digital Protection of Power System

Power System Modeling

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Describe and apply the mathematical modeling of power system.
2	Model and analyze the non electrical parameters.
3	Develop, apply and analyze the mathematical modeling of transformers & transmission line.
4	Analyze and evaluate the mathematical modeling of synchronous machines.
5	Describe, apply and analyze the mathematical modeling of load and excitation system.

UNIT – I	**Power System Stability**	**(08 Hours)**
	Introduction, Statement of the Problem, Methods of Simulation, Requirements of a Reliable Electrical Power Service, Effect of an Impact upon System Components. Swing Equation, Units, Mechanical Torque, Electrical Torque, Power-Angle Curve of a Synchronous Machine, Natural Frequencies of Oscillation of a Synchronous Machine, System of One Machine against an Infinite Bus-The Classical Model, Equal Area Criterion, Classical Model of a Multi machine System, Classical Stability Study of a Nine-Bus System, Short comings of the Classical Model, Block Diagram of One Machine.	
UNIT – II	**Modeling of Non-Electrical Parameters**	**(08 Hours)**
	Different areas of power system analysis, Need for mathematical modeling of power system, Simplified models of non-electrical components such as boiler, steam & hydro turbine, governor system	
UNIT – III	**Modeling of Transformers &Transmission Line**	**(08 Hours)**
	Transformer modeling for two winding transformer, tap-changer, phase shifting transformer, three winding transformer and auto-transformer Modeling of transmission network, Transformation to Alpha-Beta components using D-Q components, Steady state equations.	
UNIT – IV	**Synchronous Machine Modeling**	**(08 Hours)**
	Introduction, Park’s Transformation, Flux Linkage Equation, Voltage Equations, Formulation of State-Space Equation, Current Formulation, Per Unit Conversion, Normalizing Voltage equations, Normalizing Torque Equations, Torque & Power Equivalent Circuit of Synchronous Machine	
UNIT – V	**Load and Excitation System Modeling**	
	Basic Load Modeling concepts, Static load representation, Dynamic load representation, Induction motor (as load) modeling, synchronous motor (as load) modeling, acquisition of load model parameters Types of excitation systems, Control and protective systems, Modeling of excitation systems (excitation system components and entire excitation system, Voltage Response Ratio, Exciter voltage ratings	**(08 Hours)**

Text Books:

1. K. R. Padiyar”, Power System Dynamics”, B.S. Publications
2. John J. Granier & W.D. Stevenson Jr., “Power System Analysis “, 4th Edition, McGraw Hill

International Student Edition
3. Olle Elegard, “Electrical Energy System Theory - An Introduction”, TMH Publishing Company, 2nd Edition
4. Kundur, “Power System Dynamics & Control”, IEEE Press, New York
Reference Books:
1. Anderson & Foud, “Power System Control & Stability”, Vol-I, IEEE Press, New York
2. P.S.R Murthy, “ Power System Operation & Control”
Internal Assessment
Continuous evaluation by Assignments/Presentation/Quiz/Test

Energy Audit & Power Quality Issues

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Apply and Analyze the concept of energy audit.
2	Analyze and evaluate the energy conservation and its economics.
3	Describe, estimate and evaluate the voltage sag.
4	Depict and analyze the transient over voltages.
5	Review and analyze the harmonics.

UNIT - I	**Energy Audit**	**(08 Hours)**
	Definition, Need of energy audit, Preliminary and detailed energy audit. Procedure for carrying out energy audit, Instruments used for energy audit, Data Analysis-Energy– production relationship, specific energy consumption, Sankey diagram, CUSUM Technique, Bench marking energy performance, Recommendations for energy conservation, Action plan, Executive Summary.	
UNIT - II	**Energy Conservation & its Economics**	**(08 Hours)**
	Energy conservation in motive power, Illumination, Heating & cooling systems, Pumping systems, Thermal power stations and Transmission & Distribution Sector. Cogeneration &Waste heat recovery systems. Cost factors, Budgeting, Standard costing and Sources of capital, Cash flow diagram and activity chart, Simple Pay back period analysis, Time value of money, Net present value method, internal rate of return method, Profitability index for benefit cost ratio.	
UNIT - III	**Voltage sag; swells and interruptions**	**(08 Hours)**
	Introduction; importance of power quality; terms and definitions of power quality as per IEEE std. 1159. Sources & Effects of Power Quality Problems; Sources of sag; swell and interruptions; Estimation of voltage sag performance; Fundamental principles of protection; solutions at end user level; utility systems and fault clearing issues; motor starting sags; evaluation of the economics of different alternatives.	
UNIT - IV	**Transient Over- Voltages**	**(08 Hours)**
	Sources of transient over voltages; capacitor switching; lightening; Ferro resonances and other switching transients; Principles of over voltage protections; devices of over voltage protections; Utility capacitor switching transients; Utility system lightening protection; managing Ferro resonance; switching transients problems with loads; computer tools for transient analysis.	
UNIT - V	**Fundamentals of Harmonics and its Analysis**	**(08 Hours)**
	Introduction; the Mechanism of Harmonic Generation; Definitions and Standards: Factors Influencing the Development of Standards, Existing Harmonic Standards, General Harmonic Indices.	

