

M. Tech Electrical Power Systems

# MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE MADANAPALLE

(UGC-AUTONOMOUS)

[www.mits.ac.in](http://www.mits.ac.in)



## MASTER OF TECHNOLOGY ELECTRICAL POWER SYSTEMS

### COURSE STRUCTURE & DETAILED SYLLABUS (R20)

For the students admitted to

Master of Technology in Electronic Power Systems from the academic year 2020-21 Batches onwards



**M. Tech Regular Two-Year P. G. Degree Course**

## M. Tech Electrical Power Systems

### CURRICULUM STRUCTURE

#### I Year I Semester

Sl. No.	Course Code	Course Title	Hours Per Week				Credits
			L	T	P	Total Contact Hours	
1	20EPSP101	Mathematical Methods for Power Engineering	3	0	0	3	3
2	20EPSP102	Advanced Power System Analysis	3	0	0	3	3
<b>DISCIPLINE ELECTIVE – I</b>							
3	20EPSP401	Power System Dynamics – I	3	0	0	3	3
	20EPSP402	Smart Grid					
	20EPSP403	High Power Converters					
	20EPSP404	Distributed Generation Systems					
<b>DISCIPLINE ELECTIVE – II</b>							
4	20EPSP405	Electrical Power Distribution Systems	3	0	0	3	3
	20EPSP406	Wind and Solar Systems					
	20EPSP407	Pulse Width Modulation for PE Converters					
	20EPSP408	Electric and Hybrid Vehicles					
5	20ICP101	Research Methodology and IPR	2	0	0	2	2
6	20EPSP201	Power Systems Laboratory	0	0	4	4	2
7	20EPSP202	Renewable Energy Laboratory	0	0	4	4	2
<b>AUDIT COURSE – I</b>							
8	20AUP901	Disaster Management	2	0	0	2	0
	20AUP902	Sanskrit for Technical Knowledge					
	20AUP903	Constitution of India					
	20AUP904	Pedagogy Studies					
<b>Total</b>			<b>16</b>	<b>0</b>	<b>8</b>	<b>24</b>	<b>18</b>

## M. Tech Electrical Power Systems

### I Year II Semester

Sl. No.	Course Code	Course Title	Hours Per Week				Credits
			L	T	P	Total Contact Hours	
1	20EPSP103	Power Quality	3	0	0	3	3
2	20EPSP104	Digital Protection of Power System	3	0	0	3	3
<b>DISCIPLINE ELECTIVE – III</b>							
3	20EPSP409	Restructured Power Systems	3	0	0	3	3
	20EPSP410	Power System Dynamics - II					
	20EPSP411	Dynamics of Electrical Machines					
	20EPSP412	Power Apparatus Design					
<b>DISCIPLINE ELECTIVE – IV</b>							
4	20EPSP413	Advanced Micro-Controller Based Systems	3	0	0	3	3
	20EPSP414	SCADA System and Applications					
	20EPSP415	Advanced Digital Signal Processing					
	20EPSP416	Introduction to AI Techniques					
5	20EPSP203	Power System Protection Laboratory	0	0	4	4	2
6	20EPSP204	Power Grid Laboratory	0	0	4	4	2
7	20EPSP701	Mini Project	0	0	4	4	2
<b>AUDIT COURSE – II</b>							
8	20AUP905	English for Research Paper Writing	2	0	0	2	0
	20AUP906	Value Education					
	20AUP907	Stress Management by Yoga					
	20AUP908	Personality Development through Life Enlightenment Skills					
<b>Total</b>			<b>14</b>	<b>0</b>	<b>12</b>	<b>26</b>	<b>18</b>

## M. Tech Electrical Power Systems

### Tentative Curriculum Structure for II Year

#### II Year I Semester

Sl. No.	Course Code	Course Title	Hours Per Week				Credits
			L	T	P	Total Contact Hours	
		<b>DISCIPLINE ELECTIVE – V</b>					
1	20EPSP417	Power System Transients					
	20EPSP418	Fuzzy Logic, ANN and Introduction to GA	3	0	0	3	3
	20EPSP419	Industrial Load Modeling and Control					
	20EPSP420	Dynamics of Linear Systems					
		<b>OPEN ELECTIVE</b>					
2	20OEP301	Business Analytics					
	20OEP302	Industrial Safety					
	20OEP303	Operations Research	3	0	0	3	3
	20OEP304	Cost Management of Engineering Projects					
	20OEP305	Composite Materials					
	20OEP306	Waste to Energy					
3	20EPSP702	Dissertation Phase I	0	0	20	20	10
<b>Total</b>			<b>6</b>	<b>0</b>	<b>20</b>	<b>26</b>	<b>16</b>

## M. Tech Electrical Power Systems

### II Year II Semester

Sl. No.	Course Code	Course Title	Hours Per Week				Credits
			L	T	P	Total Contact Hours	
1	20EPSP703	Dissertation Phase II	0	0	32	32	16
<b>Total</b>			<b>0</b>	<b>0</b>	<b>32</b>	<b>32</b>	<b>16</b>

# **M. TECH I YEAR I SEM**

## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP101 MATHEMATICAL METHODS FOR POWER ENGINEERING

L T P C

3 0 0 3

#### Course Description:

This course facilitates the students with the mathematical methods to solve and apply engineering problems.

#### Course Objectives:

Students will be able to:

1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

#### UNIT I: Vector Spaces and Linear Transformations

Vector spaces, linear transformations, Matrix representation of linear transformation. Eigen values and Eigen vectors of linear operator.

(9)

#### UNIT II: Linear and Nonlinear Programming

Linear Programming Problems, Simplex Method, Duality, Non Linear Programming problems

(9)

#### UNIT III: Constrained & Unconstrained Problems

Unconstrained Problems, Search methods, Constrained Problems

(9)

#### UNIT IV: Optimization Techniques I

Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions.

(9)

#### UNIT V: Optimization Techniques II

Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes

(9)

## M. Tech Electrical Power Systems

### Course Outcomes: -

Students will be able to:

1. Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators.
2. To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology.
1. 3.Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems.
2. 4.Understanding the concept of random variables, functions of random variable and their probability distribution.
1. Understand stochastic processes and their classification.

### Text/Reference Books:

1. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 1992.
2. Erwin Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, 2004.
3. Irwin Miller and Marylees Miller, John E. Freund's "Mathematical Statistics", 6th Edn, PHI, 2002.
4. J. Medhi, "Stochastic Processes", New Age International, New Delhi., 1994.
5. A Papoulis, "Probability, Random Variables and Stochastic Processes", 3rd Edition, McGraw Hill, 2002.
6. John B Thomas, "An Introduction to Applied Probability and Random Processes", John Wiley, 2000.
7. Hillier F S and Liebermann G J, "Introduction to Operations Research", 7th Edition, McGraw Hill, 2001.
8. Simmons D M, "Non Linear Programming for Operations Research", PHI, 1975.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.



## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

20EPSP102

### ADVANCED POWER SYSTEM ANALYSIS

L T P C  
3 0 0 3

#### Course Description:

This course deals with concept of load flow analysis in a power system, various types of faults and its analysis, power system security concepts, state estimation algorithms and voltage instability phenomenon.

#### Course Objectives:

1. Study various methods of load flow and their advantages and disadvantages.
2. Understand how to analyze various types of faults in a power system.
3. Understand power system security concepts and to study the methods to rank the contingencies.
4. Understand the need of state estimation and to study simple algorithms for state estimation.
5. Study the voltage instability phenomenon.

#### UNIT I: Load flow Analysis

Load flow: Overview of Newton-Raphson, Gauss-Siedel, fast decoupled methods, convergence properties, sparsity techniques, handling Q-max violations in constant matrix, inclusion in frequency effects. AVR in load flow, handling of discrete variable in load flow.

(9)

#### UNIT II: Fault Analysis

Fault Analysis: Simultaneous faults, open conductors faults, generalized method of fault analysis.

(9)

#### UNIT III: Security Analysis

Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking.

(9)

#### UNIT IV: Power System Equivalent & State Estimation

Power System Equivalent: WARD, REI equivalents.

State Estimation: Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction.

(9)

#### UNIT V: Voltage Stability

Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multiplies load flow, voltage collapse proximity indices.

(9)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

Upon successful completion of the course, students will be able to

1. Calculate the voltage phasors at all buses using various methods of load flow.
2. Carryout fault analysis in a power system.
3. Rank various contingencies according to their severity.
4. Estimate the bus voltage phasors using the details like power flow, voltages, taps, CB status etc.
5. Estimate closeness to voltage collapse and calculate PV curves using continuation power flow.

### **Text Books**

1. J.J. Grainger &W.D. Stevenson, “Power system analysis”, McGraw Hill ,2003
2. A. R. Bergen & Vijay Vittal, “Power System Analysis”, Pearson, 2000

### **Reference Books:**

1. L.P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2006
2. G.L. Kusic, “Computer aided power system analysis”, Prentice Hall India, 1986
3. A.J. Wood, “Power generation, operation and control”, John Wiley, 1994
4. P.M. Anderson, “Faulted power system analysis”, IEEE Press, 1995

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **DISCIPLINE ELECTIVE – I**

## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP401 POWER SYSTEM DYNAMICS - I

L	T	P	C
3	0	0	3

**Course Prerequisite:** Electrical Machines

#### **Course Description:**

This course deals with the system dynamics and mathematical modeling of a synchronous machine and an induction motor.

