# ADVANCED COMPUTER AIDED POWER SYSTEM ANALYSIS

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19PS6111 | 3 | 0 | 0 | 3 |

**Prerequisite:** Computer Methods in Power Systems

**Course Objectives:**

- To analyze a Power System Network using graph theory.
- To interpret the formation of Network matrices.
- To construct the necessity of load flow studies and various methods of Analysis.
- To examine short circuit analysis using Z bus.

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- Remember proper mathematical models for analysis.
- Conclude methodologies of load flow studies for the power network.
- Apply contingency Analysis.
- Analyze power system studies.

**UNIT-I**

Admittance Model and Network Calculations, Branch and Node Admittances, Mutually CoupledBranches in Y-BUS , An Equivalent Admittance Network, Modification of YBUS , Network Incidence Matrix and Y-BUS, Method of Successive Elimination, Node Elimination, Triangular Factorization,Sparsity and Near Optimal Ordering.

**UNIT-II**

Impedance Model and Network Calculations, the BUS Admittance and Impedance Matrices,Thevenin's Theorem and Z-BUS ,Algorithms for building Z-BUS Modification of existing Z-BUS, Calculationof Z-BUS elements from Y-BUS, Power Invariant Transformations, Mutually Coupled Branches in Z-BUS.

**UNIT-III**

Gauss Seidel method, N-R Method, Decoupled method, fast decoupled method, DC load flow.Load flow studies with Renewable energy sources.

**UNIT-IV**

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

**UNIT-V**

Fault Analysis: Symmetrical faults-Fault calculations using Z-BUS- Fault calculations using Z-BUSequivalent circuits –Selection of circuit breakers- Unsymmetrical faults-Problems on various types offaults.

**TEXT BOOKS**

1. John J. Grainger and W. D. Stevenson, "Power System Analysis"- T.M.H. Edition.
2. Modern Power System Analysis– by I. J. Nagrath & D. P. Kothari Tata McGraw – HillPublishing Company Ltd,2nd edition.

**REFERENCE BOOKS**

1. Power System Analysis and Design by J. Duncan Glover and M.S. Sarma., Cengage 3rd Edition.
2. Olle. L.Elgard, "Electrical Energy Systems Theory"-T.M.H. Edition.
3. Power systems stability and control, Prabha Kundur, The McGraw – Hill companies**.**
4. Power System Operation and Control, Dr. K. Uma Rao, Wiley India Pvt. Ltd.
5. Operation and Control in Power Systems, PSR Murthy, Bs Publications.
6. Power System Operation, Robert H. Miller, Jamesh H. Malinowski, The McGraw – Hill companies**.**
7. Power Systems Analysis, operation and control by Abhijit Chakrabarti, Sunitha Halder, PHI3/e , 2010

# POWER SYSTEM PROTECTION AND RELAYING

| **M.Tech (EPS) I Year I semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code: 19PS6112** | **3** | **0** | **0** | **3** |

**Prerequisite:** Switch Gear and Protection

**Course Objectives:**

- To distinguish all kinds of circuit breakers and relays for protection of Generators,
- Transformers and feeder bus bars from Over voltages and other hazards.
- To generalize neutral grounding for overall protection.
- To illustrate the phenomenon of Over Voltages and its classification.

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- Understand the basic function of a circuit breaker, all kinds of circuit breakers and differentiatefuse and circuit breakers under fault condition.
- Describe the necessity for the protection of alternators, transformers and feeder bus bars fromover voltages and other hazards
- Illustrate neutral grounding, and how over voltages can be generated and how system can beprotected against lightning and switching transient over voltages with various protective means
- Identify operation and control of microprocessor based relays.

**UNIT-I**

**Static Relays:**Over view of static relays**,**Advantages of static relays-Basic construction of static relays-Level detectors-Replicaimpedance –Mixing circuits-General equation for two input phase and amplitude comparators-Dualitybetween amplitude and phase comparators.
**Static over Current Relays:** Instantaneous over-current relay-Time over-current relays-basicprinciples –definite time and Inverse definite time over-current relays.

