ELECTRICAL ENGINEERING DEPARTMENT

Structure and syllabus

Of

M. Tech. (Electrical Engineering)

With effect from July 2017

Program Educational Objectives:

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

Program Outcomes:

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

ELECTRICAL ENGINEERING DEPARTMENT

Proposed Teaching and Examination Scheme for
M. Tech. (Electrical Engineering) w. e. f. July 2017

SEMESTER I

Subject Code	Name of the Subject	Teaching Scheme (Hours/Week)			Credit	Examination Scheme				
						Theory		CA	PR/OR	Total
		L	T	P		TH	Tests			
MTEE101	Power System Modeling	03	01	--	04	60	20	20	--	100
MTEE102	Advanced Power Electronics	03	01	--	04	60	20	20	--	100
MTEE103	Modern Control System	03	01	--	04	60	20	20	--	100
MTEE104	Elective-I	03	-	--	03	60	20	20	--	100
MTEE105	Elective-II	03	-	--	03	60	20	20	-	100
MBS106	Communication Skills	02	-	--	02	-	-	25	25	50
MTEE107	PG Lab-I	--	-	03	02			25	25	50
	Total	**17**	**03**	**03**	**22**	**300**	**100**	**150**	**50**	**600**

Elective-I MTCS104	Elective-II MTCS105
1) Advanced Topics in Power System 2) Renewable Energy Systems 3) Advanced Digital Signal Processing	1) Electrical Transients in Power System 2) Power Electronics for Renewable Energy Systems 3) Power Electronics and Control

SEMESTER II

Subject Code	Name of the Subject	Teaching Scheme (Hours/Week)			Credit	Examination Scheme				
						Theory		CA	PR/OR	Total
		L	T	P		TH	Tests			
MTEE201	AC /DC drives	03	01	--	04	60	20	20	--	100
MTEE202	Advance Power System Protection	03	01	--	04	60	20	20	--	100
MTEE203	Elective-III	03	-	--	03	60	20	20	--	100
MTEE204	Elective-IV	03	-	--	03	60	20	20	--	100
MTEE205	Elective-V (Open)	03	-	--	03	60	20	20	-	100
MTEE206	Seminar-I	--	-	04	02	-	-	50	50	50
MTEE07	PG Lab-II or Mini Project	--	-	04	02	-	-	50	50	50
	Total	**15**	**02**	**08**	**21**	**300**	**100**	**200**	**100**	**700**

Elective-III MTCS203	Elective-IV MTCS204	Elective-V MTCS205
1) Power Sector Economics Restructuring & Regulation 2) Distributed generation and micro grid 3) Embedded Systems	1) Application of Power Electronics to Power System 2) Electric and Hybrid Vehicles 3) Control System design and estimation	1) Modern Optimization Techniques. 2) Sustainable energy system 3) Energy Management and Auditing. 4) Energy storage system. 5) Research Methodology 6) Finance management 7) Intelligent systems

P.S. Any other course approved by BoS for elective.

M. Tech. (ELECTRICAL ENGINEERING)

SEMESTER–III

Subject Code	Name of the Subject	Teaching Scheme (Hours/Week)			Credit	Examination Scheme				
						Theory		CA	PR/OR	Total
		L	T	P		TH	Tests			
MTME301	**Project Management and Intellectual Property Rights** (Self Study)*	--	--	--	02	--	--	50	50	100
MTEE302	**Project work Phase-I**	--	--	--	14	--	--	50	50	100
	Total	**--**	**--**	**--**	**16**	**--**	**--**	**100**	**100**	**200**

SEMESTER–IV

Subject Code	Name of the Subject	Teaching Scheme (Hours/Week)			Credit	Examination Scheme				
						Theory		CA	PR/OR	Total
		L	T	P		TH	Tests			
MTEE401	**Project work Phase-II**	--	--	--	28	--	--	100	100	200
	Total	**--**	**--**	**--**	**28**	**--**	**--**	**100**	**100**	**200**

SEMESTER I

MTEE101: POWER SYSTEM MODELING

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE101	**Power System Modeling**	**core**	**3-0-1**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Pre-Requisites: Engineering mathematics, Circuit analysis, Electrical machine and power system analysis, power electronics

Course Objective:

To describe characteristics and appropriate mathematical models for representations of power system components such as synchronous machine, transmission line, transformer, induction motor, excitation systems and non-electrical components in power system dynamic studies. Review of steady state and transient performance characteristic of synchronous machine.

Course Outcomes:

CO1	Develop power system components modeling and analyze their performance
CO2	Develop modeling of synchronous machine and analyze its performance
CO3	Perform steady state and dynamic analysis on simulation models
CO4	Understand configuration and functioning of synchronous machine excitation system.
CO5	Develop excitation system components modeling and analyze their performance.
CO6	Understand and transmission line, load and reactive power compensator modeling.

Course Content

UNIT-1: Modeling of Power System Components: [8 Hours]

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

UNIT-2: Synchronous machine modeling [8 Hours]

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

UNIT-3: Analysis of synchronous machine modeling [6 Hours]

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

UNIT-4 Excitation systems [7 Hours]

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

UNIT-5 Excitation system modeling **[7 Hours]**

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

UNIT-6-Transmission line, SVC and load modeling: **[6 Hours]**

Transmission line modeling, Modeling of static V AR compensators, load modeling.

Reference books:

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
2. R.Ramunujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009.
3. Electric Power Systems: B.M. Weddy and B.J. Cory, John Wiely and Sons, Fourth adition (2002).
4. Power System Analysis and Design :J. Duncan Glover, MulukutlaS. Sarma, Thomson Brooks/cole/ Third Edition (2003)

SEMESTER I

MTEE102. ADVANCED POWER ELECTRONICS

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE102	ADVANCED POWER ELECTRONICS	core	3-0-1	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Pre-Requisites: Power Electronics, Circuit theory.

Course Objectives:

To understand configuration and characteristics of different power semiconductor devices used in power system operation and control. To analyses principle of operation of various power converter used in power system operation. To understand various advance power conversion techniques using power semiconductor devices. To explore the ability of advance power conversion techniques in harnessing renewable energy sources.

Course Outcomes:

Upon successful completion of this course the students will be able to:

CO1	Understand the behavior of power semiconductor devices operated as power switches.
CO2	analyze operation of various power converters
CO3	Understand advance power conversion techniques
CO4	Apply power conversion technology for exploring RES
CO5	Ability to design and test power electronic circuits in the laboratory

MTEE102. ADVANCED POWER ELECTRONICS

Course content:

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

Solid State Power Semi-conducting Devices: Review of the thyristors, traic, GTO, transistor MOSFET and other modem power devices (IGBT, SIT, SITCH, MCT), characteristics ratings, commutation methods, protection and requirement of firing circuits.

UNIT-II Phase Controlled Rectifiers: [8 Hours]

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

UNIT-III DC-DC Converters: [9 Hours]

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

UNIT-IV Inverters: [9 Hours]

Single-phase and three-phase inverters- 120^0 and 180^0 modes of operation- PWM techniques: single- multiple- and sinusoidal PWM techniques- selective harmonic elimination- space vector modulation- current source inverter- multi-level inverters- techniques for reduction of harmonics.

UNIT-V Advance Techniques [5 Hours]

Advanced power conversion techniques viz resonant power conversion, multilevel converters etc.

UNIT-VI Convertor for Non-Conventional Energy Sources [5 Hours]

Power Electronics Controller for Wind Energy Electric Conversion Systems, Photo Voltaic Arrays, energy saving in AC and DC Drives.

Reference:

1. Power Electronics-circuits, Devices & Applications, M.H. Rashid : 3rd ed., PHI, 2005.

2. Power Electronics: Converters, Applications, Ned Mohan, T.M. Undeland, William P. Robbins: 3rd ed., John Wiley & Sons, 2009

SEMESTER I

MTEE103: MODERN CONTROL SYSTEM

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE102	**MODERN CONTROL SYSTEM**	**core**	**3-0-1**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Pre-Requisites: Linear control systems.

COURSE OUTCOMES:

1) Analyze dynamics of a linear system by State Space Representation.
2) Determine the stability of a linear system using pole-placement technique.
3) Design state observers.
4) Analyze basics of Non-linear control system.
5) Determine the stability of Non-linear systems.
6) Formulate and solve deterministic optimal control problems in terms of performance indices.
7) Realize the structure of a discrete time system and model its action mathematically.

COURSE CONTENTS:

UNIT I: STATE SPACE ANALYSIS (09 Hours)

The Concept of State and State Models, State Diagram, State Space and State Trajectory, State Space Representation using Phase Variable and Canonical Variables, Solution of State Equation, State Transition Matrix and its Properties, Eigen Values, Eigen Vectors, Model Matrix, Diagolization, Generalized Eigen vectors, Computation of State Transition Matrix using Laplace Transformation, Power Series Method, Cayley-Hamilton Method, Similarity Transformation Method. Controllability and Observability Tests: Kalman's test, Gilbert's Test, Controllability and Observability Canonical Forms.

UNIT II: POLE PLACEMENT TECHNIQUES (07 Hours)

Controller Design by State Feedback, Necessary and Sufficient Condition for Arbitrary Pole Placement-State Regulator Problem and State Regulator Design, Evaluation of State Feedback Gain Matrix K, Selection of Location of Desired Closed Loop Poles, State Observer Design, Full Order/Reduced Order Observer Design, Observer Based State Feedback Control, Separation Principle.