#### **Course Objectives:**

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for synchronous machine
3. Modeling of induction motor

#### **UNIT I: BASIC MACHINE MODELING**

Synchronous Machines: Per unit systems - Park's Transformation (modified) -Flux-linkage equations. (9)

#### **UNIT II: SYNCHRONOUS MACHINE MODELING I**

Voltage and current equations, Formulation of State-space equations, Equivalent circuit. (9)

#### **UNIT III: SYNCHRONOUS MACHINE MODELING II**

Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines. (9)

#### **UNIT IV: SMALL SIGNAL MODELING**

Small signal model: Introduction to frequency model.

Excitation systems and Philips-Heffron model, PSS Load modeling. (9)

#### **UNIT V: INDUCTION MOTOR MODELING**

Modeling of Induction Motors - Prime mover controllers. (9)

#### **Course Outcomes:**

Upon successful completion of the course, students will be able to

1. Understand the modeling of synchronous machine.
2. Carry out simulation studies related to power system dynamics using MATLAB-SIMULINK or MIPOWER
3. Carry out stability analysis with and without power system stabilizer (PSS)
4. Understand the load modeling in power system

## **M. Tech Electrical Power Systems**

### **Text Books:**

1. P. M. Anderson & A. A. Fouad “Power System Control and Stability”, Galgotia, New Delhi, 1981.
2. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc., 1994.

### **Reference Books:**

1. J. Machowski, J Bialek & J. R W. Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997.
2. E.W. Kimbark, “Power system stability”, Vol. I & III, John Wiley & Sons, New York 2002.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

#### 20EPSP402 SMART GRID

L T P C  
3 0 0 3

**Course Prerequisite:** Power Systems

#### **Course Description:**

This course deals with concept of smart grid, smart metering techniques, wide area measurement techniques, integration of distributed generation & its solution through smart grid.

#### **Course Objectives:**

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

#### **UNIT I: SMART GRID**

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid Present development & International policies in Smart Grid. (9)

#### **UNIT II: SMART METERING**

Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicles (PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation Smart Substations, Substation Automation, Feeder Automation. (9)

#### **UNIT III: SMART STORAGE AND WIDE AREA MEASUREMENTS**

Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU). (9)

#### **UNIT IV: MICRO-GRID**

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines Captive power plants, Integration of renewable energy sources. (9)

#### **UNIT V: POWER QUALITY**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit, Advanced Metering Infrastructure (AMI), Basics of CLOUD Computing & Cyber Security for Smart Grid. (9)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

Upon successful completion of the course, students will be able to

1. Appreciate the difference between smart grid & conventional grid
2. Apply smart metering concepts to industrial and commercial installations
3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
4. Come up with smart grid solutions using modern communication technologies.

### **Text/Reference Books:**

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press , 2009
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012
4. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions", CRC Press
5. A.G. Phadke, "Synchronized Phasor Measurement and their Applications", Springer

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

#### 20EPSP403 HIGH POWER CONVERTERS

**Course Prerequisite:** Power Electronics

**L T P C**  
**3 0 0 3**

#### **Course Description:**

This course provides understanding about the requirements of high power converters, operation of semiconductor devices and its characteristics, and provides idea to design protection circuits for these converters.

#### **Course Objectives:**

1. Understand the requirements of high power rated converters
2. To learn the operation of semiconductor devices and its characteristics.
3. Able to understand the design of protection circuits for these converters.

#### **UNIT I: POWER ELECTRONIC SYSTEMS**

Power electronic systems, an overview of PSDs, multipulse diode rectifier, multipulse, SCR rectifier. (8)

#### **UNIT II: MULTILEVEL INVERTERS**

Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, cascaded, H bridge multilevel inverter, Diode clamped multilevel inverters, flying capacitor multilevel inverter. (10)

#### **UNIT III: SWITCH MODE CONVERTERS**

DC to DC switch mode converters - Buck converter, boost converter, buck - boost converter, averaged circuit modeling, input-output equations, ripple calculations, filter design, case studies, PWM current source inverters. (9)

#### **UNIT IV: AC VOLTAGE CONTROLLERS**

AC voltage controllers: single phase and three phase circuits employing Phase angle control, on-off control, case studies. Cyclo-converters, matrix converter, Power conditioners and UPS. (9)

#### **UNIT V: DESIGN AND PROTECTION OF CONVERTERS**

Design aspects of converters, protection of devices and circuits - heat sink design, snubber design drive and protection circuits, commutation circuits, Soft switching. (9)



## **M. Tech Electrical Power Systems**

### **Course Outcomes: -**

Students will be able to:

1. Learn the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
2. Knowledge of working of multi-level VSIs, DC-DC switched mode converters, cyclo-converters and PWM techniques and the ability to use them properly.
3. Acquire knowledge of power conditioners and their applications.
4. Ability to design power circuit and protection circuit of PSDs and converters

### **Text/Reference Books**

1. N. Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converter, Applications and Design", John Wiley and Sons, 1989
2. M.H. Rashid, "Power Electronics", Prentice Hall of India, 1994
3. B. K. Bose, "Power Electronics and A.C. Drives", Prentice Hall, 1986
4. Bin Wu, "High power converters and drives", IEEE press, Wiley Enter science
5. Singh M.D., Khanchandani K. B., 'Power Electronics', Tata McGraw-Hill, 2nd Edition, 2008.
6. Umanand L., 'Power Electronics: Essentials & Applications', Wiley India

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## **M. Tech Electrical Power Systems**

### **M. Tech. I Year I Semester**

#### **20EPSP404 DISTRIBUTED GENERATION SYSTEMS**

**L T P C**

**3 0 0 3**

**Course Prerequisite:** Power Electronics

**Course Description:**

**Course Objectives:**

1. To illustrate the concept of distributed generation
2. To analyze the impact of grid integration.
3. To study concept of Micro grid and its configuration
4. To find optimal size, placement and control aspects of DGs

#### **UNIT I: NEED FOR DISTRIBUTED GENERATION**

– Renewable sources in distributed generation – Current scenario in distributed generation – Planning of DGs – Siting and sizing of DGs – Optimal placement of DG sources in distribution systems. (9)

#### **UNIT II: GRID INTEGRATION OF DGS**

Different types of interfaces – Inverter based DGs and rotating machine-based interfaces – Aggregation of multiple DG units – Energy storage elements – Batteries, ultracapacitors, flywheels. (9)

#### **UNIT III: TECHNICAL IMPACTS OF DGS**

Transmission systems, Distribution systems, De-regulation – Impact of DGs upon protective relaying – Impact of DGs upon transient and dynamic stability of existing distribution systems. (9)

#### **UNIT IV: ECONOMIC AND CONTROL ASPECTS OF DGS**

Market facts, issues and challenges – Limitations of DGs – Voltage control techniques, Reactive power control, Harmonics, Power quality issues – Reliability of DG based systems – Steady state and Dynamic analysis. (9)

#### **UNIT V: INTRODUCTION TO MICRO-GRIDS**

Types of micro-grids – Autonomous and non-autonomous grids – Sizing of micro-grids – Modeling & analysis – Micro-grids with multiple DGs – Micro-grids with power electronic interfacing units – Transients in micro-grids – Protection of micro-grids – Case studies. (9)

## **M. Tech Electrical Power Systems**

### **Course Outcomes: -**

Students will be able to:

1. Find the size and optimal placement DG
2. Analyze the impact of grid integration and control aspects of DGs
3. Model and analyze a micro grid taking into consideration the planning and operational issues of the DGs to be connected in the system
4. Describe the technical impacts of DGs in power systems

### **Text/Reference Books**

1. H. Lee Willis, Walter G. Scott , ‘Distributed Power Generation – Planning and Evaluation’, Marcel Decker Press, 2000.
2. M.Godoy Simoes, Felix A.Farret, ‘Renewable Energy Systems – Design and Analysis with Induction Generators’, CRC press.
3. Robert Lasseter, Paolo Piagi, ‘ Micro-grid: A Conceptual Solution’, PESC 2004, June 2004.
4. F. Katiraei, M.R. Iravani, ‘Transients of a Micro-Grid System with Multiple Distributed Energy Resources’, International Conference on Power Systems Transients (IPST’05) in Montreal, Canada on June 19-23, 2005.
5. Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson, ‘Facility Microgrids’, General Electric Global Research Center, Niskayuna, New York, Subcontract report, May 2005.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **DISCIPLINE ELECTIVE – II**

## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

#### 20EPSP405 ELECTRICAL POWER DISTRIBUTION SYSTEMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Prerequisite:** Power Systems

#### **Course Description:**

This course facilitates the students with the fundamentals of power distribution system, SCADA System and Distribution Automation

#### **Course Objectives:**

1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

#### **UNIT I: POWER DISTRIBUTION AND LOAD FORECASTING**

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting. (9)

#### **UNIT II: DISTRIBUTION AUTOMATION**

Advantages of Distribution Management System (D.M.S.) Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction. (9)

#### **UNIT III: INTERCONNECTION OF DISTRIBUTION SYSTEMS AND METERING**

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation. (9)

#### **UNIT IV: SCADA**

SCADA: Introduction, Block Diagram, SCADA Applied to Distribution Automation, Common Functions of SCADA, Advantages of Distribution Automation through SCADA. (9)

#### **UNIT V: DISTRIBUTION AUTOMATION**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches –Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation. (9)

#### **Course Outcomes:-**

Students will be able to:

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice
3. To learn SCADA system

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. A.S. Pabla, “Electric Power Distribution”, Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M. K. Khedkar, G.M. Dhole, “A Text Book of Electrical power Distribution Automation”, University Science Press, New Delhi
3. Anthony J Panseni, “Electrical Distribution Engineering”, CRC Press
4. James Momoh, “Electric Power Distribution, automation, protection & control”, CRC Press

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

#### 20EPSP406 WIND AND SOLAR SYSTEMS

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Prerequisite:** Electrical Machines, Power Systems

#### **Course Description:**

This course is designed to obtain thorough knowledge on wind and solar systems and to understand the factors involved in installation and commissioning of a Solar or Wind plant. Also to understand the dynamics involved when interconnected with power system grid.