	Introduction to Harmonic Analysis; Fourier Series and Coefficients; Simplifications Resulting from Waveform Symmetry; Complex Form of the Fourier Series; Convolution of Harmonic Phasors; The Fourier Transform; Sampled Time Functions; Discrete Fourier Transform (DFT); The Nyquist Frequency and Aliasing; Fast Fourier Transform (FFT); Window Functions; Efficiency of FFT Algorithms; Alternative Transforms.	

References:

1. Understanding power quality problems; voltage sag and interruptions - M. H. J. Bollen IEEE press; 2000; series on power engineering.
2. "POWER SYSTEM HARMONICS", Second Edition By Jos Arrillaga and Neville R. Watson; John Wiley and Publication, 2003 ISBN: 0-470-85129-5.
3. Electrical power system quality - Pogei C. Dugan; Mark F. McGranghan; Surya santoso; H. Wayne Beaty; second edition; McGraw Hill Pub.
4. Power system quality assessment - J. Arrillaga; M.R. Watson; S. Chan; John Wiley and sons.
5. Electric power quality - G. J. Heydt.
6. Power system harmonics: Computer modeling and analysis- Enriques Acha; Manuel Madrigal; John wiley and sons ltd.
7. Power System Harmonics – J. Arrillaga & N. Watson
8. IEEE std 519-1992/ IEEE std 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.
9. ECBC Code 2007 (Edition 2008) published by Bureau of Energy Efficiency; New Delhi Bureau of Energy Efficiency Publications Rating System; TERI PUBLICATIONS GRIHA Rating System; LEEDS Publications

Internal Assessment
Continuous evaluation by Assignments/Presentation/Quiz/Test

POWER SYSTEM PLANNING AND RELIABILITY		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Apply the concept of load forecasting.
2	Explain the concept of substation design
3	Evaluate the concept of reliability and generation system model.
4	Illustrate the planning and reliability for transmission.
5	Relate the concept of planning and reliability for distribution.

UNIT - I	**Load Forecasting :**	**(08 Hours)**
	Introduction, Factors affecting Load Forecasting, Load Research, 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 sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting, Objectives & Factors affecting to System Planning , Short Term Planning, Medium Term Planning, Long Term Planning.	
UNIT - II	**Substation Design**	**(08 Hours)**
	Bus Bar material, Isolating Switches, Voltage and current transformers**,** Introduction, 3 winding- 2 winding transformer, tertiary winding (function and rating)**,** Determination of the bank rating, location, connection of capacitor bank, Earthing system, Design of earthing grid	
UNIT - III	**Generation Planning and Reliability :**	**(08 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, Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, 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 - IV	**Transmission Planning and Reliability**	**(08 Hours)**
	Transmission Planning and Reliability: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability.	
UNIT - V	**Distribution Planning and Reliability**	**(08 Hours)**
	Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices. Parallel & Meshed Networks - Introduction, Basic Evaluation Techniques, Bus Bar Failure, Scheduled Maintenance, Temporary and Transient Failure, Weather Effects, Breaker Failure.	

Text Books:	
1. Roy Billinton& Ronald N. Allan, Reliability Evaluation of Power System - Springer Publication.	
2. R.L. SullivanPower System Planning -, Tata McGraw Hill Publishing Company Ltd.	
3. Miler& Freund's, Probability and Statistic for Engineers, Pearson Education, Richard Johnson.	
Reference Books:	
1. X. Wang & J.R. McDonald, Modern Power System Planning –, McGraw Hill Book Company	
2. T. Gönen, Electrical Power Distribution Engineering - McGraw Hill Book Company	
3. B.R. Gupta Generation of Electrical Energy –, S. Chand Publications	
4. A.S. Pabla, Electrical Power Distribution Tata McGraw Hill Publishing Company Ltd.	
5. T.W.Berrie, Electricity Economics & Planning –, Peter Peregrinus Ltd., London	
6. "Power System Planning", Hyde M.Merrill, 3rd Edition, CRC press	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective - I: Demand Response and Demand Side Management		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Illustrate the concept of Demand Side Management.
2	Analyze the issues of residential and commercial Demand Side Management.
3	Describe and evaluate the different techniques of Demand Side Management.
4	Evaluate and apply the different measures and regulatory actions for energy savings and money savings.
5	Compare and analyze the measures of Demand Side Management.