UNIT III: NONLINEAR CONTROL SYSTEM (10Hours)

Introduction, Properties of Nonlinear System, Behavior of Non-Linear System, Classification of Nonlinearities, Common Physical Nonlinearities: Saturation, Friction, Backlash, Dead-Zone, Relay, On-Off Nonlinearity, Nonlinear Spring, Limit cycle, Jump resonance. Phase-Plane Method, Singular points, Stability of Nonlinear System, Construction of Phase Trajectories, Describing Functions Method, Stability Analysis by Describing Function Method. Lyapunov's Stability Analysis, Lyapunov's

Stability Criterion, Direct Method of Lyapunov and the Linear Systems, Method of Construction of Lyapunov Functions for Nonlinear Systems.

UNIT IV: OPTIMAL CONTROL (08 Hours)

Introduction to Optimal Control, Parameter Optimization: Servomechanism, Optimal Control Problem: Transfer Function and State Variable Approach, State Regulator Problem, Infinite Time Regulator Problem, Output Regulator and the Tracking Problem, Parameter Optimization: Regulators.

UNIT V: DIGITAL CONTROL SYSTEMS (08 Hours)

Introduction to Discrete Time Systems, Necessary for Digital Control System, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems, Stability using Jury Criterion, Bilinear Transformation.

REFERENCES:

1) Katsuhiko Ogata, Modern Control Engineering Prentice-Hall of India, New Delhi.
2) I. J. Nagarath and M. Gopal, Control system Engineering, New Age International (P) Ltd.
3) Katsuhiko Ogata, State Space Analysis of Control Systems, Prentice Hall Inc, New Jersey.
4) Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 8th Edition, John Wiley & Sons.
5) H. Khalil, Nonlinear Control systems, Prentice Hall Inc, New Jersey.
6) Brogan W. L., Modern Control theory, Prentice Hall International, New Jersey.
7) Jean-Jacques E, Slotine, Weiping Li, Applied Nonlinear Control, Prentice Hall Inc., New Jersey.
8) Donald Kirk, Optimal Control Theory, an Introduction, Prentice Hall, Inc, Englewood Cliffs, New Jersey.
9) Brain D., Anderson and J. B. Moore, Optimal Control, Prentice Hall.
10) Andrew P., Sage, Optimum Systems Control, Prentice Hall.
11) M. Gopal , Digital Control & State Variable Methods, TMH.
12) A. Nagoor Kani, Control System, RBA Publications.

MTEE104-1. ADVANCE TOPICS IN POWER SYSTEM

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE104-1	**ADVANCE TOPICS IN POWER SYSTEM**	**Elective-I**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Pre-Requisites: Power system operation and analysis

Course Objectives:

This course objectives to study power system stability and reliability. To overcome the stability problem for complex and large capacity units. Classification of stability on the basis of nature of perturbation and evaluation time. In this course we will try to understand how to analyze the stability of a power system, how to improve the stability and finally how to prevent system becoming unstable.

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand facts, concepts and classification of stability on the basis of perturbation and economical aspect of energy exchange.
CO2	Analyze the characteristics of synchronous alternator under small and large disturbances.
CO3	Understand the apply knowledge of electrical subjects for solving stability problem and use method for enhancing stability
CO4	Understand and analyze the voltage stability problems and methods of improving voltage stability.
CO5	Understand and analyze the contingency issues in lines and apply the different techniques to improve it.
CO6	Understand and apply the state estimation technique for system security and load forecasting.

MTEE104-1. ADVANCE TOPICS IN POWER SYSTEM

Course contents:

UNIT-I: **[7 hours]**

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

UNIT-II: **[7 hours]**

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

UNIT-III: **[7 hours]**

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

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

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

Unit-V: **[7 Hours]**

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

Unit-VI: **[7 Hours]**

Introduction to power system security. System state classification, Load Forecasting & State Estimation: Estimation of average, periodic, stochastic components of load, basic idea of state estimation of power system. State estimation in power systems Security analysis.

Reference books:

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

8. Voltage Stability of Electric Power Systems. C. Van Custem, T. Vournas, Rlever Academic Press (U.K.), 1999.
9. Power System Analysis and Design. B.R. Gupta, III Edition, A.H. Wheeler & Co. Ltd., New Delhi, 1998.
10. Reactive Power Control in Electric Power Systems. T.J.E. Miller John Wiley and Sons, New York, 1982.

MTEPS104-2: RENEWABLE ENERGY SYSTEM

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
elective	**RENEWABLE ENERGY SYSTEMS**	**elective**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Pre-Requisites: Power Plant engineering, Power system-I

Course Objectives:

- To introduce the new paradigm of power generation in the form of renewable energy and the various means used for power processing and optimization.
- To relate and study the various energy storage technology and their significance in the context of renewable energy based applications.

Course Outcomes:

CO1	Understand current energy scenario and their impact on environment(K1 A1)
CO2	Understand the process of power generation by renewable energy sources(K1 A1)
CO3	Understand configuration of various renewable energy systems (K1 A1)
CO4	Understand various forms of energy storage and their importance (K1 A1)
CO5	Analyze the performance of grid connected system.(K2 A2)
CO6	Understand the various standards and quality issues for grid integration.(

MTEE104-2: RENEWABLE ENERGY SYSTEMS

Course contents:

UNIT-1: Energy Scenario **[7 Hours]**

Classification of Energy Sources., Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. World-wide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (COM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable

UNIT-2: Solar Energy **[7 Hours]**

Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications. Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components, sizing and economics. Peak power operation. Standalone and grid interactive systems.

UNIT 3:-Wind Energy **[7Hours]**

Wind Energy: wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, suitability of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connectivity, environmental impacts of wind farms.

UNIT-4: Other Energy Sources **[7Hours]**

Biomass - various resources, energy contents, technological advancements, conversion of biomass in other form of energy - solid, liquid and gases. Gasifiers, Biomass fired boilers, Co firing, Municipal solid waste systems, Problems in harnessing. Hydro energy - feasibility of small, mini and micro hydel plants scheme layout economics. Tidal and wave energy - schemes, feasibility and viability. Geothermal and Ocean thermal energy conversion (OTEC) systems schemes, feasibility and viability. Fuel Cell Technology

UNIT-5: Energy storage and hybrid system configurations **[7Hours]**

Energy storage: Battery' - types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel- energy relations, components, benefits over battery. Other energy storage systems.

Stand alone systems, Hybrid systems - hybrid with diesel, with fuel cell, solar-wind, wind -hydro systems, mode controller, load sharing, system sizing. Hybrid system economics.

UNIT-6 Grid Integration [7Hours]

Grid connected system and their electrical performance: Interface requirements, synchronization with grid, inrush, stable operation, load transient, safety. Operating limits of voltage, frequency, stability margin, energy storage, and IQad scheduling. Quality of power- harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness. Effect of Utility restructuring.

References:

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
3. Wind Energy Technology - Njenkins, John Wiley & Sons,
4. Solar & Wind energy Technologies - McNeils, Frenkel, Desai, Wiley Eastern.
5. Solar Energy - S.P. Sukhatme, Tata McGraw Hill.
6. Renewable energy technologies - R. Ramesh, Narosa Publication.
7. Energy Technology - S. Rao, 'Parulkar .
8. Solar Energy - S. Bandopadhay, Universal Publishing.
9. Non-conventional Energy Systems - Mittal, Wheelers Publication

SEMESTER I

ELECTIVE I: MTEE104-3: ADVANCED DIGITAL SIGNAL PROCESSING

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE104-3	**ADVANCED DIGITAL SIGNAL PROCESSING**	**Elective**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Pre-Requisites: Power Plant engineering, Power system-I

COURSE OUTCOMES:

1) Apply digital signal processing techniques to analyze LTI systems in time and frequency domain.
2) Design and Analyze FIR digital filters.
3) Design and Analyze IIR digital filters.
4) Understand and be able to implement adaptive signal processing algorithms.
5) Acquire the basics of multirate digital signal processing.

6) Explain and implement digital signal processing techniques on general purpose Digital signal processors.

COURSE CONTENTS:

UNIT I: DISCRETE TIME SIGNALS (08 Hours)
Introduction to Discrete time signals LTI system-stability-properties-sampling frequency domain Representation of discrete time signals and systems, discrete random signals-transforms, Properties, Inverse Z transforms.

UNIT II: DIGITAL FIR FILTER DESIGN (08 Hours)
Design of FIR filters - structures, windowing method, optimal method, Frequency sampling method.

UNIT III: DIGITAL IIR FILTER DESIGN (06 Hours)
Design of IIR filter: Impulse invariant method, Matched z-transform method, bilinear method.

UNIT IV: ADAPTIVE DIGITAL FILTERS (08 Hours)
Adaptive filters, Examples of Adaptive filtering, the minimum mean square error criterion; The Windrow and Hoff LMS Algorithm, Recursive least square Algorithm, Applications.

UNIT V: MULTI RATE DIGITAL SIGNAL PROCESSING (06 hours)
The basic sample rate Alteration Devices-Filters with sampling rate Alteration systems, Multistage Design of Decimators and Interpolators, Arbitrating rate sampling rate converter, Polyphase decomposition, digital filter design –Application.

UNIT VI: GENERAL PURPOSE DIGITAL SIGNAL PROCESSORS (06 hours)
Architecture of general purpose Digital signal processors, Implementation of DSP algorithms on general purpose processors.