#### **Course Objectives:**

1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. Learning the dynamics involved when interconnected with power system grid.

#### **UNIT I: WIND POWER GENERATION**

Historical development and current status, Characteristics of wind power generation, network integration issues. (9)

#### **UNIT II: WIND GENERATORS AND INTERCONNECTION STANDARDS**

Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm and PV systems with power systems. (9)

#### **UNIT III: REACTIVE POWER AND VOLTAGE CONTROL IN WIND SYSTEMS**

Isolated wind systems, reactive power and voltage control, economic aspects. (9)

#### **UNIT IV: SOLAR POWER GENERATION**

Solar thermal power generation, PV power generation, Energy Storage device, Designing the solar system for small installations. (9)

#### **UNITV: SOLAR SYSTEMS**

Introduction of solar systems, merits and demerits, concentrators, various applications. (9)

## **M. Tech Electrical Power Systems**

### **Course Outcomes: -**

Students will be able to:

1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems
2. Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems
3. Demonstrate the knowledge of physics of solar power generation and the associated issues
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

### **Text/Reference Books:**

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Willy and sons Ltd. 2005
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons Ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata Mac Graw Hill, Second Edition, 1996

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.



## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP407 PULSE WIDTH MODULATION FOR PE CONVERTERS

**Course Prerequisite:** Power Electronics

**L T P C**

**3 0 0 3**

**Course Description:**

This course facilitates the students with the necessity of PWM techniques and controllers

**Course Objectives:**

1. To understand Necessity and Importance of PWM techniques
2. Implementation of PWM controllers

#### **UNIT I: PE CONVERTERS**

Introduction to PE converters, Modulation of one inverter phase leg, Modulation of single phase VSI - Voltage control of single phase inverters - sinusoidal PWM – modified PWM –phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation, Modulation of 3 phase VSI -Voltage Control of Three-Phase Inverters- Sinusoidal PWM-Third Harmonic PWM. (10)

#### **UNIT II: SPACE VECTOR MODULATION STRATEGIES, MODULATION OF CSI**

Space Vector Modulation- Zero space vector placement modulation strategies, Losses Discontinuous modulation, modulation of CSI. (9)

#### **UNIT III: MODULATION OF CONVERTERS**

Over modulation of converters, programmed modulation strategies. (8)

#### **UNIT IV: MULTILEVEL INVERTERS**

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying- Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Pulse width modulation for multilevel inverters, Implementation of modulation controller. (10)

#### **UNIT V: PWM MODULATION**

Continuing developments in modulation as random PWM, PWM for voltage unbalance. Effect of minimum pulse width and dead time. (8)

**Course Outcomes: -**

Students will be able to:

1. Analyze the PWM techniques
2. Implement PWM using different strategies
3. Control CSI and VSI using PWM
4. Compare performance of converter for different PWM techniques

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. Bin Vew, “High Power Converter”, Wiley Publication
3. Marian K. Kazimierczuk, “Pulse width modulated dc-dc power converter”, Wiley Publication

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP408 ELECTRIC AND HYBRID VEHICLES

L	T	P	C
3	0	0	3

**Course Prerequisite:** Power Electronics, Electric Drives and Control

**Course Description:** This subject aims to study electric and Hybrid Vehicles and design of storage and Energy Management Strategies

#### Course Objectives:

1. To study the power flow of electric and hybrid vehicles and control in Hybrid Vehicles
2. To study the operation and control of electric train
3. To study energy storage and energy management strategies

#### UNIT I: HYBRID AND ELECTRIC VEHICLES

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance. (9)

#### UNIT II: CONCEPT OF HYBRID TRACTION & DRIVE-TRAIN TOPOLOGIES

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, Review of Toyota Prius. (9)

#### UNIT III: ELECTRIC TRAINS

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. (9)

**UNIT IV: ENERGY STORAGE** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. (9)

## M. Tech Electrical Power Systems

### UNIT V: ENERGY MANAGEMENT STRATEGIES

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).  
(9)

**Course Outcomes:** At the end of this course, students will able to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the Principles of Hybrid electrical drives
3. Understand the principles and control of Electric trains
4. Understand the different possible ways of energy storage.
5. Understand the different energy management strategies related to energy storage systems.

#### Text

##### Books:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

#### Reference

##### Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016
3. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 2nd Edition, CRC Press, 2011.
4. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech. I Year I Semester

#### 20ICP101 RESEARCH METHODOLOGY AND IPR

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>2</b>	<b>0</b>	<b>0</b>	<b>2</b>

**Course Prerequisite:** None

#### **Course Description:**

This course provides the fundamental aspects of data collection, analysis, and interpretation of research problem. It also provides the effective way of paper writing, intellectual property rights and process of patenting.

#### **Course Objectives:**

1. To obtain solution for research problem, data collection and analysis.
2. To know effective paper writing
3. know the patenting process
4. To know the new developments in IPR
5. To understand the electrical wiring systems for residential, commercial and industrial consumers.

#### **UNIT I: INTRODUCTION**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, Effective literature studies approaches, analysis Plagiarism., research ethics. (6)

#### **UNIT II: EFFECTIVE PAPER WRITING**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. (6)

#### **UNIT III: NATURE OF INTELLECTUAL PROPERTY**

Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. (6)

#### **UNIT IV: PATENT RIGHTS**

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical indications. (6)

#### **UNIT V: NEW DEVELOPMENTS IN IPR**

Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. (6)

#### **Course Outcomes:**

1. Analyze research related information.
2. Follow research ethics.
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

## **M. Tech Electrical Power Systems**

4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasize the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.

5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

### **Text Books:**

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”.

2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”.

### **Reference Books:**

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP201 POWER SYSTEMS LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Course Prerequisite:** Power System Laboratory

#### Course Objectives:

1. To analyze various faults in power system.
2. To carry out the load flow analysis of a power system.
3. To carry out the transient Stability Studies.

#### LIST OF EXPERIMENTS

1. Fault Analysis-I
  - i) LG Fault
  - ii) LL Fault
2. Fault Analysis-II
  - i) LLG Fault
  - ii) LLLG Fault
3. Gauss Seidal load flow analysis using MATLAB Software
4. Newton Raphson method of load flow analysis using MATLAB Software.
5. Formation of Y bus matrix by inspection / analytical method using MATLAB Software.
6. Fast decoupled load flow analysis using MATLAB Software.
7. Load Forecasting and Unit Commitment.
8. Transient Stability Studies.

#### Course Outcome:

At the end of the course, students will able to

1. Analyze the various faults in power system.
2. Obtain the Y bus and Z bus matrix using MATLAB software.
3. Carryout the various load flow analysis using MATLAB software.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination

## M. Tech Electrical Power Systems

### M. Tech I Year I Semester

#### 20EPSP202 RENEWABLE ENERGY LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Course Prerequisite:** 18EPSP404

#### **Course Objectives:**

1. To learn the basic modeling of a wind generator using MATLAB software.
2. To understand the operation of a wind generator/wind farm.
3. To understand the basic modeling and operation of a Solar PV System using MATLAB.
4. To test the capabilities of Solar Panels and Wind Turbines under different operating conditions.

#### **List of experiments**

1. Modeling of a wind generator system using MATLAB software.
2. Obtain the Power Vs Wind Velocity Curve of a Wind Turbine.
3. Build a Wind Farm using wind generators MATLAB software.
4. The Effect of load on Wind Turbine Output.
5. Modeling of a Solar PV System using MATLAB software.
6. Effect of Temperature on Solar Panel Output.
7. Variables Affecting Solar Panel Output.
8. Effect of Load on Solar Panel Output.
9. Test the Capabilities of Solar Panels and Wind Turbines under different operating conditions (irradiation; wind velocity, grid distortions etc.).
10. Test the Capabilities of the Hydrogen Fuel Cells and Capacitors.

#### **Course Outcome:**

At the end of the course, students will able to

1. Model a Wind Generator using MATLAB software.
2. Model a Solar PV System using MATLAB software.
3. Testing of Wind Generator and Solar PV System under various operating conditions.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination



# **AUDIT COURSE - I**

**20AUP901 DISASTER MANAGEMENT**

**L T P C**  
**2 0 0 0**

**Course Prerequisite: Nil**

**Course Description:**

This course deals with disaster management in case of natural calamities, Tsunami, flood etc.