UNIT - I	**Introduction**	**(08 Hours)**
	Introduction to DSM, concept of DSM, benefits of DSM, Cost reduction and environmental motives, reliability and network motives, Challenges of implementing DSM programmes.	
UNIT - II	**Residential and commercial DSM issues**	**(08 Hours)**
	Residential, Commercial, General interests of DSM, Management and organization of energy conservation awareness programs	
UNIT - III	**Ongoing programmes and initiatives**	**(08 Hours)**
	Different techniques of DSM – time of day pricing, multi-utility power exchange model, time of day models for planning, load management, load priority technique, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment.	
UNIT - IV	**Energy savings actions and money savings**	**(08 Hours)**
	No-cost actions, Short payback time actions, Medium payback time measures, Long payback time measures. regulation for energy efficiency, tariff design as a tool for DSM, Regulatory options, upgradation of standards and equipment labeling with reference to energy efficiency.	
UNIT - V	**Types of DSM measures**	**(08 Hours)**
	Energy reduction programmes, Load management programmes, Load growth and conservation programmes, Information dissemination on DSM	

References:

1. Electricity Demand-side Management, prepared by the Treasury, New Zealand, October 2005
2. Implementing Agreement on Demand Side Management Technologies and Programmes, INDEEP Analysis Report 2004, accessed 06 July 06 on http://dsm.iea.org
3. Energy Efficiency and Demand Side Management, Course Module, University of Warwick, REEEP, April 2005

Reference Books:

1. Demand-Side Management Planning [Hardcover] BY : Clark W. Gellings (Author), John H. Chamberlin (Author)
2. Energy efficiency through demand-side management By : Montana. Dept. of Natural Resources and Conservation; United States. Bonneville Power Administration
3. "Energy Conservation and Demand Management Program." Queensland Government. Queensland

	Government, n.d. Web. 2 Dec 2010.
	4. Bradbury, Danny. "Volatile energy prices demand new form of management." Business Green. Association of Online Publishers, 05 Nov 2007. Web. 2 Dec 2010.
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective - I: FACTS & HVDC		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Classify Flexible AC transmission controllers and converter topologies, issues.
2	Distinguish and decide the series and shunt compensation.
3	Evaluate the concept of Unified power flow controller.
4	Categorize and compare the different configurations of HVDC link, converter connections.
5	Identify and list out the multi terminal HVDC Systems.

UNIT - I	**FACTS**	**(08 Hours)**
	Conventional methods to increase transmission capacity, Series, Shunt reactors, Phase shifting transformers, Synchronous condensers, Flexible AC transmission controllers Basics, Challenges and needs, Static Power converter structures, AC controller based structures, DC link converter topologies, Converter output and harmonic control, Power converter control issues	
UNIT - II	**Shunt and Series Compensation:**	**(08 Hours)**
	Operation and control of thyristor controlled reactor, Thyristor switched Capacitor, SVC, STATCOM configuration and control, Applications of SVC, Power oscillation damping, Mitigation of sub-synchronous resonance, TCSC operation, Layout and protection, Applications of TCSC, Static Synchronous Series Compensator (SSSC)	
UNIT - III	**Unified Power Flow Controller:**	**(08 Hours)**
	UPFC configuration, Independent real and reactive power flow control, Control scheme for UPFC, Basic control system for P and Q control, Dynamic performance, Operational constraints of UPFC, Power flow studies in UPFC embedded systems.	
UNIT - IV	**General Background of HVDC Transmission:**	**(08 Hours)**
	EHV AC versus HVDC Transmission, Different configurations of HVDC link - Monopolar, Bipolar, Back to Back, Power flow through HVDC link, Equation for HVDC power flow, Connections of three phase six pulse and twelve pulse converter bridges, Voltage and current waveforms. Effect of delay angle, Extinction angle, Overlap angle, Control of DC voltage	
UNIT - V	**Multi Terminal HVDC:**	**(08 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	

Text Books:	
1. E.Acha, V.A.Agelidis, O.Anaya-lara and TJE MillerNewnes, Power Electronic control in Electrical Systems Oxford.	
2. N.G. Hingorani and L.Gyugi, Understanding FACTS- IEEE Press, New York.	
3. J. Arrilaga, Y.H.Liu and N.R.Watson, Flexible Power Transmission- The HVDC Options,	
Reference Books:	
1. T J E Miller, "Reactive Power Control in Electric Systems", John Wiley	
2. Padiyar K R "FACTS Controllers in Power Transmission & Distribution", New Age.	
3. R. Mohan and R.K.Varma, "Thyristor-Based FACTS Controllersfor Electrical Transmission Systems", IEEE Press.	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective - I: Energy Storage Systems		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Learn about economics of ESS.
2	Explain Energy Storage source andstorage systems.
3	Illustrate battery chargers and battery testing procedures.
4	Describe battery management system and other energy storage systems.
5	Examine recycling technologies and battery charging :