REFERENCES:

1) Digital signal processing: A Practical Approach, Emmanuel C. Ifeachor, Barrie W. Jervis, Pearson Education.
2) Digital Signal Processing Principal, Algorithms and Applications, John G. Proakis, Dimitris G. Manolakis Pearson
3) Digital signal processing: A Computer Based Approach, Sanjit K. Mitra, Tata McGraw hill Pub, Company Limited New Delhi, 2001.
4) Digital signal processing, Alan Oppenheim, V and Ronals W. Schafer, Prentice Hall of India Private Limited, New Delhi, 1992.
5) Signals and systems, Simon Haylaim and Barry van veen, John wiley and sons India.
6) Digital signal processing, S,Salivahanan, Tata Mc Graw Hill Education Private Limited, New Delhi, 2010.

MTEE105-1-3 ELECTRICAL TRANSIENTS IN POWER SYSTEM

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE105-1	**ELECTRICAL TRANSIENTS IN POWER SYSTEM**	**Elective-II**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Pre-Requisites: Electromagnetic wave theory, Power system operation and analysis

Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand basic concepts of travelling wave
CO2	Understand and analyze the electrical transients and effects on transmission line
CO3	Evaluate system parameters and model the overhead lines and underground cables systems using advance digital computing tools.
CO4	Apply advance digital computing tools in evaluation of system parameters.

MTEE105-1 ELECTRICAL TRANSIENTS IN POWER SYSTEM

Course contents:

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

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

UNIT-II Lightning, Switching and Temporary Overvoltage [9 Hours]

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

UNIT-III Parameters and Modelling of Overhead Lines [9 Hours]

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

UNIT IV - Parameters of Underground Cables [8 Hours]

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

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

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

References:

1., Electrical Transients in Power System, Allan Greenwood Wiley & Sons Inc. New York, 1991.

2. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, (Second edition) Newage International (P) Ltd., New Delhi, 1990.

3. High Voltage Engineering, Naidu M S and Kamaraju V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

4. EMTP Theory Book, Hermann W. Dommel, second Edition, Microtran Power System Analysis
corporation, Vancouver, British Columbia, Canada, May 1992, Last Update: April 1999.

4. EMTP Literature from www.microtran.com.

MTEE105-1-2 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE105-2	**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**	**Elective-II**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Pre-Requisites: Power Electronics, Renewable energy sources.

ELECTIVE III: MTEE 105-2: POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

COURSE OUTCOMES:

1) Provide knowledge about the stand alone and grid connected renewable energy systems.
2) Equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
3) Analyze and comprehend the various operating modes of wind electrical generators and solar energy systems.
4) Design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
5) Develop maximum power point tracking algorithms.

COURSE CONTENTS:

UNIT I: INTRODUCTION (08 Hours)
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems: operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II: ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION (08 Hours)
Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III: POWER CONVERTERS (09 Hours)
Solar: Block diagram of solar photo voltaic system, line commutated converters,(inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV: ANALYSIS OF WIND AND PV SYSTEMS (09 Hours)
Stand alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS, Grid Integrated solar system

UNIT V: HYBRID RENEWABLE ENERGY SYSTEMS (08 Hours)
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

REFERENCES:

1) S.N.Bhadra, D. Kastha, & S. Banerjee “Wind Electricaal Systems”, Oxford University Press, 2009
2) Rashid M. H. “Power Electronics Hand book”, Academic press, 2001.
3) Rai G.D., “Non Conventional Energy Sources”, Khanna publishes, 1993.
4) Rai. G.D.,” Solar Energy Utilization”, Khanna publishes, 1993.

MTEE105-3 POWER ELECTRONICS AND CONTROL

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE105-3	POWER ELECTRONICS AND CONTROL	Elective-II	3-0-0	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Pre-Requisites: Power Electronics, Control systems. electrical machines

MTBS106: COMMUNICATION SKILLS

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTBS106	**COMMUNICATION SKILLS**	**compulsory**	**2-0-0**	**28**

Evaluation scheme:

PR/OR	Test	Continuous Assessment	Total	Credits
25	0	25	50	2

Pre-Requisites: Basic English language understanding

Course Objectives:

Develop the verbal and written English communication skill among the students

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Students are found to be confident while using English
CO2	Engage in analysis of speeches or discourses and several articles
CO3	Identify and control anxiety while delivering speech
CO4	Write appropriate communications(Academic/Business)
CO5	Prepared to take the examinations like GRE/TOFEL/IELTS
CO6	Identify and control the tone while speaking
CO7	Develop the ability to plan and deliver the well-argued presentations

MTBS106: COMMUNICATION SKILLS

Course Contents:

UNIT-I: Communication and Communication Processes **[4 Hours]**

Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication, Ways of Effective Communication.

UNIT-II: Oral Communication **[6 Hours]**

Use of Language in Spoken Communication, Features of Good Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication, Presentation Skills, Telephonic Etiquettes, Extempore, Elocution, Describing Experiences and Events.

UNIT-III: Study of Sounds in English **[4 Hours]**

Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English, Stress Mark.

UNIT-IV: English Grammar **[4 Hours]**

Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors, Sentence Formation and Sentence Structures, Use of Appropriate Diction.

UNIT-V: Writing Skills **[6 Hours]**

Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Business Writing, Advertisements, Essay Writing, (Technical, Social, and Cultural Topics), Technical Reports: Report Writing: Format, Structure and Types, Writing Memorandum, Circulars, Notices, Agenda and Minutes, Technical Manuals, Brochures

Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

UNIT-VI: Reading Skills & Listening Skills **[4 Hours]**

Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.

Listening : Importance of Listening, Types of Listening, Barriers to Listening.

REFERENCES:

1. *Communications Skills for Engineers*, Mohd. Ashraf Rizvi, Tata McGraw Hill
2. *Communication Skills*, Sanjay Kumar, Pushp Lata Oxford University Press, 2016
3. *Communication Skills*, Meenakshi Raman, Sangeeta Sharma,Oxford University Press, 2017
4. Michael Gamble, *Communication Works*, Teri Kwal Gamble, Tata McGraw Hill Education, 2010

MTEE107 P.G. LABORATORY –I

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE107	P.G–I	compulsory	0-3-0	00

Evaluation scheme:

PR/OR	Test	Continuous Assessment	Total	Credits
25	0	25	50	2

Objective: To develop the analytical and practical skills in the students.

Course Outcomes:

Upon successful completion of this LAB-I the student will be able to:

CO1	Apply the knowledge to design the practical circuits for applications.
CO2	Model and simulate different electrical and electronics systems
CO3	Simulate and test the circuit performance for comparative study.

The power system lab -1 will be comprising of **at least TWO** experiments from each of the subjects MTEE101 to MTEE105 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 using MATLAB-SIMULINK, PSCAD, CAPS software. Study of power semiconductor devices, study AC to DC, DC to DC converter circuits etc using software, design as well as by building up the circuits in laboratories. Renewable energy systems

Semester-II

MTEE201 AC/ DC DRIVES

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE105-3	AC/ DC DRIVES	Core	3-0-1	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Pre-Requisites: Power Electronics, electrical machines

MTEE201: AC/ DC DRIVES

COURSE OUTCOMES:

1) Explain the basics of Electrical Drives.
2) Develop the closed loop controlled DC drives.
3) Describe the modern trends of DC Dives.
4) Explain the basics methods of speed control of Induction motor.
5) Apply the various speed control methods for controlling the speed of Induction motor.
6) Apply the various speed control methods for controlling the speed of synchronous motor.
7) Use vector control method for controlling the Induction motor drive.

COURSE CONTENTS:

UNIT I: INTRODUCTION (03 Hours)
Electrical Drives, advantages, elements of drive system, drive characteristics, criteria for selection of drive components, dynamics of D.C. motor drives, steady-state stability.

UNIT II: D.C. DRIVES (09 Hours)
Introduction, principle of DC motor speed control, phase controlled converters, steady state analysis of three phase converter controlled DC motor Drive, two quadrant three phase controlled DC drive. Introduction, Principle of operation of the chopper, Chopper controlled drives, Duty-ratio control, current-limit control, steady state analysis, four quadrant chopper circuit, chopper for inversion, chopper with other power devices, mode of chopper, input to the chopper, steady state analysis of chopper controlled DC Drives, pulsating torques, DC motor Drive with field weakening, four quadrant DC motor drives, converter selection and characteristics

UNIT III: CLOSED-LOOP CONTROL OF DRIVES (08 Hours)
Introduction- Basic features of an Electric Drive- Block diagram representation of Drive systems, signal flow graph representation of the systems, Transfer functions, transient response of closed loop drives systems. Speed control of a separately excited DC drive with inner current loop and outer speed loop,

UNIT IV: SPEED CONTROL OF INDUCTION MOTOR (10 Hours)

Principles of speed control , Various methods of Induction motor drive, Variable voltage operation, Variable frequency operation, Constant flux operation, Torque-Slip characteristic, Constant Torque and Constant power operation, Implementation of V/f control with slip compensation scheme Speed control of VSI and CSI fed drives - design examples. Closed loop control schemes - dynamic and regenerative braking - speed reversal.
Torque slip characteristics- speed control through slip - rotor resistance control- chopper controlled resistance equivalent resistance combined stator voltage control and rotor resistance control- design solutions. Closed loop control scheme. Slip power recovery - torque slip characteristics - power factor considerations.

UNIT V: VECTOR CONTROL OF INDUCTION MOTOR DRIVE (07 Hours)
Review of dq0 model of 3-Ph IM, Principle of vector control of IM - Direct vector control - Indirect vector control with feedback - Indirect vector control with feed-forward - Indirect vector control in various frames of reference, Decoupling of vector control with feed forward compensation - Direct Torque Control of IM

UNIT VI: SPEED CONTROL OF SYNCHRONOUS MOTOR DRIVES (09Hours)
Three phase synchronous machine and analysis of steady state operation - voltage and torque equations in machine variables and rotor reference frame variables (Park's equations) – analysis of dynamic performance for load torque variations.
Types of PM Synchronous motors - Torque developed by PMSM - Model of PMSM - Implementation of vector control for PMSM

; .