**Course Objectives:**

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

**UNIT I: DISASTER CLASSIFICATION**

Disaster: definition, factors and significance; difference between hazard and Disaster; natural disaster: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches; man-made disasters: nuclear reactor meltdown, industrial accidents, oil slicks  
Study of seismic zones; areas prone to floods and droughts, landslides and Avalanches; man-made disasters: nuclear reactor meltdown, industrial accidents, oil slick areas and spills, outbreaks of disease and epidemics, war and conflicts. (6)

**UNIT II: REPERCUSSIONS OF DISASTERS**

Economic damage, loss of human and animal life, destruction of ecosystem.  
Disaster Prone Areas in India - Study of seismic zones; areas prone to floods and droughts, landslides and Avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami. (6)

**UNIT III: DISASTER PREPAREDNESS AND MANAGEMENT**

Preparedness: monitoring of phenomena triggering a disaster or hazard; Evaluation of risk, application of remote sensing, data from meteorological and Other agencies, media reports: governmental and community preparedness. (6)

**UNIT IV: RISK ASSESSMENT**

Disaster risk: concept and elements, disaster risk reduction, global and national disaster risk situation. Techniques of risk assessment, global co-operation in risk assessment and warning. (6)

**UNIT V: DISASTER MITIGATION**

Meaning, concept and strategies of disaster mitigation, emerging trends in Mitigation. Structural mitigation and non-structural mitigation, programs of Disaster mitigation in India. (6)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

1. Students will be able to understand disaster and its types in general.
2. They will understand the post disaster damage in terms of both like and commodity.
3. They will have clear picture of disaster prone zones,
4. They will be able to understand the pre and post disaster preparedness needed to mitigate the disaster impact in large scale.
5. Student will also understand to quantify the risk in terms of monetary for both commodity and life.

### **Text Books:**

1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies New Royal Book Company.

### **Reference Books:**

1. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

**Mode of Evaluation:** Assignment, Mid Term Tests.

## M. Tech Electrical Power Systems

M. Tech. I Year I Semester

Audit Course I

### 20AUP902 SANSKRIT FOR TECHNICAL KNOWLEDGE

L T P C  
2 0 0 0

**Course Prerequisite:** Nil

**Course Description:**

The students will study about value of this language and its ancient history.

**Course Objectives:**

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
- 3 Learning of Sanskrit to develop the logic in mathematics, science & other subjects
- 4 Enhancing the memory power
- 5.The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

**UNIT I: INTRODUCTION**

Alphabets- Vowels- Consonants - Māheśvara sutras - Combined alphabets- Verbs- Basic words. (6)

**UNIT II: STUDY OF GRAMMER**

Singular/Dual/Plural – Nominative case – Accusative case - Instrumental case - Dative case - Ablative case- Genitive case - Locative case (6)

**UNIT III:**

Nouns and adjectives – Indeclinables - Present tense - Past tense - Future tense- Order and request– Prefixes - Number word - Combinations and cases. (6)

**UNIT IV:**

Sanskrit literature-Harsacaritasangrah-Kumarasambhava-sabdamanjari. (6)

**UNIT V:**

Technical concept of Architecture-Manasar text –logic- nyaya sutras –pramana-mathematics- sulva sutras-baudhyana theorem. (6)

**Course Outcomes:**

1. Understanding basic alphabets and vowels
2. Understanding the cases in Sanskrit language
3. Understanding of Nouns and tense
4. Understanding of some literature
5. Analyzing the observation through pramana, application of architecture and mathematics

## **M. Tech Electrical Power Systems**

### **Text Books:**

1. Abhyastakam, Dr. Vishwas, Samskrita-Bharti Publication, New Delhi.
2. Teach Yourself Sanskrit, Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi.

**Mode of Evaluation:** Assignment, Mid Term Tests.

## M. Tech Electrical Power Systems

M. Tech. I Year I Semester

Audit Course I

### 20AUP903 CONSTITUTION OF INDIA

L	T	P	C
2	0	0	0

**Course Prerequisite:** Nil

#### **Course Description:**

This course deals with basics of electrical wiring systems for residential, commercial and industrial consumers, and its representation with standard symbols and drawings, various components of industrial electrical systems and its sizing and control aspects of industrial electrical system using PLC and SCADA.

#### **Course Objectives:**

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
  2. To address the growth of Indian regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
  3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.
  4. To get knowledge about the Indian Federal System and Center – State Relations
  5. To Understand the Election Commission functions and administration system
2. Identify critical evidence gaps to guide the development.

#### **UNIT I: INTRODUCTION**

Historical Background – Drafting Committee (Composition & Working) – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. (6)

#### **UNIT II: - STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT**

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review. (6)

#### **UNIT III: STRUCTURE AND FUNCTION OF STATE GOVERNMENT**

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts. (6)

#### **UNIT IV: CONSTITUTION FUNCTIONS**

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments – Constitutional Functionaries - Assessment of working of the Parliamentary System in India. (6)

#### **UNIT V: RESEARCH GAPS AND FUTURE DIRECTIONS**

Central Election Commission - Role and functioning – Chief Election Commissioner and Election Commissioners – State Election Commission – Institute and Bodies for the welfare of SC/ST/OBC and Women. (6)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

1. Know about Human rights protection by Indian Constitution.
2. Understand the functions of the Indian government
3. Understand and abide the rules of the Indian constitution.
4. Role of Constitution in Socio-economic development and welfare activities of the Country.1.

### **Text Books:**

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi
- Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare.
2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi 31 (2):245-261.
- S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.

### **Reference Books:**

1. The Constitution of India, 1950 (Bare Act), Government Publication. .

**Mode of Evaluation:** Assignment, Mid Term Tests.

**20AUP904 PEDAGOGY STUDIES**

**L T P C**  
**2 0 0 0**

**Course Objectives:** Nil

**Course Description:**

1. Review existing evidence on the review topic to inform program design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

**UNIT I : INTRODUCTION AND METHODOLOGY**

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching. (6)

**UNIT II - THEMATIC OVERVIEW**

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. (6)

**UNIT III -EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES**

Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy. Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies. (6)

**UNIT IV - PROFESSIONAL DEVELOPMENT:**

Alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes. (6)

**UNITV - RESEARCH GAPS AND FUTURE DIRECTIONS:**

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment Dissemination and research impact. (6)

**Course Outcomes:**

1. What pedagogical practices are being used by teachers in formal and informal classroom in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.



## **M. Tech Electrical Power Systems**

### **Text Books:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.

**Mode of examination:** Assignment, Mid Term Tests.

# **M. TECH I YEAR II SEM**

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP103 POWER QUALITY

**Course Prerequisite:** Power Electronics **L T P C**  
**3 0 0 3**

#### **Course Description:**

This course facilitates the students with the necessity understanding of power quality

#### **Course Objectives:**

1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies like IEEE, IEC, etc on voltage & frequency, harmonics
3. Understanding STATIC VAR Compensators

#### **UNIT I: INTRODUCTION TO POWER QUALITY**

Introduction-power quality-voltage quality-overview of power quality phenomena, classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C, message weights-flicker factor transient phenomena-occurrence of power quality problems, power acceptability curves-IEEE guides, standards and recommended practices. (8)

#### **UNIT II: HARMONICS ANALYSIS**

Harmonics-individual and total harmonic distortion, RMS value of a harmonic waveform, Triplex harmonics-important harmonic introducing devices-SMPS, Three phase power converters, arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads. (8)

#### **UNIT III: MATHEMATICAL MODELLING OF NETWORKS AND COMPONENTS**

Modeling of networks and components under non-sinusoidal conditions transmission and distribution systems, Shunt capacitors-transformers-electric machines-ground, systems loads that cause power quality problems, power quality problems created by drives and its impact on drive. (8)

#### **UNIT IV: POWER FACTOR IMPROVEMENT**

Power factor improvement- Passive Compensation, Passive Filtering, Harmonic, Resonance, Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC, Based on Bilateral Single Phase and Three Phase Converter. (9)

#### **UNIT V: DESIGN OF STATIC VAR COMPENSATORS AND STATCOMS**

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, three-phase three-wire and three-phase fourwire systems, d-q domain control of three phase shunt active filters uninterruptible power supplies constant voltage, transformers, series active power filtering techniques for harmonic cancellation and isolation, Dynamic Voltage Restorers for sag, swell and flicker problems. Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, typical grounding and wiring problems solutions to grounding and wiring problems. (12)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

Students will be able to:

1. Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
2. To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
3. To introduce the student to active power factor correction based on static VAR compensators and its control techniques
4. To introduce the student to series and shunt active power filtering techniques for harmonics

### **Text/Reference Books:**

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
3. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R. Wood , "Power system Harmonic Analysis", Wiley, 1997

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech. I Year II Semester

#### 20EPSP104 DIGITAL PROTECTION OF POWER SYSTEM

L	T	P	C
3	0	0	3

**Course Prerequisite:** Power System Protection

#### Course Description:

This course facilitates the students with the necessity of digital protection of power system

#### Course Objectives:

1. Study of numerical relays
2. Developing mathematical approach towards protection
3. Study of algorithms for numerical protection

#### UNIT I: INTRODUCTION TO DIGITAL RELAYS

Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection. (6)

#### UNIT II: MATHEMATICAL MODEL OF PROTECTION ALGORITHMS

Mathematical background to protection algorithms, Finite difference techniques. (6)

#### UNIT III: FOURIER ANALYSIS

Interpolation formulae, Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis. (8)

#### UNIT IV: BASIC ELEMENTS OF DIGITAL PROTECTION

Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and software Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms. (16)

#### UNIT V: ADVANCES IN DIGITAL PROTECTION OF POWER SYSTEM

Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. Walsh function based algorithm. Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems. (9)

#### Course Outcomes:

Students will be able to:

1. Learn the importance of Digital Relays
2. Apply Mathematical approach towards protection
3. Learn to develop various Protection algorithms

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009.
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press, 1999.
3. Gerhard Zeigler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006.
4. S. R. Bhide “Digital Power System Protection” PHI Learning Pvt.Ltd.2014.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **DISCIPLINE ELECTIVE – III**

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP409 RESTRUCTURED POWER SYSTEMS

**Course Prerequisite:** Power Systems

L	T	P	C
3	0	0	3

#### **Course Description:**

This course facilitates the students with the necessity understanding of restructured power system

#### **Course Objectives:**

1. Understand what is meant by restructuring of the electricity market
2. Understand the need behind requirement for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

#### **UNIT I: FUNDAMENTALS OF RESTRUCTURED POWER SYSTEM**

Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization. (8)

#### **UNIT II: CONGESTION MANAGEMENT**

OPF: Role in vertically integrated systems and in restructured markets, congestion management. (8)

#### **UNIT III: OPTIMAL BIDDING & TRANSMISSION PRICING**

Optimal bidding, Risk assessment, Hedging, Transmission pricing, Tracing of power. (8)

#### **UNIT IV: APPLICATIONS IN RESTRUCTURED POWER MARKETS**

Ancillary services, Standard market design, Distributed generation in restructured markets  
Developments in India, IT applications in restructured markets. (14)

#### **UNIT V: RECENT TRENDS IN RESTRUCTURING**

Working of restructured power systems, PJM, Recent trends in Restructuring. (7)

#### **Course Outcomes: -**

Students will be able to:

1. Describe various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5. Classify different market mechanisms and summarize the role of various entities in the market.