UNIT - I	**Electrical Energy Storage:**	**(08 Hours)**
	Introduction to energy storage sources and storage,requirements of energy in electric vehicles. Capacitor, Battery, Fuel cell, Supercapacitor and their comparison, AC/DC capacitors, Challenges in concept of hybridization of different energy storage devices. High capacity and low capacity applications of energy storage devices.	
UNIT - II	**Energy Storage Source and Storage Systems:**	**(08 Hours)**
	LAB all aspects, Lithium Batteries (LMO, NMC, LFP and LTO with their comparative study) and sodium ion, Zinc air, Aluminium –air batteries, Lithium supercapacitor, Asymmetrical supercapacitors, supercapacitors and battery combination for e-mobility application, Classification of Fuel Cells,Specifications of Fuel cells, Hydrogen Storage, Role of various EES, Emerging needs of EES	
UNIT - III	**Battery Chargers and Battery Testing Procedures:**	**(08 Hours)**
	Introduction to various battery charging guns/ chargers, constant current and constant voltage, trickle charging methods, Hybrid methods Inductive chargers, Battery constructions, Battery specifications, Battery capacity tester, Battery testing for urban and highway driving cycles, testing for limiting thermal runaway and safety.	
UNIT - IV	**Battery Management System and other Energy Storage Systems:**	**(08 Hours)**
	Concept of C rating, Wh and Ah rating, SOH, SOC, DOD, CCA ratings, active and passive cell balancing, Fundamentals of battery management systems, block diagram and controls. Batteries, Flywheel Energy Storage System (FESS), Super Capacitor Energy Storage (SCES), Superconducting magnetic energy storage (SMES),Parameters and characteristics of different storage technologies and their applications.	
UNIT - V	**Recycling Technologies and Battery Charging:**	**(08 Hours)**
	Introduction to IS 17387: 2020, Technology and economic aspects of battery recycling, lead acid battery recycling. Introduction of lithium recycling, Supply chain in battery industry. Types of EV charging stations, Selection and sizing of charging station, Components and specification of charging station, introduction to various charging system guns and their comparative study, V2X concept	

References:

1. Energy Storage for Power System, 2E, A.G. Tar-Gazarian, IET Power & Energy Series 63, Peter Peregrines Ltd, The Institute of Engineering & Technology London, UK.
2. Electrical Vehicle Technology Explained, James Larminie, John Lowory, John Willy & Sons ltd. The

Atrium, Southern Gate, Chichester, West Sussex, PO19 S8Q, England.	
3. Report: Validating Modeling of Electrochemical Energy Storing Devices. Niklas Mellgren, Sept. 2009, Royal Institute of Technology, SE-100 44 Stockholm, Sweden.	
4. Energy Storage, Robert A. Huggins, Springer. DOI 10.1007/978-1-4419-1024-0	
5. Energy Storage, Richard Basxter, PenWell Corporation, 1421 South Sheridan Road, Tulsa, Oklahoma 74112-6600 USA.	
6. Large Energy Storage System, Frank Barnes, Jonah Levine, Tayler & Fransis Group, CRC Press.	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Lab Practice I		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 04 Hours / Week	TW: 25 Marks & OR: 25 Marks	Practical: 02 Credits
		Total: 02 Credits

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Apply the knowledge to design the practical circuits for applications
2	Model and simulate different electrical and electronics systems
3	Simulate and test the circuit performance for comparative study.

The lab practice -1 will be comprising of at least TWO experiments from each of the courses such as representation of Power System Elements like Synchronous machines, transformers, transmission lines, loads, power system load flow, short circuit studies and power system stability studies, modeling of energy storage devices and renewable energy systems using MATLAB-SIMULINK, ETAP, CAPS software.

Lab Practice II		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 04 Hours / Week	TW: 25 Marks & OR: 25 Marks	Practical: 02 Credits
		Total: 02 Credits

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Apply the knowledge to design and analyze the power system.
2	Evaluate the model for optimization.
3	Conclude the study with future scope.

The lab practice -II is based on topics for Design and analysis of Power system by application software .

Power System Dynamics and Stability		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Examine and conclude classical methods of power system dynamics
2	Inspect and estimate small signal stability.
3	Compare and elaborate large signal analysis methods
4	Discuss power system stabilizers.
5	Compare and compile multi machine system.