REFERENCES:

1) G.K.Dubey, Power Semi conductor controlled Drives, New Age Int. Pub.
2) S.B.Dewan, G.R.Slemon & A.Stranghan, Power Semi conductor controlled Drives, Johnwiley Pub.
3) Shepherd Hullay & Liag, Power Electronics & Motor Control: Cambridge Univ. Press
4) R.Krishnan, Electric Motor drives – Modelling, Analysis & Control:, PHI India,Ltd.
5) Vedam Subramanyam, Thyristor Control of Electric Drives.
6) Vector Control of AC Drives, I. Boldea and S. A. Nasar, CRC Press LLC, 1992.

MTEE202 ADVANCED POWER SYSTEM PROTECTION

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE202	**ADVANCED POWER SYSTEM PROTECTION**	**Compulsory**	**3-0-1**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	4

Course Objectives:-

- To understand various Optimization Techniques applicable in Power System and Optimal Power flow solution methods.
- To understand the concept of power System Security.
- To apply state estimation in power system.

Course Outcomes:-

Upon successful completion of this course the student will be able to:

CO1	Understand philosophy of various relays used in power system protection.
CO2	Understand basic principle of digital relaying

MTEE202 ADVANCED POWER SYSTEM PROTECTION

Course content:

UNIT-I: Static Relays [9 Hours]

Advantages of static relays-Basic construction of static relays-Level detectors-Replica impedance –Mixing circuits-General equation for two input phase and amplitude comparators-Duality between amplitude and phase comparators. AMPLITUDE COMPARATORS: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.

UNIT-II: Phase Comparators [8 Hours]

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

UNIT-III: Static Differential Relays [9 Hours]

Analysis of Static Differential Relays –Static Relay schemes –Duo bias transformer differential protection –Harmonic restraint relay. STATIC DISTANCE RELAYS: Static impedance-reactance–MHO and angle impedance relaysampling comparator –realization of reactance and MHO relay using sampling comparator.

UNIT-IV: Multi-Input Comparators [8 Hours]

Conic section characteristics-Three input amplitude comparator –Hybrid comparator-switched distance schemes –Poly phase distance schemes- phase fault scheme –three phase scheme –combined and ground fault scheme. POWER SWINGS: Effect of power swings on the performance of distance relays –Power swing analysis-Principle of out of step tripping and blocking relays-effect of line and length and source impedance on distance relays.

UNIT-V: Microprocessor Based Protective Relays [8 Hours]

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

TEXT BOOK:

1. Power system protection and Switch gear ,Badri Ram and D.N.Vishwakarma, "TMH publication New Delhi 1995.

REFERENCES:

1 Static relays, T.S.Madhava Rao, TMH publication, second edition 1989.

2. Protection and Switchgear, Bhavesh Bhalja, R. P. Mahesheari, Nilesh G. Chothani, Oxford University Press.

3. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

MTEE203-1 POWER SECTOR ECONOMICS, REGULATION & RESTRUCTURING

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE203-1	POWER SECTOR ECONOMICS, REGULATION & RESTRUCTURING	Elective-III	3-0-0	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Course Objectives:-

Course Outcomes:-

Upon successful completion of this course the student will be able to:

CO1	Understand power sector scenario in India
CO2	Understand the national policy, economics and regulation.
CO3	Understand the power sector restructuring and market reforms.
CO4	Understand the transmission planning and pricing techniques.

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

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

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

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

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

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

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

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

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

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

UNIT-VI: Transmission Planning and pricing [7 Hours]

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right.

Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, and security constrained unit commitment. Ancillary services for restructuring, forward ancillary service auction

References

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

MTEE203-2 DISTRIBUTED GENERATION AND MICROGRID

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE203-2	**DISTRIBUTED GENERATION AND MICROGRID**	**Elective-III**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Course Objectives:-

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand exploration of renewable energy sources
CO2	Understand philosophy of distributed generation
CO3	Understand various issues of DG with grid integration
CO4	Understand the concept of micro grid and various power quality issues.

MTEE203-2 DISTRIBUTED GENERATION AND MICROGRID

Course content:

UNIT I – INTRODUCTION (9 hours)

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

UNIT II – DISTRIBUTED GENERATIONS (DG) (9 hours)

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

UNIT III – IMPACT OF GRID INTEGRATION (9 hours)

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

UNIT IV- MICROGRIDS (10 hours)

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

UNIT V- POWER QUALITY ISSUES IN MICROGRIDS (5 hours)

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

REFERENCES:

1. Voltage Source Converters in Power Systems: Modeling, Control and Applications, AmirnaserYezdani, and Reza Iravani, IEEE John Wiley Publications,2009.
2. Power Switching Converters: Medium and High Power, Dorin Neacsu, CRC Press, Taylor & Francis, 2006.
3. Solar Photo Voltaics, Chetan Singh Solanki, PHI learning Pvt. Ltd., New Delhi,2009.
4. Wind Energy Explained, theory design and applications, J.F. Manwell, J.G. McGowan Wiley publication,2002.
5. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York, 1987.
6Renewable Energy Resources, John Twidell and Tony Weir, Tyalor and Francis Publications, 2005.

ELECTIVE III: MTEE203-3: EMBEDDED SYSTEMS

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE203-3	EMBEDDED SYSTEMS	Elective-III	3-0-0	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

COURSE OUTCOMES:

1) Define and explain embedded systems and the different embedded system design technologies explain the various metrics or challenges in designing an embedded system
2) Become aware of the architecture of the ARM processor and its programming aspects (assembly Level)
3) Foster ability to understand the internal architecture Processor LPC 2148
4) Understand key concepts of embedded systems like IO, timers, interrupts, interaction with peripheral devices
5) Design real time embedded systems using the concepts of RTOS.
6) Analyze various examples of embedded systems based on ARM processor.

COURSE CONTENTS:

UNIT I: INTRODUCTION TO EMBEDDED SYSTEMS (08 Hours)

Introduction to embedded system -Definition and Classification, Design challenges, Optimizing design metrics, time to market, applications of embedded systems and recent trends in embedded systems, memory management, Overview of Processors and hardware units in an embedded system, Software embedded into the system, communication protocols like SPI, I2C, CAN etc.

UNIT II: ARCHITECTURE OF ARM7TDMI (05 Hours)

Introduction to ARM core architecture, ARM extension, family, Pipeline, memory management, Bus architecture, Programming model, Registers, Operating modes, instruction set, Addressing modes, memory interface.

UNIT III: ON CHIP PERIPHERALS AND INTERFACING LPC2148 (08 Hours)

Study of on-chip peripherals – Input/ output ports, Timers, Interrupts, on-chip ADC, DAC, RTC modules, WDT,PLL, PWM,USB, I2C, SPI, CAN etc.

UNIT IV: INTERFACING WITH LPC2148 (08 Hours)

Need of interfacing, interfacing techniques, interfacing of different displays including Graphic LCD, controlling a DC motor using PWM, Keypad controllers, stepper motor controllers.

UNIT V: REAL TIME OPERATING SYSTEMS (08 Hours)

Definitions of process, tasks and threads, I/O Subsystems, Interrupt Routines Handling in RTOS, RTOS Task scheduling models, Handling of task scheduling and latency and deadlines as performance metrics, Co-operative Round Robin Scheduling, Case Studies of Programming with RTOS.

UNIT VI: INTRODUCTION TO ARM 9 (05 Hours)

ARM926EJ-S, Features, Specifications (LPC314x /LPC315x As reference controllers)

REFERENCES:

1) Embedded Systems Architecture, Programming and Design, Rajkamal, TATA McGraw-Hill, First reprint Oct, 2003.
2) Embedded Systems Design, Second Edition, Steve Heath, Elsevier India Pvt. Ltd. 2007.
3) Andrew Sloss, Andew Sloss, "ARM System Developers Guide"
4) Introduction to Embedded systems, Shibu K V, Tata McGraw Hill First print – 2009.
5) An Embedded Software Primer, David E,Simon, Pearson Education Asia, 2000.
6) Embedded Systems Design, A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Computers as Components; Principles of Embedded Computing System Design Wayne Wolf, Harcourt India, Morgan Kaufman Publishers, First Indian Reprint 2001

MTEE204-1 APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE204-1	**APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS**	**Elective-IV**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

Course Objectives:-

- To know the basic principle of conventional active and reactive power flow control in power systems and problems associated with long distance power transmission.
- To make students aware how power electronics devices can be used to find solution to the problems in long distance power transmission.

Course Outcomes:

Upon successful completion of this course the student will be able to:

CO1	Understand the concept of FACTs
CO2	Select and implement proper compensator to solve the problems occurring power transmission
CO3	Model and analyze the FACT controllers
CO4	Understand and apply the active filtering techniques in mitigation of harmonic distortion.