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. Lorrin Philipson, H. Lee Willis, "Understanding electric utilities and de-regulation", Marcel Dekker Pub., 1998
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
3. Mohammad Shahidehpour, Muwaffaq Alomoush, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.



## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP410 POWER SYSTEM DYNAMICS - II

L	T	P	C
3	0	0	3

**Course Prerequisite:** Power Systems Dynamics-I

#### **Course Description:**

This course facilitates the students with the necessity understanding of power system dynamics-II.

#### **Course Objectives:**

1. Study of power system dynamics
2. Interpretation of power system dynamic phenomena
3. Study of various forms of stability

#### **UNIT I: INTRODUCTION TO DYNAMIC SYSTEM AND STABILITY**

Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System. (8)

#### **UNIT II: FLUX VARIATION AND AVR**

Effect of Damper, Flux Linkage Variation and AVR. (8)

#### **UNIT III: STABILITY ENHANCEMENT TECHNIQUES**

Large Signal Rotor Angle Stability, Dynamic Equivalents and Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer. (9)

#### **UNIT IV: ASYNCHRONOUS OPERATION AND MULTI MACHINE STABILITY**

Asynchronous Operation and Resynchronization, Multi-Machine Stability. (6)

#### **UNIT V: DYNAMIC ANALYSIS OF VOLTAGE STABILITY**

Dynamic Analysis of Voltage Stability Voltage Collapse, Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures. (14)

#### **Course Outcomes: -**

Students will be able to:

1. Gain valuable insights into the phenomena of power system including obscure ones.
2. Understand the power system stability problem
3. Analyze the stability problems and implement modern control strategies.
4. Simulate small signal and large signal stability problems

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajarapu, “Computational Techniques for voltage stability assessment & control”; Springer, 2006 Course

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP411 DYNAMICS OF ELECTRICAL MACHINES

**Course Prerequisite:** Electrical Machines, Control Systems

**L T P C**  
**3 0 0 3**

#### **Course Description:**

This course facilitates the students with the necessity understanding of dynamics of electrical machines

#### **Course Objectives:**

1. Learn Performance characteristics of machine
2. To understand the dynamics of the machine
3. To understand how to determine stability of machine
4. Learn the synchronous machine

#### **UNIT I: STABILITY ANALYSIS OF COMMUTATOR MACHINE**

Stability, Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding Commutator Machine. (8)

#### **UNIT II: ANALYSIS OF 3-PHASE INDUCTION MOTORS**

Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations, The Three Phase Induction Motor. Transformed Equations, Different Reference Frames for Induction Motor Analysis Transfer Function Formulation. (9)

#### **UNIT III: ANALYSIS OF SYNCHRONOUS MACHINES**

Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis. (8)

#### **UNIT IV: DYNAMIC ANALYSIS OF INTERCONNECTED MACHINES**

Large Signal Transient, Small Oscillation Equations in State Variable form, Dynamical Analysis of Interconnected Machines. (8)

#### **UNIT V: TRANSIENT ANALYSIS**

Large Signal Transient Analysis using Transformed Equations, DC Generator /DC Motor System, Alternator /Synchronous Motor System. (12)

#### **Course Outcomes: -**

Students will be able to:

1. Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics
2. Knowledge of transformations for the dynamic analysis of machines
3. Knowledge of determination of stability of the machines under small signal and transient conditions
4. Study about synchronous machine

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. D.P. Sengupta & J.B. Lynn, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company, 1987
4. I. Boldia & S.A. Nasar, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP412 POWER APPARATUS DESIGN

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Prerequisite:** Electrical Machines

#### **Course Description:**

This course facilitates the students with the necessity understanding of power apparatus design

#### **Course Objectives:**

1. Study the modelling analysis of rotating machine.
2. Learning electromagnetic energy conversion
3. To know about rating of machines.

#### **UNIT I: PRINCIPLES OF DESIGN OF MACHINES**

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling. (9)

#### **UNIT II: INDUCTION MACHINES AND SYNCHRONOUS MACHINES**

Specific loadings, choice of magnetic and electric loadings Real and apparent flux -densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating. (8)

#### **UNIT III: CALCULATION OF EFFICIENCY AND REGULATION**

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes Calculation of losses, efficiency and regulation, Forces winding during short circuit. (8)

#### **UNIT IV: ESTIMATION OF HARMONIC TORQUE**

General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques. (8)

#### **UNIT V: INTRODUCTION TO COMPUTER AIDED ELECTRICAL MACHINE DESIGN**

Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energy efficient machines. (12)

## **M. Tech Electrical Power Systems**

### **Course Outcomes: -**

Students will be able to:

1. To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used
2. Ability to model and design all types of rotation machines including special machines

### **Text/Reference Books:**

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", Dhanpat Rai & Sons, 5th Edition

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

# **DISCIPLINE ELECTIVE – IV**

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP413 ADVANCED MICRO-CONTROLLER BASED SYSTEMS

**Course Prerequisite:** Microprocessors and Microcontrollers

**L T P C**  
**3 0 0 3**

**Course Description:**

This course facilitates the students with the necessity understanding of advanced micro controller based systems

**Course Objectives:**

1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA

**UNIT I: BASIC COMPUTER ORGANIZATION**

Basic Computer Organization, Accumulator based Processes-Architecture, Memory Organization-I/O Organization. (8)

**UNIT II: MICROCONTROLLERS 8051/8056**

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication Timers, Interrupts, Programming. (9)

**UNIT III: INTERRUPTS**

Intel 8051 – Assembly language programming, Addressing-Operations, Stack &Subroutines, Interrupts-DMA. (8)

**UNIT IV: PIC MICROCONTROLLER**

PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication. (8)

**UNIT V: DIGITAL SIGNAL PROCESSOR**

Digital Signal Processor (DSP), Architecture-Programming, Introduction to FPGA, Microcontroller development for motor control applications, Stepper motor control using micro controller. (12)

**Course Outcomes: -**

Students will be able to:

1. To learn how to program a processor in assembly language and develop an advanced processor based system.
2. To learn configuring and using different peripherals in a digital system.
3. To compile and debug a Program.
4. To generate an executable file and use it.



## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. John. F. Wakerly: “Microcomputer Architecture and Programming”, John Wiley and Sons 1981
2. Ramesh S. Gaonker: “Microprocessor Architecture, Programming and Applications with the 8085”, Penram International Publishing (India), 1994
3. Raj Kamal: “The Concepts and Features of Microcontrollers”, Wheeler Publishing, 2005
4. Kenneth J. Ayala, “The 8051 microcontroller”, Cengage Learning, 2004
5. John Morton,” The PIC microcontroller: your personal introductory course”, Elsevier, 2005
6. Dogan Ibrahim,” Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series”, Elsevier, 2008
7. Microchip datasheets for PIC16F877

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP414 SCADA SYSTEM AND APPLICATIONS

**Course Prerequisite:** Computer Architecture

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Description:**

This course facilitates the students with the necessity understanding of SCADA systems and applications

#### **Course Objectives:**

1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application

#### **UNIT I: INTRODUCTION TO SCADA**

Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies. (8)

#### **UNIT II: SCADA APPLICATIONS**

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA. (6)

#### **UNIT III: SCADA SYSTEM COMPONENTS**

Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems. (9)

#### **UNIT IV: SCADA ARCHITECTURE**

SCADA Architecture, Various SCADA architectures, advantages and disadvantages of each system, single unified standard architecture -IEC 61850. (8)

#### **UNIT V: SCADA COMMUNICATION**

SCADA Communication, various industrial communication technologies, wired and wireless methods and fiber optics, Open standard communication protocols SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water. (14)

#### **Course Outcomes: -**

Students will be able to:

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3. Knowledge about single unified standard architecture IEC 61850

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society of America Publications, USA, 2004
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004
3. William T. Shaw, "Cybersecurity for SCADA systems", Penn Well Books, 2006
4. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003
5. Michael Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well 1999

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP415 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

**Course Prerequisite:** Digital Signal Processing

#### **Course Description:**

This course facilitates the students with the necessity understanding of Advanced Digital Signal Processing

#### **Course Objectives:**

1. To understand the difference between discrete-time and continuous-time signals
2. To understand and apply Discrete Fourier Transforms (DFT)