UNIT - I	**Classical Methods of Power System Dynamic Studies**	**(08 Hours)**
	Equality and inequality constraints in power system operation, state transition diagram, concept of system security and stability, classical model of system of one machine connected to infinite bus, Clark diagram for two machines series reactance system, extension of Clark diagram to cover any reactance network, elementary model of overall power system	
UNIT - II	**Small Signal Stability**	**(08 Hours)**
	Small signal analysis, analysis of synchronizing & damping torque, state equation for small signal model, Simplified synchronous machine model, calculation of initial conditions, system simulation, improved model of synchronous machine, small signal stability of multi machine system	
UNIT - III	**Large Signal Analysis**	**(08 Hours)**
	Elementary view of transient stability, Large signal analysis, Analysis using numerical integration methods (Modified Euler's, Runge-Kutta), Simulation of power system dynamic response, Analysis of unbalanced faults, Case study of a large system	
UNIT - IV	**Power System Stabilizers**	**(08 Hours)**
	Basic concepts of control signals in power system stabilizers (PSS), Structure and tuning, Field implementation, PSS design and application, Future trends	
UNIT - V	**Multi-machine system**	**(08 Hours)**
	Simplified model, Improved model of the system for linear load, Inclusion of load and SVC, Introduction to analysis of large power system	

References:

1. K R Padiyar, "Power System Dynamics", B S Publications
2. PrabhaKundur, "Power system Stability & control", TMH
3. C.W.Taylor, "Power System Voltage Stability", TMH

Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Advanced Power Electronics & Drives		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Decide and design the voltage source converters for harmonic elimination and voltage control.
2	Choose, compare and develop current source convereters.
3	Compare and conclude the multilevel inverters for reactive power compensation.
4	Choose and design the DC Drives.
5	Decide and develop the synchronous motor drives.

UNIT - I	**Voltage Source Converters**	**(08 Hours)**
	Review of 3-ph-full wave bridge converter, operation and harmonics, 3 level voltage source converters. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques. Converter rating.	
UNIT - II	**Current source converters**	**(08 Hours)**
	(i) Matrix Converter: 3×3 matrix converter, principle of working, mathematical treatment, comparison of matrix converter with multipulse converter (ii) Self and Line commutated current source converter: Basic concepts of CSC, converters with self commutating devices	
UNIT - III	**Multilevel Inverters**	**(08 Hours)**
	Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, switching device currents, D.C. link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel inverters. Applications of multilevel Inverter: Reactive power compensation Back to back intertie system	
UNIT - IV	**DC Drives**	**(08 Hours)**
	Single phase and 3 phase converter drives. Four quadrant Chopper drives, closed loop control of DC motor, Permanent magnet DC motor drives, DC Servo drives, applications	
UNIT - V	**Synchronous Motor Drives:**	**(08 Hours)**
	Voltage and frequency control, closed loop control of synchronous motors. Synchronous motor servo drive with sinusoidal waveform, synchronous motor servodrive with trapezoidal waveform. Load commutated invertor drives, speed control of synchronous motors by cyclo-convertors, applications	

References:

1. Bimal K Bose, Modern power electronics and AC drives, Pearson education asia
2. G. K. Dubey, Fundamentals of Electrical Drives CRC press 2002
3. M. H. Rashid Power Electronics, Prentice Hall of India Pvt. Ltd. New Delhi, (3rd Edition)

4. R Krishnan, Electric motor drives, modeling, analysis and control, PHI learning Pvt. ltd. 2001	
5. S.K. Pillai, A first course in electrical drives, Newage international publishers. 2010	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Distributed Generation		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Discuss the distributed generation needs and future.
2	Compare and elaborate grid integration, Integration of mini and micro generation in distribution grids.
3	Analyze and decide the protection of distributed generation.
4	Elaborate the power quality disturbances in distributed generation.
5	Justify the smart grid applications in distributed generation.

UNIT - I	**Introduction**	**(08 Hours)**
	Definition, Integration in power systems, Distributed generation advantages, needs and technology trends. Implications of DG on distribution system Economical and Financial aspects of DG in power system, case study of DG in electric power system, Future of Distributed generation.	
UNIT - II	**Distributed Generation units**	**(08 Hours)**
	Microturbines, wind generators, photovoltaic generators, fuel cells, and other technologies. Integration of mini and micro generation in distribution grids. V2G integration. The electric grid vs. micro grids: technical and historic perspective. Grid interconnection. Issues, planning, advantages and disadvantages both for the grid and the micro grid.	
UNIT - III	**Distributed Generation Protection**	**(08 Hours)**
	Distributed grids protection, Problems in distributed grids. Distributed generation interconnection relaying, sensing using CTs and PTs. Intentional and unintentional islanding of distribution systems. Passive and active detection of unintentional islands, non detection zones.	
UNIT - IV	**Power Quality Disturbances in DG**	**(08 Hours)**
	Impact of Distributed generation on power system, Fast voltage fluctuations (in wind power and solar power), rapid voltage changes, low frequency harmonics, High Distortions, Voltage dips	
UNIT - V	**Smart Grid applications in DG**	**(08 Hours)**
	General Features of smart grid, advantages, challenges of distribution system, role of DG in smart grid, smart grid power control in distributed generation environment.	