MTEPS204-1 APPLICATION OF POWER ELECTRONICS TO POWER SYSTEMS

Course contents:

Unit 1

Review of semiconductor devices, Steady state and dynamic problems in AC systems, Power flow [5 hrs]

Unit 2

Flexible AC transmission systems (FACTS): Basic realities & roles, Types of facts controller, Principles of series and shunt compensation. [6 hrs]

Unit 3

Description of static var compensators (SVC), Thyristor Controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller (UPFC). [9 hrs]

Unit 4

Modelling and Analysis of FACTS controllers. Control strategies to improve system stability. Power Quality problems in distribution systems. [8 hrs]

Unit 5

Harmonics, harmonics creating loads, modelling, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters. [7 hrs]

Unit 6

Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker. Mitigation of power quality problems using power electronic conditioners. IEEE standards. [7 hrs]

References:

1. Understanding of FACTs., Hingorani, N. G.; IEEE Press 1996.

2. Power Quality.; Heydt G.T.; Stars in a Circle Pblications , Indiana, 1991.

3. Static Reactive Power Compensation.; Miller T.J.E.; John Wiley & Sons, New York, 1982

4. Flexible AC Transmission System. (FACTs).; Yong Hua Song.; IEE 1999.

5. Recent Publications on IEEE Journals.

ELECTIVE IV: MTEE204-2: ELECTRIC AND HYBRID VEHICLES

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE204-2	ELECTRIC AND HYBRID VEHICLES	Elective-IV	3-0-0	42

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

COURSE OUTCOMES:

CO1	Describe the configuration and performance of Electric vehicles
CO2	Design the structure of Hybrid Electric Vehicle
CO3	Describe the operation of Fuel Cells
CO4	Explain Electric propulsion system and Motor control systems
CO5	Discuss energy storage devices and generators

CO-PO Mapping

	1	2	3	4	5	6	7	8	9	10	11	12
CO1	2					1						
CO2		2				1	1					
CO3	2						1					
CO4	2											
CO5	2					1						1

COURSE CONTENTS:

UNIT I ELECTRIC VEHICLES **(08 Hours)**

Introduction, Layout of an Electric Vehicle, Performance of Electric Vehicles a) Traction Motor Characteristics b) Tractive Effort and Transmission Requirements c) Vehicle Performance , Energy Consumption, Advantages and Limitations, Specifications, System Components, Electronic Control System.

UNIT II: HYBRID VEHICLES **(08 Hours)**

Concepts of Hybrid Electric Drive Train, Architectures of Series Hybrid Electric Drive Trains, Architectures of Parallel Hybrid Electric Drive Trains, Merits and Demerits, Series Hybrid Electric Drive Train Design, Parallel Hybrid Electric Drive Train Design.

UNIT III: FUEL CELLS & SOLAR CARS **(08 Hours)**

Photovoltaic Cells, Tracking, Efficiency, Solar Cars, Fuel Cells - Construction & Working, Equations, Possible Fuel Sources, Fuel Reformer, Design, Cost Comparison.

UNIT IV: ELECTRIC PROPULSION SYSTEM AND MOTOR CONTROL SYSTEM **(10 Hours)**

DC Motors Characteristics, Speed and Torque Control, Regenerative Braking.
AC Motors Characteristics, Speed and Torque Control.
PM- BLDC Motors Characteristics, Speed and Torque Control.

Reluctance Motors Characteristics, Speed and Torque Control, Regenerative Braking.

UNIT V: ENERGY STORAGES & GENERATORS (08 Hours)

Electrochemical Batteries: Types of Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries, Electro Chemical Reactions, Thermodynamic Voltage, Specific Energy, Specific Power, Energy Efficiency, Ultra Capacitors, DC Generators, AC Generators, Voltage and Frequency Regulations

REFERENCES:

1) Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
2) James Larminie and John Loury, “Electric Vehicle Technology – Explained”, John Wiley & Sons Ltd, 2003.
3) Sandeep Dhameja, “Electric Vehicle Battery Systems”, Butterworth – Heinemann, 2002.
4) Ronald K Jurgen, “Electric and Hybrid – Electric Vehicles”, SAE, 2002.
5) Ron Hodkinson and John Fenton, “Light Weight Electric/Hybrid Vehicle Design”, Butterworth – Heinemann, 2001.
6) Iqbal Husain, “Electric and Hybrid Vehicles- Design Fundamentals” CRC Press, 2011.

ELECTIVE IV: MTEE204-3: CONTRO SYSTEM DESIGN AND ESTIMATION

Teaching Scheme:

Course code	Course name	Course	Teaching (L-P-T)	Total teaching hours
MTEE204-3	**CONTRO SYSTEM DESIGN AND ESTIMATION**	**Elective-IV**	**3-0-0**	**42**

Evaluation scheme:

Theory	Test	Continuous Assessment	Total	Credits
60	20	20	100	3

SEMESTER II

ELECTIVE V: MTEDC205-1: MODERN OPTIMIZATION TECHNIQUES

COURSE OUTCOMES:

After the completion of the course the student will be able to

1) Understand the theoretical workings of the simplex method for linear programming and perform iterations of it by hand.
2) Understand the relationship between a linear program and its dual, including strong duality and complementary slackness.
3) Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
4) Solve specialized linear programming problems like the transportation and assignment problems.
5) Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
6) Understand the applications of, basic methods for, and challenges in integer programming

COURSE CONTENTS:

UNIT I: FUNDAMENTALS OF OPTIMIZATION (08 hours)

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

UNIT II: EVOLUTIONARY COMPUTATION TECHNIQUES (10 hours)

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

UNIT III: PARTICLE SWARM OPTIMIZATION (08 hours)

Fundamental principle-Velocity Updating-Advanced operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) -Binary, discrete and combinatorial PSO-Implementation issues-Convergence issues- PSO based applications to Drive Control

UNIT IV: ADVANCED OPTIMIZA TION METHODS (08 Hours)

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

UNIT V: MULTI OBJECTIVE OPTIMIZATION (08 Hours)

Concept of pareto optimality-Conventional approaches for MOOP-Multi objective GA-Fitness assignment-Sharing function- MOGA-Multiobjective PSO and its application in Drive Control.

REFERENCES:

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

SEMESTER II

ELECTIVE V: MTEDC205-3: ENERGY MANAGEMENT AND AUDITING

COURSE OUTCOMES:

Upon successful completion of this course the student will be able to:

1) Identify and describe present state of energy security and its importance.
2) Identify and describe the basic principles and methodologies adopted in energy audit of utility.
3) Describe the energy performance evaluation of some common electrical and thermal installations and identify the energy saving opportunities.
4) Analyze the data collected during performance evaluation and recommend energy saving measures

COURSE CONTENTS:

UNIT I: BASIC PRINCIPLES OF ENERGY AUDIT (08 Hours)

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

UNIT II: ENERGY COST AND LOAD MANAGEMENT (06 Hours)

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

UNIT III: ENERGY EFFICIENT MOTORS (06 Hours)

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

UNIT IV: METERING FOR ENERGY MANAGEMENT (06 Hours)

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

UNIT V: LIGHTING SYSTEMS AND COGENERATION (08 Hours)

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

UNIT VI: ECONOMIC ASPECTS AND ANALYSIS (08 Hours)

Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment.

REFERENCES:

1) Eastop T.D and Croft D.R, "Energy Efficiency for Engineers and Technologists", Logman Scientific & Technical, 1990.
2) Reay D.A., "Industrial Energy Conservation", first edition, Pergamon Press, 1977.
3) IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities, IEEE, 1996.
4) Amit K. Tyagi, "Handbook on Energy Audits and Management", TERI, 2003.

Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", Fifth Edition, The Fairmont Press, Inc., 2006.

ELECTIVE V: MTEDC205-5: RESEARCH METHODOLOGY

COURSE OUTCOMES:

After the completion of the course the students will be able to:

1) Understand the research meaning apply the same for doing the research work
2) Identify and formulate the research problem.
3) Design the research work in the proper structured manner using sample techniques.

COURSE CONTENTS:

UNIT I: Foundations of Research (0 7 Hours)

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

UNIT II: Problem Identification & Formulation (0 7 Hours)

Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

UNIT III: Research Design (0 7 Hours)

Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT IV: Qualitative and Quantitative Research (0 7 Hours)

Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

UNIT V: Sampling (0 7 Hours)

Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

UNIT VI: Data Analysis (0 7 Hours)

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

REFERENCES:

1) Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2) Business Research Methods – Alan Bryman& Emma Bell, Oxford University Press.

SEMESTER II

ELECTIVE III: MTEE203-7: INTELLIGENT SYSTEMS

COURSE OUTCOMES:

After completing the course, students will be able to:

1) Identify the basic neural networks paradigms.
2) Describe the basic concepts of training in neural networks.
3) Describe the concept of fuzziness involved in various systems.
4) Understand the basic concepts of about fuzzy set theory.
5) Analyze the different techniques used for modelling and control of the AC and DC drives.
6) Apply neural network and fuzzy techniques for designing successful applications.

COURSE CONTENTS:

UNIT I: ARTIFICIAL NEURAL NETWORKS (08 hours)

Biological Neuron and Their Artificial Model; Models of Artificial Neural Network: Single Layer and Multilayer, Feed-forward Network, Feedback Network; Neural Processing; Types of Neuron Activation Function; Learning Strategy: Supervised, Unsupervised, Reinforcement; Learning Rules; Auto-Associative and Hetro-Associative Memory.

UNIT II: BACK PROPAGATION NETWORKS (08 hours)

Architecture: Perceptron model, Single-Layer Perceptron Network, Multilayer Perception Model; Back Propagation Learning Methods; Generalized Delta Learning Rule; Back Propagation Algorithm; Factors Affecting Back-Propagation Training; Learning Factors: Initial Weights, Steepness of the Activation Function, Learning Constant, Momentum Factor, Necessary Number of Hidden Neurons.