#### **UNIT I: INTRODUCTION TO DISCRETE TIME FOURIER TRANSFORM AND Z TRANSFORM**

Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signals, Discrete time Fourier transform, Discrete Fourier series, Discrete Fourier transform, Z transform-Properties of different transforms. (8)

#### **UNIT II: COMPUTATION OF DFT DESIGN**

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method. (8)

#### **UNIT III: FIR AND IIR FILTER DESIGN**

FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters. (8)

#### **UNIT IV: POWER SPECTRUM ESTIMATION**

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals. (14)

#### **UNIT V: OPTIMAL LINEAR FILTERS**

Optimum linear filters, Optimum signal estimation, Mean square error estimation Optimum FIR and IIR Filters. (7)

## **M. Tech Electrical Power Systems**

### **Course Outcomes: -**

Students will be able to:

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
5. Design of optimum FIR and IIR filters

### **Text/Reference Books:**

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach", TataMc Grow-Hill Edition 1998
2. Dimitris G. Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions. -2000

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP416 INTRODUCTION TO AI TECHNIQUES

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course Prerequisite:** Control Systems

#### **Course Description:**

This course facilitates the students with the necessity understanding of artificial intelligence techniques

#### **Course Objectives:**

1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

#### **UNIT I: INTRODUCTION TO INTELLIGENT SYSTEM**

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks. (10)

#### **UNIT II: FUZZY LOGIC CONTROL SYSTEM**

Fuzzy Logic Knowledge Representation and Inference Mechanism Defuzzification Methods. (6)

#### **UNIT III: FUZZY NEURAL NETWORKS**

Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA, System Identification using Fuzzy and Neural Network. (14)

#### **UNIT IV: GENETIC ALGORITHM**

Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary program. (8)

#### **UNIT V: APPLICATIONS OF ARTIFICIAL INTELLIGENCE TECHNIQUES**

Applications of above mentioned techniques to practical problems. (7)

#### **Course Outcomes: -**

Students will be able to:

1. Learn the concepts of biological foundations of artificial neural networks
2. Learn Feedback networks and radial basis function networks and fuzzy logics
3. Identifications of fuzzy and neural network
4. Acquire the knowledge of GA

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. J M Zurada , “An Introduction to ANN”, JaicoPublishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg. Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination.

## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP203 POWER SYSTEM PROTECTION LABORATORY

L	T	P	C
0	0	4	2

**Course Prerequisite:** Power System Protection

#### Course Objectives:

1. To interpret the operating characteristics of various protective relays.
2. To understand the transformer protection and feeder protection concepts.

#### List of experiments

1. Modelling of Relay using MATLAB (Differential Relay).
2. Characteristics of IDMT over Current Relay.
3. Characteristics of Static Negative Sequence Relay.
4. Characteristics of Over Voltage Relay.
5. Principle of Reverse Power Protection.
6. Differential Protection of Transformer.
7. Radial Feeder Protection.
8. Parallel Feeder Protection.
9. Relay co-ordination of radial transmission/distribution system
10. Impact of Induction Motor Starting on Power System.

#### Course Outcome:

At the end of the course, students will able to

1. Analyze the operating characteristics of various protective relays.
2. Understand the transformer protection and feeder protection concepts.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination



## M. Tech Electrical Power Systems

### M. Tech I Year II Semester

#### 20EPSP204 POWER GRID LABORATORY

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Course Prerequisite:** Smart Grids

#### **Course Objectives:**

1. To understand the operation of smart grid and smart metering aspects.
2. To understand the concept of smart energy storage, measurement and protection of smart grids.

#### **List of experiments**

1. Operation of Smart appliances.
2. Smart metering.
3. Smart Energy storage.
4. Protection equipment's for Smart Grid.
5. Monitoring and measurement equipment.
6. Wide area monitoring – Phasor Measurement Units (PMUs).

#### **Course Outcome:**

At the end of the course, students will able to

1. Understand the operation of smart grid and smart metering aspects.
2. Understand the concept of smart energy storage, measurement and protection of smart grids.

**Mode of Evaluation:** Continuous Internal Evaluation and End Semester Examination

# **AUDIT COURSE - II**

## M. Tech Electrical Power Systems

M. Tech. I Year II Semester

Audit Course II

### 20AUP905 ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	2

#### Course Prerequisite:

#### Course Description:

This course will be useful for learning English knowledge.

#### Course Objectives:

1. Conceptualize various components of academic writing.
2. Enhance and use academic vocabulary.
3. Plan and write quality research papers in their respective field.
4. Ensure the good quality of paper at very first-time submission.

#### UNIT I: SCIENTIFIC WRITING

What is scientific writing – Language in scientific writing – Use and miss-use of English – Elements of scientific writing - Paraphrasing and Plagiarism - Hedging and Criticizing – How to identify research problem

(6)

#### UNIT II: WRITING TITLE AND ABSTRACT

Strategies for writing effective title – Planning and preparing your abstract - Things to consider while writing abstract – Useful phrases for writing abstract.

(6)

#### UNIT III: ORGANIZING REVIEW OF THE LITERATURE; METHODS OF DATA COLLECTION AND DATA ANALYSIS

What is review of the literature - Techniques of reading and citing various studies relevant to the study – Things to consider while organizing review of the literature – useful phrases while writing review of the literature. Introduction to various methods of data collection – Preparing tools and describing them - How to interpret and analyze data.

(6)

#### UNIT IV: WRITING FINDINGS, DISCUSSION AND CONCLUSION

Useful vocabulary while writing findings, discussion, and conclusion – elaboration of the findings - Preparing and describing charts and graphs – how to organize.

(6)

#### UNIT V: PREPARING REFERENCES, APPENDIXES AND PROOFREADING THE PAPER

Various styles of referencing and bibliography (APA, MLA, Oxford, Harvard, Chicago), – Organizing and preparing Appendixes – Various strategies of proofreading.

(6)

#### Course Outcomes:

1. Become aware of various components of academic writing
2. Improve and use academic vocabulary while writing a research papers
3. Plan and write quality research papers in their respective field

#### Text Books:

1. Adrian Wallwork, (2011). English for Writing Research Papers. Springer New York
2. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

## **M. Tech Electrical Power Systems**

### **Reference Books:**

1. Kate L. Turabian, "A Manual for Writers of Research Papers, Theses, and Dissertations, Seventh Edition: Chicago Style for Students and Researchers [7th ed.] Chicago, Guides to Writing, Editing, and Publishing, 2007.

**Mode of Evaluation:** Assignments, Mid Term Tests

## M. Tech Electrical Power Systems

M. Tech. I Year II Semester

Audit Course II

### 20AUP906 VALUE EDUCATION

Course Prerequisite: Nil

L	T	P	C
2	0	0	2

#### Course Description:

The students will be able to study:

1. Understand value of education
2. Understand value of self- development
3. Imbibe personality development
4. Imbibe spiritual development and to about the importance of character
5. Incorporate good emotional intelligence with self -Control.

#### Course Objectives:

1. To understand the electrical wiring systems for residential, commercial and industrial consumers.
2. To learn the representation of systems with standard symbols and drawings.
3. To understand the various components of industrial electrical systems.
4. To analyse and select the proper size of several electrical system components.
5. To study the control aspects of industrial electrical system using PLC and SCADA

#### UNIT I:

Values and self-development -Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

(6)

#### UNIT II:

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

(6)

#### UNIT III:

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labor. Universal brotherhood and religious tolerance. True friendship Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

(6)

#### UNIT IV:

Character –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message.

(6)

#### UNIT V:

Competence- Emotional Intelligence- Mind your Mind, Self-control-. Honesty, Studying Effectively.

(6)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the moral personality
4. Development of spiritual personality
5. Development of emotional personality for efficiency in

### **Text Books:**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford

**Mode of Evaluation:** Assignments, Mid Term Tests.

**20AUP907 STRESS MANAGEMENT BY YOGA**

**Course Prerequisite:**

**L T P C**  
**2 0 0 2**

**Course Description:**

Learn to know Yoga for mental health.

**Course Objectives:**

1. To know the human psyche: Yogic and modern concepts.
2. To have the importance for mental health.
3. To know the relationship between mind and body.
4. To understand the concept of stress according to modern science and yoga.
5. To achieve overall health of mind through yoga.

**UNIT I: SCIENTIFIC FOUNDATIONS OF STRESS**

Concept of stress – Sources of stress - Types of Stress – Personality factors and Stress – Stress and the college student.

**(6)**

**UNIT II: CONSEQUENCES OF STRESS ON HUMAN MIND**

Human Psyche: Yogic and Modern concepts, behavior and consciousness – Frustration – Conflicts – Psychosomatic, Disorders.

**(6)**

**UNIT III: MENTAL HYGIENE AND YOGA**

Mental health: A Yogic Perspective – Mental hygiene and role of Yoga in mental hygiene – Yogic principles for the management of stress (Prayer and meditation for mental health)

**(6)**

**UNIT IV: ASHTANGA YOGA INTRODUCTION**

Introduction to Ashtanga Yoga – Concepts and techniques of stress management in Ashtanga yoga of Patanjali Yoga sutra (i.e. Benefits of Meditation for stress management).

**(6)**

**UNIT V: YOGIC MANAGEMENT OF STRESS**

Specific practices for stress management: Yogasana, breath awareness, shvasana, yoganidra, pranayama and meditation.

**(6)**

**Course Outcomes:**

1. Understand the role of yoga in stress management
2. Understanding the role of yoga in life management
3. Understanding the role of yoga in mental hygiene
4. To Develop strong mental health
5. To Develop healthy mind and there by improve efficiency.