References:

1. G. Masters, Renewable and Efficient Electric Power Systems
2. Arthur R. Bergen, Vijay Vittal, Power Systems Analysis, Prentice Hall,1999.
3. D N Gaonkar, Distributed Generation, Publisher: InTech.
4. Distributed Generation in Liberalised Electricity Markets International Energy Agency ISBN: 9789264175976 (PDF)
5. Math H. Bollen, “Integration of Distributed Generation in the Power System”, Wiley & Sons

Publication.	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective II: Power Sector Restructuring & Deregulation		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes:	**After learning this course students will be able to**
1	Explain the power sector in India.
2	Relate the fundamentals of economics and power sector regulation.
3	Simplify the power tariff.
4	Inspect the power sector restructuring and market reform.
5	Examine the electricity markets pricing and non-price issues.

UNIT - I	**Power Sector in India**	**(08 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, CERC, MNRE, Load Dispatch Centers, Utilities and their roles. Critical issues / challenges before the Indian power sector, Electricity act 2003-Provision in the Generation, Transmission& Distribution Sector, Various national policies and guidelines under this act.	
UNIT - II	**Fundamentals of Economics& Power Sector Regulation**	**(08 Hours)**
	Fundamentals of economics applicable to Power Sector, Consumerbehavior, Supplier behavior, Market Equilibrium, Short- run & Long- run costs, Various costs of production- Total cost (TC), Average fixed cost (AFC), Average variable cost (AVC), Average cost (AC) and Marginal cost (MC),Relationship between short-run and long-run average costs, Perfectly competitive market, 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, Role of regulation and evolution of regulatory commission in India, Types and methods of economic regulation, Regulatory process in India.	
UNIT - III	**Power Tariff**	**(08 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, and different tariff based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff,Availability based tariff, Latest reformsand amendments	
UNIT - IV	**Power sector restructuring and market reform**	**(08 Hours)**
	Introduction to power sector restructuring,Reasons for restructuring / deregulation of power industry, Understanding the restructuring process- Entities involved, The levels of competition, The market place mechanisms and Sector-wise major changes required , Different industry structures and ownership models, Market models based on contractual arrangements-Monopoly Model, Single buyer Model, Wholesale	

	competition model and Retail competition model, Marketarchitecture, Timeline for various energy markets, Bilateral / forward contracts, The spot market, Models for trading arrangements, ISO or TSO model,Reasons and objectives of deregulation of various power systems acrossthe world-The US, The UK, The Nordic Pool and The developing countries.Congestion Management, Ancillary Services	
UNIT - V	**Electricity Markets Pricing and Non-price issues**	**(08 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:

1. Loi Lei Lai, 'Power System Restructuring &Deregulation, John Wiley & Sons Ltd.
2. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune
3. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy
4. D. S. Kirschen& G. Strbac,'Fundamentals of Power System Economics', John Wiley & Sons Ltd.
5. Central Electricity Regulatory Commission, Regulations and Orders - www.cercind.org
6. "Power System Planning", Hyde M.Merrill, 3rd Edition, CRC press

Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective II: Smart Grid

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes: After learning this course students will be able to

1	Discuss the basics of smart grid.
2	Classify and compare the smart grid technologies.
3	Categorize and conclude the smart grid technologies.
4	Elaborate the power quality management in smart grid.
5	Identify and decide the information and communication technology for smart grid.

UNIT - I	**Introduction**	**(08 Hours)**
	Concept, Needs and Functions of Smart Grid, Opportunities & Barriers, Difference Between Conventional & Smart Grid, Concept of Resilient & Self-Healing Grid, Present Developments & International Policies in Smart Grid	
UNIT - II	**Smart Grid Technologies**	**(08 Hours)**
	Smart Substations, Substation Automation, Feeder Automation, Geographic Information System (GIS), Plug-in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers	
UNIT - III	**Smart Meters and Advanced Metering Infrastructure**	**(08 Hours)**
	Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Intelligent Electronic Devices (IED) & Their Application for Monitoring & Protection, Smart Storage, Wide Area Measurement System (WAMS), Phase Measurement Units (PMU)	
UNIT - IV	**Power Quality Management in Smart Grid**	**(08 Hours)**
	Power Quality and Energy Management in Smart Grid, Power Quality Issues, Power Quality Conditioners for Smart Grid, Web Based Power Quality Monitoring, Power Quality Audit	
UNIT - V	**Information and Communication Technology for Smart Grid**	**(08 Hours)**
	Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN), Bluetooth, Zig-Bee, GPS, Wi-Fi, Wi-Max Based Communication, Wireless Mesh Network, Basics of CLOUD Computing and Cyber Security for Smart Grid, Broadband Over Power line (BPL), IP Based Protocols	

References:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press JanakaEkanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama," Smart Grid: Technology and Applications", Wiley
3. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell

4. Tony Flick and Justin Morehouse, "Securing the Smart Grid", Elsevier Inc. (ISBN: 978-1-59749-570-7)	
5. Peter S. Fox-Penner, "Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities"	
Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Elective II: Digital Protection of Power System		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 04 Hours / Week	End Semester Examination: 50 Marks	Theory: 04 Credits
	Internal Assessment: 50 Marks	Total: 04 Credits

Course Outcomes:	**After learning this course students will be able to**
1	Discuss the need of power system protection and digital protection.
2	Compare and decide the relays for protection.
3	Elaborate the elements of digital protection.
4	Analyze and decide the scheme for protection of transmission line
5	Recommend the scheme for transformer and generator protection. Also develop the model with artificial intelligence.

UNIT - I	**Introduction:**	**(08 Hours)**
	Need for Power system protection, Digital Protection: State of Art, Merits of Microprocessor relaying scheme, Power System Components, Basic Philosophy of Protection Scheme, Section of Protection Scheme, Circuit Breakers and Relays, Types and Applications. Architecture of Modern Digital Relay	
UNIT - II	**Static Relays:**	**(08 Hours)**
	Introduction to Static Relay, Overcurrent Relay, Distance Relay, Protection Schemes of transmission lines, Switched distance relay, Poly-phase relay, Relay as Comparator - Dual input Comparator, Relay characteristics by comparison of constants, Multi-input comparator, Pilot Relaying Scheme. An Expert System (ES) for Protective Relay Settings: Introduction, Problem Description, ES Approach, Typical Application.	
UNIT - III	**Elements of Digital Protection:**	**(08 Hours)**
	Basic components of a digital relay, Signal conditioning subsystem: Transducers, Surge protection circuits, Analog filtering and analog multiplexers, Conversion subsystems, Sampling Theorem, Digital filter signal aliasing error, Sample and hold circuit, Digital multiplexing, Digital to analog conversion, Analog to digital conversion, Digital relay subsystem, Digital relay as unit	
UNIT - IV	**Digital Protection of Transmission Line:**	**(08 Hours)**
	Protection scheme of transmission line, Distance Relay, Travelling wave relays. Digital protection scheme based on fundamental signal: hardware design, software design, Digital protection of EHV/UHV transmission line based on travelling wave phenomena, New relaying scheme using amplitude comparison	
UNIT - V	**Digital Protection of Transformer and Synchronous Generator:**	**(08 Hours)**
	Faults in Transformer, Schemes used for Transformer Protection, Digital Protection of Transformer Faults in Synchronous generator, Protection schemes for Synchronous generator, Digital Protection of Synchronous Generator. Fuzzy Logic (FL) for Power system Protection: Introduction, Problem Description, FL Approach, Artificial Neutral Network (ANN) in Phase Selection: Introduction, Problem Description, Measurement of fault	

	generated in high frequency components, ANN Approach.	

References:

1. "Digital Protection – Protective Relaying from Electro-Mechanical to Microprocessor" By L.P. Singh. 2nd Edition, Reprint-2004, New Age International Publisher, New-Dehli.
2. "Digital Power System Protection" By S.R. Bhide. PHI Learning Private Limited, New Delhi.
3. "Artificial Intelligence Techniques in Power Systems", By Kevin Warwick, Auther Ekwue & Raj Aggarwal, Publication : Institution of Electrical Engineers, London, UK.
4. "Digital Protection for Power system" by A.T Johns and S.K. Salman. Peter Peregrinus Ltd. Of The Institute of Electrical Engineers, London, United Kindom.
5. "Soft Computing Techniques and its Applications in Electrical Engineering" By Dr. Devendra Chaturvadi, Publication: Springer – Verlag Berlin Heidelburg.
6. "Power System Protection 4: Digital Protection and Signalling" edited by ETA Electricity Training Association. Published by Institute of Engineers, London, UK.
7. "Digital Signal Processing in Power System Protection and Control" By Waldemar Rebizant, Janusz Szafran, Andrzej Wiszniewski.

Internal Assessment	Continuous evaluation by Assignments/Presentation/Quiz/Test

Lab Practice I		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 04 Hours / Week	TW: 25 Marks & OR: 25 Marks	Practical: 02 Credits
		Total: 02 Credits

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Apply the knowledge to design the practical circuits for applications
2	Model and simulate different electrical and electronics systems
3	Simulate and test the circuit performance for comparative study.