UNIT III: INTRODUCTION TO FUZZY LOGIC (08 hours)

Classical Sets and Fuzzy Sets: Operations and Properties; Classical relations and fuzzy relations: Cartesian product, Crisp relations, Fuzzy relations, Operations on fuzzy relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition; Tolerance and Equivalence Relations; Fuzzy Tolerance and Equivalence Relations; Value Assignments.

UNIT IV: FUZZY LOGIC SYSTEM (08 hours)

Membership Function: Various Forms, Membership Value Assignments; Fuzzification and Defuzzification Module, Rule Base, Choice of Variable and Contents of Rules, Derivation of Rules, Data Base, Fuzzy Inference System, Choice of Membership Function and Scaling Factors, Choice of Fuzzification and Defuzzification Procedure, Various Methods; Fuzzy Associative Memories.

UNIT V: APPLICATIONS OF NEURAL NETWORKS AND FUZZY LOGIC (10 hours)

Speed Control of DC Motor, Induction Motor, Switched Reluctance, Brushless DC Motor, Synchronous Machine, Modelling and Control of DC and AC Drive, Hybrid Neuro-Fuzzy Applications.

REFERENCES:

1. B. Yegnanarayana, “Artificial neural networks”, Prentice Hall of India, Private limited, New Delhi.
2. J. M. Zurada, “Introduction to Artificial Systems”, Singapore: Info Access and distributions/ West Publishing Company.
3. James A. Anderson, “An Introduction to Neural Networks”, Practice Hall India Publication.
4. D. Drainkov, H. Hellendoorn and M. Reinfrank, “An Introduction to Fuzzy Control”, Narosa Publishing House.

5. Siman Haykin, “Neural Networks”, Prentice Hall of India.
6. T. J. Ross, “Fuzzy Logic with Engineering Applications”, John Wiley & Sons.
7. S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural network, Fuzzy logic and Genetic Algorithm”, Prentice Hall of India.
8. S. N. Sivanandam, S. Sumathi, S. N. Deepa, “Introduction to Neural Network Using MATLAB 6.0”, Tata McGraw Hill.

SEMESTER II

MTEDC206: SEMINAR-I

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 state of the art topic in front of the external examiners/internal examiners, staff and student colleagues. 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/institute. The assessment shall be based on selection of topic its relevance to present context, report documentation and presentation skills.

SEMESTER II

MTEDC207: PGLAB-II or MINI PROJECT

Students are instructed to frame and perform laboratory assignment/experiments based on each of theory Course. The assignment should encompass the hardware and engineering computation software such as MATLAB, PSCAD, ETAP etc. techniques/tools introduced in the concerned subjects and should prove to be useful for the PG program in the relevant field with moderate to high complexity. Assignment should be a full-fledged system design problems with multidimensional solutions suggested.

Or

The student should select a small project (as suggested by faculty adviser) relevant to Electrical Drives or Control System. Project work based on signal analysis, signal conditioning, state of art, professional software acquaintance like MATALAB, ETAP, PSCAD, PSIM similar work.

SEMESTER III

MTME301: PROJECT MANAGEMENT AND INTELLECTUAL PROPERTY RIGHTS

COURSE OUTCOMES:

At the end of the course the student will be able to:

1) Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.
2) Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
3) Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
4) Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
5) Apply trade mark law, copy right law, patent law and also carry out intellectual property audits.
6) Manage and safeguard the intellectual property and protect it against unauthorized use.

COURSE CONTENTS:

A. PROJECT MANAGEMENT:

UNIT I:

Introduction to Project management**:** Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.

UNIT II:

Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

UNIT III:

Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management. Post-Project Analysis.

B. IPR:

UNIT IV:

Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents ;their definition; granting; infringement; searching & filing; Utility Models an introduction.

UNIT V:

Copyrights; their definition; granting; infringement; searching & filing, distinction between related and copy rights; Trademarks, role in commerce, importance, protection, registration; domain names.

UNIT VI:

Industrial Designs ; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications , international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; legal issues, enforcement ;Case studies in IPR.

REFERENCES:

1) Shtub, Bard and Globerson, Project Management: Engineering, Technology, and Implementation, Prentice Hall, India.
2) Lock, Gower, Project Management Handbook.
3) Prabuddha Ganguli, IPR published by Tata McGraw Hill 2001.

SEMESTER III

MTEDC302: PROJECT STAGE-I

The dissertation Seminar will consist of a type written report covering the topic selected for Final Dissertation. This should include the Extensive literature survey, technical details, Data collection from R&D organizations/Industries/etc, Study of the viability, applicability and scope of the dissertation, Detailed Design (H/W and S/W as applicable) and related data required for the proposed dissertation work. The candidate will make a comprehensive project Phase-I make a comprehensive project Phase-I report in detail and make the presentations along with the future work towards fulfillment of the dissertation and deliver the dissertation seminar on the topic which will be judged by two examiners appointed by the University (one external and one internal guide). The assessment shall be based on selection of topic its relevance to present context, report documentation and presentation skills, utility of the dissertation work & publications based on the same.

SEMESTER IV

MTEDC401: PROJECT STAGE-II

The student shall be allowed to submit the dissertation- II report only after the completion of dissertation- I. Student should deliver Viva-Voca Presentation on topic of Dissertation-II in front of the external examiners and internal examiners appointed by the University, staff and student colleagues. The assessment shall be based on design and implementation aspects, report documentation and presentation skills, utility of the dissertation work & publications based on the same.

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY LONERE

Model lesson plan

DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Lesson Plan for the academic year 2016-17

Class: M.Tech (EE) Semester: I Subject: Electrical and hybrid vehicle

Unit	Period	Details of Coverage	Teaching aids used
01	**01**	**Electric Vehicles** Introduction	Chalk and board
	02	Layout of an Electric Vehicle	PP T &Chalk and board
	03	Performance of Electric Vehicles	PP T &Chalk and board
	04	a) Traction Motor Characteristics	PP T &Chalk and board
	05	b) Traction Effort and Transmission Requirements	Chalk and board
	06	c) Vehicle Performance	Chalk and board
	07	Energy Consumption	Chalk and board
	08	Advantages and Limitations	Chalk and board
	09	Specifications	Chalk and board
	10	System Components	Chalk and board
	11	Electronic Control System	Chalk and board
02	**12**	**Hybrid vehicles** Introduction	
	13	Concepts of Hybrid Electric Drive Train	PP T &Chalk and board
	14	Architectures of Series Hybrid Electric Drive Trains	PP T &Chalk and board
	15	Architectures of Parallel Hybrid Electric Drive Trains	PP T &Chalk and board
	16	Merits and Demerits	PP T &Chalk and board
	17	Series and parallel Hybrid Electric Drive Train Design	
03	**18**	**Fuel cells and solar car** Introduction	PP T &Chalk and board
	19	Photovoltaic Cells	Chalk and board
	20	Tracking	PP T &Chalk and board
	21	Efficiency	PP T &Chalk and board
	22	Solar Cars	PP T &Chalk and board
	19	Fuel Cells - Construction & Working	PP T &Chalk and board
	20	Equations	PP T &Chalk and board
	21	Possible Fuel Sources	PP T &Chalk and board
	22	Fuel Reformer	PP T &Chalk and board
	23	Design	PP T &Chalk and board
	24	Cost Comparison	PP T &Chalk and board
04	**25**	**Electric Propulsion System and Motor Control system** Introduction	Chalk and board
	26	DC Motors Characteristics Speed and Torque Control System Principle Regenerative Braking	Chalk and board
	27	AC Motors	PP T &Chalk and board

		Characteristics Speed and Torque Control	
	28	PM- BLDC Motors Characteristics Speed and Torque Control	PP T &Chalk and board
	29	Reluctance Motors Characteristics Speed and Torque Control Regenerative Braking	PP T &Chalk and board
05	**30**	**Energy Storages & Generators** Introduction	PP T &Chalk and board
	31	Electrochemical Batteries	PP T &Chalk and board
	32	Types of Batteries Lead-Acid Batteries Nickel Based Batteries Lithium Based Batteries	PP T &Chalk and board
	33	Electro Chemical Reactions Thermodynamic Voltage	Chalk and board
	34	Specific Energy Specific Power Energy Efficiency	Chalk and board
	35	Ultra Capacitors	Chalk and board
	36	DC Generators	Chalk and board
	37	AC Generators	Chalk and board
	38	Voltage and Frequency Regulations	PP T &Chalk and board
	39	Ultra Capacitors	Chalk and board
	40	DC Generators	PP T &Chalk and board
	41	AC Generators	PP T &Chalk and board
	42	Voltage and Frequency Regulations	PP T &Chalk and board

Text Book

1. Mehrdad Ehsani, Yimin Gao, Sebatien Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel cell vehicles: Fundamentals, Theory and Design", CRC Press, 2004.

Reference Books

1. James Larminie and John Loury, " Electric Vehicle Technology – Explained", John Wiley & Sons Ltd, 2003.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth – Heinemann, 2002.
3. Ronald K Jurgen, "Electric and Hybrid – Electric Vehicles", SAE, 2002.
4. Ron Hodkinson and John Fenton, "Light Weight Electric/Hybrid Vehicle Design", Butterworth – Heinemann, 2001.

Iqbal Husain, " Electric and Hybrid Vehicles- Design Fundamentals" CRC Press, 2011.