**Text Books:**

1. Certification of yoga professionals, Official guide book for Level 1 and Level 2” Excel books private limited, Noida.

**Mode of Evaluation:** Assignments, Mid Term Tests.

## M. Tech Electrical Power Systems

M. Tech. I Year II Semester

Audit Course II

### 20AUP908 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT

#### SKILLS

L	T	P	C
2	0	0	2

Course Prerequisite: Nil

#### Course Description:

This course intends and aims to enhance the confidence of the students by exposing them to various situations and contexts they face in their career. It is imperative for students to start preparing for the ever growing competition in the Job market. This course focuses on the practical aspects of soft skills relevant to the requirements of the prospective employers in view of globalization.

#### Course Objectives:

1. To expose the students to those soft skills which are crucial to an employee's ability to work smarter.
2. To enhance Art of Communication, Team Skills, GD handling skills and preparing resume.

#### UNIT I: VERBAL COMMUNICATIONS

Active listening - Non Verbal Communication - Body Language. (6)

#### UNIT II: RESIDENTIAL AND COMMERCIAL ELECTRICAL SYSTEMS

Importance of Team work - Leadership skills, self-realization (Identifying strengths and weaknesses). (6)

#### UNIT III: TIME MANAGEMENT

GD skills – Roles in a GD – Do's & Don'ts – Mock GD. (6)

#### UNIT IV: RESUME PREPARATION

Tips in writing resume - Interview Handling Skills Interview skills – Do's & Don't's - Goal setting. (6)

#### UNIT V:

Grooming etiquette, Professional Electronic Communication-Telephone etiquette, Email etiquette. (6)

#### Course Outcomes:

1. After completion of this course the students shall be able to communicate effectively and enhance their interpersonal relationship and building skills with renewed self-confidence.
2. Work together in teams and accomplish objectives in a cordial atmosphere.
3. Face Group Discussion with confidence.
4. Prepare resume and face interviews.
5. Understand and develop the necessary etiquette to present oneself in a professional setting.

#### Text Books:

1. Dr K Alex. Soft skills, S Chand Publications, New Delhi.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.

#### Reference Books:

1. Ludlow And Panthon, Essentials Of Effective Communication, Prentice Hall Of
2. India, 1993.

Mode of Evaluation: Assignments, Mid Term Tests.



# **DISCIPLINE ELECTIVE – V**

## M. Tech Electrical Power Systems

### M. Tech II Year I Semester

#### 20EPSP417 POWER SYSTEM TRANSIENTS

**L T P C**  
**3 0 0 3**

**Course Prerequisite:** Power System Dynamics

#### **Course Description:**

This course facilitates the students with the necessity understanding of power system transients

#### **Course Objectives:**

1. Learn the reasons for occurrence of transients in a power system
2. Understand the change in parameters like voltage & frequency during transients
3. To know about the lightning phenomenon and its effect on power system

#### **UNIT I: FUNDAMENTALS OF CIRCUIT ANALYSIS AND TRANSIENTS**

Fundamental circuit analysis of electrical transients Laplace Transform method of solving simple Switching transients, Damping circuits -Abnormal switching transients, Three-phase circuits and transients, Computation of power system transients. (8)

#### **UNIT II: PRINCIPLES OF DIGITAL COMPUTATION AND LIGHTING**

Principle of digital computation – Matrix method of solution, Modal analysis-Z transform-Computation using EMTP, Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning. (8)

#### **UNIT III: ANALYSIS OF POWER SYSTEM TRANSIENTS**

Interaction between lightning and power system Influence of tower footing resistance and Earth Resistance Switching: Short line or kilometric fault Energizing transients - closing and re-closing of lines, line dropping, load rejection – over voltages induced by faults. (8)

#### **UNIT IV: HVDC**

Switching HVDC line Travelling waves on transmission line, Circuits with distributed Parameters Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the line Terminations Lattice Diagrams – Attenuation and Distortion, Multi-conductor system and Velocity wave. (9)

#### **UNIT V: INSULATION CO-ORDINATION**

Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level Statistical approach Protective devices, Protection of system against over voltages lightning arresters, substation earthing. (12)

#### **Course Outcomes: -**

Students will be able to:

1. Knowledge of various transients that could occur in power system and their mathematical formulation
2. Ability to design various protective devices in power system for protecting equipment and personnel
3. Coordinating the insulation of various equipments in power system
4. Modelling the power system for transient analysis

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

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

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

## M. Tech Electrical Power Systems

### M. Tech II Year I Semester

20EPSP418 FUZZY LOGIC, ANN AND INTRODUCTION TO GA

L T P C  
3 0 0 3

**Course Prerequisite:** None

#### **Course Description:**

This course is designed to introduce the concepts associated with Fuzzy logic, ANN and Genetic Algorithms.

#### **Course Objectives:**

1. To expose fuzzy methods of analyzing problems which involve incomplete or vague criteria rather than crisp values.
2. To investigate requirements analysis, logical design, and technical design of components for fuzzy systems development.
3. To understand the concepts associated with Fuzzy logic.
4. To study the concepts of ANN.
5. To understand the concepts of Genetic Algorithms.

#### **UNIT – I: INTRODUCTION TO FUZZY SYSTEMS**

Different faces of imprecision – inexactness, ambiguity, undecidability, Fuzziness and certainty, Fuzzy sets and crisp sets. Intersections of Fuzzy sets, Union of Fuzzy sets the complement of Fuzzy sets- Fuzzy reasoning.

(7)

#### **UNIT II: FUZZY CONTROL BASICS**

Linguistic variables, Fuzzy propositions, Fuzzy compositional rules of inference- Methods of decompositions and defuzzification.

Methodology of fuzzy design - Direct & Indirect methods with single and multiple experts, Applications -Fuzzy controllers - Control and Estimation.

(11)

#### **UNIT III: INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS**

Introduction to Artificial Neural Networks - Biological neurons. Computational models of neuron- McCulloch - Pitts model - types of activation function. Introduction to network architectures - knowledge representation - Learning process. Learning algorithms- - error-correction learning. Boltzmann learning-Hebbian learning, competitive learning- Learning paradigms- supervised learning - unsupervised learning - method of steepest descent - least mean square algorithms - Adaline/medaline units. Perceptrons- derivation of the back propagation algorithm-Advances in Learning strategies- Computer based simulation of simple Network Structures.

(9)

#### **UNIT IV: NEURAL NETWORK ARCHITECTURE**

Neural Network Architectures-MLFFN-Recurrent NN- RBF Network structure - separability of patterns – RBF learning strategies - comparison of RBF, RNN and MLP networks- Hopfield networks- associative memory energy function - spurious states - error performance - simulated annealing - applications of neural networks .

Forecasting-the XOR problem - traveling salesman problem - image compression using MLPs – character retrieval using Hopfield networks-Advances in ANN Theory- Computer based simulation.

(11)

## M. Tech Electrical Power Systems

### UNIT V: INTRODUCTION TO GENETIC ALGORITHMS

Genetic Algorithms- basic structure-coding steps of GA, convergence characteristics, applications.

(7)

#### Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the fundamentals of Fuzzy logic theory.
2. Apply and analyze the concept of Fuzzy logic to existing systems.
3. Design Fuzzy logic Systems for engineering applications.
4. Apply ANN logic to existing systems.
5. Understand the basics of genetic algorithms.

#### Text Books:

1. Zimmermann H.J., 'Fuzzy set theory and its applications', Springer pvt Limited, 4th edition, 2012.
2. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', John Wiley & Sons Ltd Publications, 3rd edition, 2010.
3. Simon Haykin, Neural Network – A Comprehensive Foundation, 2nd Ed, Pearson Education, 2002.
4. Zurada J.M., Introduction to Artificial Neural Systems, Jaico Publishers, 2003.
5. Hassoun Mohammed H, Fundamentals of Artificial Neural Networks, Prentice Hall of India, 2002
6. M. Mitchell, 'Introduction to Genetic Algorithms', Indian reprint, MIT press Cambridge, 2nd edition, 2002.
7. Goldberg D.E., Genetic Algorithms in Search Optimization and Machine Learning, Addison Wesley, 1989

#### References:

1. John Yen, Reza Langari, 'Fuzzy Logic, Intelligence, Control & Information', Pearson Education Inc., 1st edition, 2002.
2. Zdenko Kovacic, Stjepan Bogdan, 'Fuzzy Controller Design Theory and Applications', CRC Press, 1st edition, 2006.
3. Riza C. Berkaan, Sheldon L. Trubatch, 'Fuzzy Systems Design Principles – Building Fuzzy IF THEN Rule Based', IEEE Press, 1st edition, 1997.
4. Bart Kosko, Neural Network and Fuzzy Systems, Prentice Hall of India, 2002.
5. Suran Goonatilake & Sukhdev Khebbal (Eds.), Intelligent Hybrid Systems., John Wiley, 1995.