The lab practice -1 will be comprising of at least TWO experiments from each of the courses such as power electronics for electric motors, effect of varying duty on selection of drives for enerfy efficient motors etc and Study of power semiconductor devices AC to DC, DC to DC converter circuits etc using software, design as well as building up the circuits in laboratories using MATLAB-SIMULINK, ETAP, CAPS and Ansys software.

Lab Practice II		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 04 Hours / Week	TW: 25 Marks & OR: 25 Marks	Practical: 02 Credits
		Total: 02 Credits

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Propose a suitable architecture scheme for Electric Vehicles, Hybrid Electric Vehicles and Plug in Hybrid Electric Vehicles
2	Select energy sources, power electronics and motors required for EVs and HEVs
3	Design EV & HEV system

The lab practice -II is based on topics for Design and Analysis of EV.

Contents: A brief history of EV & PHV, Basics of EV & HEV, Architectures of EV and HEV, HEV fundamentals.

Introduction to PHEVs, PHEV architectures, Power management of PHEVs, Fuel economy of PHEVs, PHEV design and component sizing, Vehicle-to-grid technology. Introduction, Principles of power electronics, Rectifiers, Converters, Inverters, Battery chargers used in EVs and HEVs, Emerging power electronic devices. Introduction, Induction motor drives, Permanent magnet motor drives, Brushed & Brushless DC motor, Switched reluctance motors. Batteries, Ultra capacitors, Fuel Cells, Controls, Aerodynamic considerations Consideration of rolling resistance, Transmission efficiency, Consideration of vehicle mass, Electric vehicle chassis & body design, General issues in design. Introduction, Fundamentals of vehicle system modeling, HEV modeling using ADVISOR & PSAT, Case studies - Rechargeable battery Vehicles, Hybrid vehicles.

References:
1. Chris Mi, M. AbulMasrur, David WenzhongGao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", 2011, Wiley publication.
2. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", 2009, CRC Press.
3. James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2003, Wiley publication.

Seminar

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Practical: 02 Hours / Week	TW: 50 Marks	Total: 05 Credits
	OR: 50 Marks	

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Identify, summarize and critically evaluate relevant literature and write a literature review on the relevant topic
2	Show evidence of clarity of argument, understanding of the chosen topic area and presentation of technical information
3	Develop written and oral presentation skills.

Seminar-I shall be on state of the art topic of student's own choice based on relevant specialization approved by an authority. Student should deliver seminar on the topic in front of the external examiners/internal examiners, faculty members and students.

Prior to presentation student should carry the details of literature survey form standard references such as international journals and periodicals, recently published reference books etc. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and Head of the department. The assessment shall be based on selection of topic and its relevance to present context, report documentation and presentation skills.

Dissertation Stage - I

TEACHING SCHEME:	EXAMINATION SCHEME:	CREDITS ALLOTTED:
Practical: 06 Hours / Week	TW: 100 Marks	Total: 15 Credits
	OR: 50 Marks	

Objective

To develop the analytical and practical skills in the students.

Course Outcomes: Upon useful completion of this lab students will be able to

1	Identify key research and development topics in the field of chosen dissertation area (Power electronics, Electrical machines, electrical drives, Energy systems and any interdisciplinary area)
2	Identify, summarize and critically evaluate relevant literature and write a literature review on the relevant topic.
3	Manage time effectively whilst working on independent research and prepare action plan.
4	Show evidence of clarity of argument, understanding of the chosen topic area, and presentation of technical information

5	Develop written and oral presentation skills.

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work will be evaluated in stage I (after semester III) by the departmental evaluation committee.

References:

1. Various books, research papers on the topic selected for the dissertation.

Dissertation Stage - II		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Practical: 08 Hours / Week	TW: 150 Marks	Total: 20 Credits
	OR: 100 Marks	

Objective	
To develop the analytical and practical skills in the students.	
Course Outcomes: Upon useful completion of this lab students will be able to	
1	Manage time and other resources effectively whilst working on independent research.
2	Identify, analyses and interpret suitable data to enable the research problem to be solved.
3	Model, Simulate/ develop innovative hardware/ develop new algorithms/ emulate/ HIL/ develop prototype for the selected topic.
4	Describe the process of carrying out independent research in written format and report your results and conclusions with reference to existing literature and Analyze and synthesize research findings.
5	Use and develop written and oral presentation skills and prepare good technical project reports for publication in journals and conferences.
6	Take up challenging issues in industry and provide solutions.

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work will be evaluated in stage II (after semester IV) by the departmental evaluation committee and final viva voce will be conducted by the external examiner

References:

1. Various books, research papers on the topic selected for the dissertation.