MODEL LESSON PLAN

Class: M. Tech (EE) Semester: I Subject: Power System Modeling

Unit	Period	Details of Coverage	Teaching aids used
01	01	**Modeling of Power System Components**: The need for modeling of power system Different areas of power system analysis.	Chalk and board
	02	Description and modeling of boiler and steam turbine **Numerical**	PP T & Chalk and board
	03	Description and modeling of hydro turbine boiler **Numerical**	PP T & Chalk and board
	04	Description and modeling of governor system.	PP T & Chalk and board
	05	Description and modeling tap-changing transformer.	Chalk and board
	06	Description and modeling of phase shifting transformer.	Chalk and board
	07	**Numerical**	Chalk and board
	08	**Revision & Assignment**	Chalk and board
02	09	**Synchronous machine modeling.** Description construction of synchronous machine. Basic modeling equations of synchronous machine.	Chalk and board
	10	d-q transformation analysis	Chalk and board
	11	Design and development of synchronous machine modeling for steady state analysis.	Chalk and board
	12	Per unit model Numerical	Chalk and board
	13	Design and development of synchronous machine modeling for dynamic studies using flux linkage method	PP T & Chalk and board
	14	Design and development of synchronous machine modeling for dynamic studies using current linkage method	PP T & Chalk and board
	15	Design and development of synchronous machine modeling for simulation studies.	PP T & Chalk and board
	16	**Revision & Assignment**	Chalk and board
03	17	**Analysis of synchronous machine modeling** Analysis of Synchronous machine connected to an infinite bus (SMIB)	PP T & Chalk and board
	18	Numerical analysis	Chalk and board
	19	SMIB for steady state analysis	PP T & Chalk and board
	20	Numerical	
	21	Simulation for steady-state condition.	
04	22	**Excitation systems** Functions and Performance Requirements. Elements of an Excitation System.	PP T & Chalk and board
	23	Types Excitation Systems: DC Excitation Systems:	PP T & Chalk and board
	24	AC excitation systems	PP T & Chalk and board
	25	Static excitation systems	PP T & Chalk and board
	26	Control and Protective Functions	PP T & Chalk and board
	27	Dynamic performance measure large signal analysis	Chalk and board
	28	Dynamic performance measure small signal analysis	Chalk and board
05	29	**Excitation system modeling.** Modeling of Separately excited dc exciter	PP T & Chalk and board
	30	Modeling of Self-excited dc exciter	PP T & Chalk and board

	31	Modeling of *AC Exciter and Rectifier*	PP T & Chalk and board
	32	Modeling of *excitation system components*	PP T & Chalk and board
	33	Modeling of Complete Excitation Systems models	PP T & Chalk and board
	34	Modeling of Complete Excitation Systems models	PP T & Chalk and board
	35	Revision	
06	**36**	**Transmission line, SVC and load modeling:** Transmission line modeling	Chalk and board
	37	Numerical, Static load modeling	Chalk and board
	38	Dynamic load modeling, load modeling parameter acquisition methods	Chalk and board
	39	Induction motor modeling, Definition, need of static VAR compensators	Chalk and board
	40	classification of static VAR compensators, Design and Modeling of TCR	PP T & Chalk and board
	41	Design and Modeling of TSC	Chalk and board
	42	Design and Modeling of FC+TCRAND TSC+TCR	PP T & Chalk and board

Model Lesson Plan

Class: M. Tech (EE) **Semester**: I **Subject**: Advanced Power Electronics

Unit	Period	Details of Coverage	Teaching aids used
01	**01**	**Overview Of Switching Power Devices:** Solid State Power Semi-conducting Devices: Review of the thyristors, traic,	Chalk and board
	02	Review of GTO, transistor MOSFET	PP T &Chalk and board
	03	Commutation methods	PP T &Chalk and board
	04	Other modern power devices (IGBT, SIT) characteristics ratings	PP T &Chalk and board
	05	Other modern power devices (SITCH, MCT), characteristics ratings,	Chalk and board
	06	Commutation methods	Chalk and board
	07	Protection and requirement of firing circuits	Chalk and board
	08	Revision	
02	**09**	**Phase Controlled Rectifiers:** Principle of phase controlled converter operation- single phase full converter	Chalk and board
	10	Principle of phase controlled converter operation- semi converters- dual converters	Chalk and board
	11	Three phase full and semi converters	Chalk and board
	12	Reactive power- power factor improvements	Chalk and board
	13	extinction angle control	Chalk and board
	14	Reactive power- power factor improvements	PPT &Chalk and board
	15	Symmetrical angle control.	PPT &Chalk and board
	16	PWM control- SPWM control.	PPT &Chalk and board
03	**17**	**DC-DC Converters:** Study of Class – A- B- choppers- non-isolated	PPT &Chalk and board
	18	C- and D choppers- non-isolated	PPT &Chalk and board
	19	DC-DC converters	Chalk and board
	20	Buck-boost converters under continuous conduction operation	PP T &Chalk and board
	21	Buck-boost converters under discontinuous conduction operation	Chalk and board
	22	Isolated DC-DC converters: forward- fly-back- push-pull	PP T &Chalk and board
	23	Half-bridge- and full-bridge converters	PP T &Chalk and board
	24	Relationship between I/P and O/P voltages- expression for filter inductor and capacitors	PP T &Chalk and board

04	**25**	**Inverters:** Single-phase inverters- 120^0 and 180^0 modes of operation	PP T &Chalk and board
	26	Three-phase inverters- 120^0 and 180^0 modes of operation	PP T &Chalk and board
	27	PWM techniques: single PWM techniques	Chalk and board
	28	multiple- and sinusoidal PWM techniques	Chalk and board
	29	Selective harmonic elimination- space vector modulation	PP T &Chalk and board
	30	Current source inverter	PP T &Chalk and board
	31	Multi-level inverters	
	32	Techniques for reduction of harmonics	
05	**33**	Advanced power conversion techniques, Multilevel converters etc.	PP T &Chalk and board
	34	Resonant power conversion	PP T &Chalk and board
	35	Multi-Resonant Converters	Chalk and board
	36	Multilevel converters	Chalk and board
	37	Multilevel converters	PP T &Chalk and board
06	**38**	Power Electronics Controller for Wind Energy,	PP T &Chalk and board
	39	Electric Conversion Systems	PP T &Chalk and board
	40	Photo Voltaic Arrays	PP T &Chalk and board
	41	Energy Saving in AC Drives	PP T &Chalk and board
	42	Energy Saving in DC Drives	PP T &Chalk and board

Reference:

1. Power Electronics-circuits, Devices & Applications**,** M.H. Rashid **:** 3rd ed., PHI, 2005.

2. Power Electronics: Converters, Applications**,** Ned Mohan, T.M. Undeland, William P. Robbins**:** 3rd ed., John Wiley & Sons, 2009

Model Lesson Plan

Class: M. Tech (EE) **Semester**: I **Subject**: Advance Topics In Power System

Unit	Period	Details of Coverage	Teaching aids used
01	**01**	Generation Control Loops	PPT, Chalk and board
	02	AVR Loop: Performance, AVR Loop: Response	PPT, Chalk and board
	03	Automatic Generation Control Of Single Area Systems	PPT, Chalk and board
	04	Automatic Generation Control Of Multi Area Systems	PPT, Chalk and board
	05	Static Response Of AGC Loops	PPT, Chalk and board
	06	Dynamic Response Of AGC Loops	PPT, Chalk and board

	07	Economic Dispatch And AGC	PPT, Chalk and board
02	08	Transient Stability Problem, Modeling Of Synchronous Machine	PPT, Chalk and board
	09	Modeling Of Loads Network	PPT, Chalk and board
	10	Modeling Of Excitation Systems	PPT, Chalk and board
	11	Turbine And Governing Systems	PPT, Chalk and board
	12	Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis	PPT, Chalk and board
	13	Data For Transient Stability Studies	PPT, Chalk and board
	14	Transient Stability Enhancement Methods	PPT, Chalk and board
03	15	Low Frequency Oscillations, Classification of Low Frequency Oscillations	
	16	Power System Model For Low Frequency Oscillation Studies	PPT, Chalk and board
	17	Eigen value analysis for Power System Modeling	PPT, Chalk and board
	18	Improvement Of System Damping With Supplementary Excitation Control	PPT, Chalk and board
	19	Damping Low Frequency Oscillation	PPT, Chalk and board
	20	Introduction To Sub Synchronous Resonance	PPT, Chalk and board
	21	Introduction To Counter measures	PPT, Chalk and board
04	22	Introduction to Voltage Stability Problem	PPT, Chalk and board
	23	Real Power Flow In Long Transmission Lines	PPT, Chalk and board
	24	Reactive Power Flow In Long Transmission Lines	PPT, Chalk and board
	25	Effect Of ULTC And Load Characteristics On Voltage Stability	PPT, Chalk and board
	26	Voltage Stability Limit ,Voltage Stability Assessment Using PV Curves	PPT, Chalk and board
	27	Voltage Collapse Proximity Indices	PPT, Chalk and board
	28	Voltage Stability Improvement Methods	PPT, Chalk and board
05	29	Contingency analysis ZBUS Method in Contingency Analysis	PPT, Chalk and board
	30	Adding & Removing Multiple Lines	PPT, Chalk and board
	31	Piecewise Solution of Interconnected Systems	PPT, Chalk and board
	32	Analysis of Single Contingencies	PPT, Chalk and board
	33	Analysis of Multiple Contingencies	PPT, Chalk and board
	34	Contingency Analysis of DC Model	PPT, Chalk and board
	35	System Reduction for Contingency and Fault Studies	PPT, Chalk and board
06	36	Introduction to power system security, System state classification	PPT, Chalk and board
	37	Load Forecasting & State Estimation	PPT, Chalk and board
	38	Estimation of average & periodic components of load	PPT, Chalk and board
	39	Estimation of stochastic components of load	PPT, Chalk and board
	40	Basic idea of state estimation of power system..	PPT, Chalk and board
	41	State estimation in power systems Security analysis	PPT, Chalk and board
	42	Revision	PPT, Chalk and board

Reference books:

1. Electric Energy System Theory: An Introduction. O.I. Elgard, .II Edition, McGraw Hill, New York, 1982.

2. Power Generation, Operation And Control., A.J. Wood, B.F. Wollenberg, .John Wiley And Sons, New York, 1984, 2nd Edition: 1996.
3. Computer Modeling Of Electrical Power Systems., J. Arrilaga, C.P. Arnold, B.J. Harker, Wiley, New York, 1983.
4. Power System Engineering, I.J. Nagrath, O.P. Kothari, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
5. Electric Power System Dynamics, Yao-Nan-Yu,
6. Power System Stability and Control. P. Kundur McGraw Hill, New York, 1994.
7 Power System Dynamics, Stability and Control, K.R. Padiyar Interline Publishing (P) Ltd., Bangalore, 1999.