**Mode of Evaluation:** Assignments, Mid Term Tests, End Semester Examination

## M. Tech Electrical Power Systems

### M. Tech II Year I Semester

#### 20EPSP419 INDUSTRIAL LOAD MODELING AND CONTROL

**Course Prerequisite:** Power Systems

**L T P C**  
**3 0 0 3**

#### **Course Description:**

This course facilitates the students with the necessity understanding of industrial load modelling and control

#### **Course Objectives:**

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

#### **UNIT I: ELECTRICITY MARKET AND DEMAND SIDE MANAGEMENT**

Electric Energy Scenario-Demand Side Management-Industrial Load, Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial, Loads, Continuous and Batch processes -Load Modeling. (8)

#### **UNIT II: OPTIMIZATION AND CONTROL ALGORITHMS**

Electricity pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load, Models, Optimization and control algorithms - Case studies. (9)

#### **UNIT III: REACTIVE POWER MANAGEMENT**

Reactive power management in industries controls-power quality impacts application of filters Energy saving in industries. (8)

#### **UNIT IV: OPTIMAL OPERATION**

Cooling and heating loads, load profiling Modelling- Cool storage Types-Control strategies, optimal operation Problem formulation- Case studies. (8)

#### **UNIT V: INDUSTRIAL CO-GENERATION**

Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration Selection of Schemes Optimal Operating Strategies, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries. (12)

#### **Course Outcomes: -**

Students will be able to:

1. Knowledge about load control techniques in industries and its application
2. Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO
3. Apply load management to reduce demand of electricity during peak time
4. Apply different energy saving opportunities in industries

## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
5. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
6. I. J. Nagarath and D. P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995
7. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

## M. Tech Electrical Power Systems

### M. Tech II Year I Semester

#### 20EPSP420 DYNAMICS OF LINEAR SYSTEMS

L T P C  
3 0 0 3

**Course Prerequisite:** Control Systems

#### **Course Description:**

This course facilitates the students with the necessity understanding of dynamics of linear system

#### **Course Objectives:**

1. To understand the linear system and its functions
2. To understand the stability analysis of linear systems and implement the same in MATLAB

#### **UNIT I: STATE VARIABLE REPRESENTATION OF SYSTEMS**

State variable representations of systems transfer function and transfer function matrix solutions of state equations. (7)

#### **UNIT II: ANALYSIS OF LINEAR TIME VARYING SYSTEMS**

Observability and controllability, minimal realization of MIMO systems, analysis of linear time varying systems, the concepts of stability. (8)

#### **UNIT III: LYAPUNOV STABILITY ANALYSIS**

Lyapunov stability analysis, Lyapunov function and its properties, controllability by state variable feedback. (8)

#### **UNIT IV: OBSERVER DESIGN**

Ackerman's Formula-stabilisation by output feedback, asymptotic observers for state measurement, observer design. (8)

#### **UNIT V: STATE SPACE REPRESENTATION OF DISCRETE SYSTEM**

State space representation of discrete systems, solution of state equations, controllability and observability, stability, analysis using Lyapunov method, State feedback of linear discrete time systems, design of observers - MATLAB Exercises. (14)

#### **Course Outcomes: -**

Students will be able to:

1. To learn linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective
2. Knowledge on carrying out detailed stability analysis of both linear and nonlinear systems
3. Design observers and controllers for linear systems
4. Acquire knowledge of discrete time linear systems modeling, analysis and design
5. Develop and utilize modern software tools for analysis and design of linear continuous and discrete time systems.



## **M. Tech Electrical Power Systems**

### **Text/Reference Books:**

1. Thomas Kailath, "Linear Systems", Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, "State Space Analysis of Control Systems", Prentice Hall Inc., Englewood Cliffs, N.J.,1965.
3. K. Ogata, "Modern Control Engineering, (second edition)" , Prentice Hall Inc., Englewood Cliffs,N.J., 1990
4. M. Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, "Linear System Theory and Design", New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. "Bishop, Modern Control Systems", Addison Wesley Longman Inc., 1999.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

# **OPEN ELECTIVE**

## M. Tech Electrical Power Systems

M. Tech. II Year I Semester

Open Elective

### 20OEP301 BUSINESS ANALYTICS

**Course Prerequisite:** NIL

**L T P C**

**Course Description:**

**3 0 0 3**

Course delves into commonly encountered business situations requiring optimization of business resources and provides basic solutions methods using traditional and advanced methods.

**Course objectives:**

1. Refresh basic statistics
2. Explain the importance of statistics in business analytics
3. Introduce predictive modeling for business decisions
4. Explain the tools for predictive modeling
5. Explain the use of simulation to make business decision
6. Explain the use of data mining techniques for making business decision

#### **UNIT-I: INTRODUCTION TO BUSINESS ANALYTICS**

Introduction to Business Analytics (BA). Evolution and Scope of Business Analytics. Data for Business Analytics. Analyzing uncertainty and model assumptions – What if analysis, Data tables, Scenario manager and Goal Seek. Regression modelling. (9)

#### **UNIT-II: STATISTICS FOR BUSINESS ANALYTICS**

Brief overview of descriptive statistics, graphical representation of data, and overview of hypothesis testing, Introduction to R statistical software (9)

#### **UNIT-III: PREDICTIVE ANALYTICS METHODS**

Forecasting techniques – Statistical forecasting techniques. Decomposition model – Estimation of trend, seasonality and cyclical components. Smoothing models for forecasting – moving average, exponential smoothing methods, time series analysis. (9)

#### **UNIT-IV: SIMULATION, RISK ANALYSIS AND DATA MINING**

Simulation and Risk Analysis – Monte Carlo simulation Examples of simulation models, Introduction to Data Mining – Scope of Data Mining. Data exploration and reduction. Classification – Measuring classification performance. Classification techniques – K nearest neighbor, Discriminant Analysis, factor analysis, and Logistic regression. (9)

#### **UNIT-V: DECISION ANALYSIS**

Decision making with uncertain information. Decision strategies for a minimize objective. Decision strategies for a maximize objective. Decision Tress. Building a decision tree. Decision trees and risk. Sensitivity analysis, Baye's Rule.

**Case Study:** Compulsory and Relevant Cases have to be discussed in each unit.

**Assignment:** Two relevant assignments have to be given to the students

(9)

## **M. Tech Electrical Power Systems**

### **Course Outcomes:**

At the end of this course students will be able to

1. Understand the need and significance of business analytics for decision making
2. Use statistical tools to extract information from raw data
3. Use regression technique to build predictive models
4. Apply simulation technique to predict business scenarios
5. Use data mining techniques to make business decisions

### **Text Books:**

Essentials of Business Analytics, Jeffrey Camm, James Cochran, Michael Fry, Jeffrey Ohlmann, David Anderson

### **REFERENCES:**

1. Albright C. S., Winston Wayne L. and Zappe C. J (2009). *Decision Making Using Microsoft Excel (India Edition)*. Cengage Learning.
2. Evans J. R (2013). *Business Analytics Methods, Models and Decisions*. Pearson, Upper Saddle River, New Jersey.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

## M. Tech Electrical Power Systems

### M. Tech. II Year I Semester

### Open Elective

#### 200EP302 INDUSTRIAL SAFETY

L T P C

**Course Prerequisite:** None

3 0 0 3

#### **Course Description:**

This course facilitates the students with the aspects of Industrial safety, fundamentals of maintenance engineering, Wear and Corrosion and their prevention and Periodic and preventive maintenance.

#### **UNIT-I INDUSTRIAL SAFETY**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods. (9)

#### **UNIT-II FUNDAMENTALS OF MAINTENANCE ENGINEERING**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment. (9)

#### **UNIT-III WEAR AND CORROSION AND THEIR PREVENTION**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods. (9)

#### **UNIT-IV FAULT TRACING**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. (9)

#### **UNIT-V PERIODIC AND PREVENTIVE MAINTENANCE**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance (9)

#### **REFERENCES:**

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

**20OEP303 OPERATIONS RESEARCH**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**UNIT-I INTRODUCTION**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models (9)

**UNIT-II LPP**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming (9)

**UNIT-III NONLINEAR PROGRAMMING PROBLEM**

Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT (9)

**UNIT-IV SCHEDULING AND SEQUENCING**

Single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming. (9)

**UNIT-V COMPETITIVE MODELS**

Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation (9)

**Course Outcomes:**

At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discrete and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

**REFERENCES:**

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

## M. Tech Electrical Power Systems

M. Tech. II Year I Semester

Open Elective

### 200EP304 COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

#### UNIT I

Introduction and Overview of the Strategic Cost Management Process (9)

#### UNIT II

Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making. (9)

#### UNIT III

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process (9)

#### UNIT IV

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. (9)

#### UNIT V

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory. (9)

#### REFERENCES:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.

**20OEP305 COMPOSITE MATERIALS**

**L T P C**  
**3 0 0 3**

**UNIT-I INTRODUCTION**

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. (9)

**UNIT – II REINFORCEMENTS**

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions. (9)

**UNIT – III MANUFACTURING OF METAL MATRIX COMPOSITES**

Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications. (9)

**UNIT-IV MANUFACTURING OF POLYMER MATRIX COMPOSITES**

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications. (9)

**UNIT – V STRENGTH**

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first ply failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations. (9)

**TEXT BOOKS:**

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

**REFERENCES:**

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.



## M. Tech Electrical Power Systems

M. Tech. II Year I Semester

Open Elective

### 20OEP306 WASTE TO ENERGY

Course Prerequisite: None

L	T	P	C
3	0	0	3

#### Course Description:

This course facilitates the students with the basics of how energy can be generated from waste materials.

#### UNIT-I INTRODUCTION

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors (9)

#### UNIT-II BIOMASS PYROLYSIS

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. (9)

#### UNIT-III BIOMASS GASIFICATION

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation. (9)

#### UNIT-IV BIOMASS COMBUSTION

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors. (9)

#### UNIT-V BIOGAS

Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion – Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India. (9)

#### REFERENCES:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**Mode of Evaluation:** Assignments, Internal Mid Examinations, External End Examination.