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Model Lesson Plan

Class: M. Tech (EE) **Semester**: I **Subject**: Renewable Energy System

Unit	Period	Details of Coverage	Teaching aids used
01	**01**	**Energy Scenario** Classification of Energy Sources., Energy resources (Conventional and non-conventional),	Chalk and board
	02	Energy needs of India and energy consumption patterns. World-wide Potentials of these sources.	PP T &Chalk and board
	03	Energy efficiency and energy security.	PP T &Chalk and board
	04	Energy and its environmental impacts.	PP T &Chalk and board
	05	Global environmental concern, Kyoto Protocol,	Chalk and board
	06	Concept of Clean Development Mechanism (COM) and Prototype Carbon Funds (PCF).	Chalk and board
	07	Factors favoring and against renewable	Chalk and board
02	**08**	**Solar Energy** Solar thermal Systems: Types of collectors,	Chalk and board
	09	Collection systems, efficiency calculations, applications.	Chalk and board
	10	Photo voltaic (PV) technology: Present status, - solar cells , cell technologies,	Chalk and board
	11	Characteristics of PV systems, equivalent circuit, array design ,	Chalk and board
	12	Building integrated PV system, its components, sizing and economics	Chalk and board
	13	Peak power operation.	PP T &Chalk and board
	14	Standalone and grid interactive systems	PP T &Chalk and board
03	**15**	**Wind Energy** Wind speed and power relation,	PP T &Chalk and board
	16	Power extracted from wind, wind distribution and wind speed predictions.	PP T &Chalk and board

	17	Wind power systems: system components, suitability of generators, turbine rating,	Chalk and board
	18	Electrical load matching, Variable speed operation,	PP T &Chalk and board
	19	Maximum power operation, control systems,	Chalk and board
	20	System design features, stand alone and grid connectivity,	PP T &Chalk and board
	21	Environmental impacts of wind farms.	PP T &Chalk and board
04	22	**Other Energy Sources** Biomass - various resources, energy contents, technological advancements,	PP T &Chalk and board
	23	Conversion of biomass in other form of energy - solid, liquid and gases, Gasifiers.	PP T &Chalk and board
	24	Biomass fired boilers, Co firing, Municipal solid waste systems.	Chalk and board
	25	Problems in harnessing, Hydro energy - feasibility of small.	Chalk and board
	26	mini and micro hydel plants scheme layout economics.	PP T &Chalk and board
	27	Tidal and wave energy - schemes, feasibility and viability.	PP T &Chalk and board
	28	Geothermal and Ocean thermal energy conversion (OTEC) systems - schemes, feasibility and viability, Fuel Cell Technology.	PP T &Chalk and board
05	29	**Energy storage and hybrid system configurations** Energy storage: Battery' - types, equivalent circuit, performance characteristics	PP T &Chalk and board
	30	Battery design, charging and charge regulators.	PP T &Chalk and board
	31	Battery management.	Chalk and board
	32	Fly wheel- energy relations, components, benefits over battery.	Chalk and board
	33	Stand alone systems,	Chalk and board
	34	Hybrid systems - hybrid with diesel, with fuel cell, solar-wind, wind -hydro systems,	Chalk and board
	35	Mode controller, load sharing, system sizing, Hybrid system economics	PP T &Chalk and board
06	36	**Grid Integration** Grid connected system and their electrical performance: Interface requirements	PP T &Chalk and board
	37	Synchronization with grid, inrush	PP T &Chalk and board
	38	Stable operation, load transient, safety.	PP T &Chalk and board
	39	Operating limits of voltage, frequency, stability margin,	PP T &Chalk and board
	40	Energy storage, and IQad scheduling.	PP T &Chalk and board
	41	Quality of power- harmonic distortion, voltage transients and sags, voltage flickers	PP T &Chalk and board
	42	Dynamic reactive power support. Systems stiffness, Effect of Utility restructuring.	PP T &Chalk and board

References:

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
3. Wind Energy Technology - Njenkins, John Wiley & Sons,
4. Solar & Wind energy Technologies - McNeils, Frenkel, Desai, Wiley Eastern.
5. Solar Energy - S.P. Sukhatme, Tata McGraw Hill.

Lesson Plan for the academic year ___________

Class: M. Tech (EE) **Semester**: I **Subject**: Electrical Transients In Power System

Unit	Period	Details of Coverage	Teaching aids used
01	**01**	**REVIEW OF TRAVELLING WAVE PHENOMENA** Lumped and Distributed Parameters	PPT, Chalk and board
	02	Travelling-wave phenomena of three-phase transmission line	PPT, Chalk and board
	03	Line-to-ground travelling waves	PPT, Chalk and board
	04	Line-to-line travelling waves	PPT, Chalk and board
	05	Wave Equation – Reflection	PPT, Chalk and board
	06	Wave Equation Refraction	PPT, Chalk and board
	07	Behaviour of Travelling waves at the line terminations	PPT, Chalk and board
	08	Lattice Diagrams, Attenuation and Distortion	PPT, Chalk and board
			PPT, Chalk and board
02	**09**	**LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES** Lightning overvoltages	PPT, Chalk and board
	10	Interaction between lightning and power system	PPT, Chalk and board
	11	Ground wire voltage	PPT, Chalk and board
	12	Voltage across insulator	PPT, Chalk and board
	13	Switching overvoltage: Short line or kilometric fault	PPT, Chalk and board
	14	Energizing transients - closing and re-closing of lines	PPT, Chalk and board
	15	Methods of control	PPT, Chalk and board
	16	Temporary overvoltages: line dropping, load rejection; voltage induced by fault	PPT, Chalk and board
	17	Very fast transient overvoltage (VFTO)	PPT, Chalk and board
03	**18**	**PARAMETERS AND MODELLING OF OVERHEAD LINES** Review of line parameters for simple configurations: series resistance	PPT, Chalk and board
	19	Line parameters for simple configurations: inductance	PPT, Chalk and board
	20	Line parameters for simple configurations: shunt capacitance	PPT, Chalk and board
	21	Bundle conductors : equivalent GMR and equivalent radius	PPT, Chalk and board
	22	Introduction to modal propagation in transmission lines	PPT, Chalk and board
	23	Modes on multiphase transposed transmission lines, α-β-0 transformation	PPT, Chalk and board
	24	Symmetrical components transformation, modal impedances	PPT, Chalk and board
	25	Analysis of modes on untransposed lines	PPT, Chalk and board
	26	Effect of ground return and skin effect; transposition schemes	PPT, Chalk and board
04	**27**	**PARAMETERS OF UNDERGROUND CABLES**	PPT, Chalk and board

		Distinguishing features of underground cables: technical features	
	28	Distinguishing features of underground cables: electrical parameters	PPT, Chalk and board
	29	Overhead lines versus underground cables	PPT, Chalk and board
	30	Cable types; single-core self-contained cables, Series impedance of single-core self-contained cables	PPT, Chalk and board
	31	Shunt admittance of single-core self-contained cables	PPT, Chalk and board
	32	Impedance matrices for three phase system formed by three single-core self-contained cables	PPT, Chalk and board
	33	Admittance matrices for three phase system formed by three single-core self-contained cables	PPT, Chalk and board
	34	Approximate formulas for cable parameters	PPT, Chalk and board
05	**35**	**COMPUTATION OF POWER SYSTEM TRANSIENTS - EMTP** Digital computation of line parameters	PPT, Chalk and board
	36	Line parameter evaluation programs, Salient features of M.T. line	PPT, Chalk and board
	37	Constructional features of that affect transmission line parameters;	PPT, Chalk and board
	38	Elimination of ground wires bundling of conductors	PPT, Chalk and board
	39	Principle of digital computation of transients: features of EMTP	PPT, Chalk and board
	40	Principle of digital computation of transients: capabilities of EMTP	PPT, Chalk and board
	41	Steady state modules: basic solution methods	PPT, Chalk and board
	42	Time step solution modules: basic solution methods	

References:

1. Electrical Transients in Power System, Allan Greenwood Wiley & Sons Inc. New York, 1991.

2. Extra High Voltage AC Transmission Engineering, Rakosh Das Begamudre, (Second edition) Newage International (P) Ltd., New Delhi, 1990.

3. High Voltage Engineering, Naidu M S and Kamaraju V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

4.EMTP Theory Book, Hermann W. Dommel, second Edition, Microtran Power System Analysis Corporation, Vancouver, British Columbia, Canada, May 1992,

Last Update: April 1999.

1. EMTP Literature from www.microtran.com.