**UNIT-II**

**Amplitude Comparators**: Circulating current type and opposed voltage type- rectifier bridge comparators, Direct and Instantaneous comparators.
**Phase Comparators:** Coincidence circuit type- block spike phase comparator, techniques to measure the period of coincidence-Integrating type-Rectifier and Vector product type- Phase comparators.

**UNIT-III**

**Static Differential Relays:** Analysis of Static Differential Relays –Static Relay schemes – Duo biastransformer differential protection –Harmonic restraint relay.
**Static Distance Relays:** Static impedance-reactance–MHO and angle impedance relay-samplingcomparator –realization of reactance and MHO relay using sampling comparator.

**UNIT-IV**

**Multi-Input Comparators:** Conic section characteristics-Three input amplitude comparator –Hybridcomparator-switched distance schemes –Poly phase distance schemes- phase fault scheme –threephase scheme – combined and ground fault scheme.
**Power Swings:** Effect of power swings on the performance of distance relays –Power swinganalysis-Principle of out of step tripping and blocking relays-effect of line and length and sourceimpedance on distance relays.

**UNIT-V**

**Microprocessor based Protective Relays:** (Block diagram and flowchart approach only)-Overcurrent relays–impedance relays-directional relay-reactance relay .Generalized mathematicalexpressions for distance relays-measurement of resistance and reactance –MHO and offset MHOrelays-Realization of MHO characteristics- Realization of offset MHO characteristics -Basic principleof Digital computer relaying, Introduction to wide area control(qualitative).

**TEXT BOOKS**

1. Badri Ram and D.N. Vishwakarma, "Power system protection and Switch gear ", TMHpublication New Delhi 1995.
2. T.S. Madhava Rao , "Static relays", TMH publication, second edition 1989.

**REFERENCE BOOKS**

1. Protection and Switchgear, Bhavesh Bhalja, R. P. Maheshearі, Nilesh G. Chothani, Oxford University Press.
2. Electrical Power System Protection, C. Christopoulos and A. Wright, Springer International.

# SMART GRID TECHNOLOGIES

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19EE6172 | 3 | 0 | 0 | 3 |

**Prerequisite:**Power Systems, Electrical Measurements, Power Quality

**Course Objectives:**

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

**Course Outcomes:**At the end of the course, the student is able to:

- Appreciate the difference between smart grid & conventional grid
- Apply smart metering concepts to industrial and commercial installations
- Formulate solutions in the areas of smart substations,distributed generation and wideareameasurements
- Come up with smart grid solutions using modern communication technologies

**UNIT-I**

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Needof Smart Grid, Concept of Robust &Self Healing Grid Presentdevelopment & Internationalpolicies in Smart Grid. Introduction to Smart Meters, Real Time Prizing, SmartAppliances,Automatic Meter Reading(AMR), Outage Management System(OMS), Plug inHybrid Electric Vehicles(PHEV), Vehicle to Grid, SmartSensors, Home & Building Automation,Smart Substations, Substation Automation, Feeder Automation .

**UNIT-II**

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

**UNIT-III**

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 solarcells, Variable speedwind generators, fuel-cells, micro-turbines, Captive power plants, Integrationof renewable energy sources.

**UNIT-IV**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable EnergySources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, PowerQuality Audit.

**UNIT-V**

Advanced Metering Infrastructure (AMI), Home Area Network(HAN), NeighborhoodArea, Network(NAN), Wide Area Network (WAN), Bluetooth, Zig Bee, GPS, Wi-Fi, Wi-Maxbased communication.

**TEXT 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", CRCPress , 2009.

**REFERENCE BOOKS**

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, "Smart Grid: Technology and Applications",Wiley 2012
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions " CRC Press
3. A.G.Phadke, "Synchronized Phasor Measurement and their Applications", Springer.

# ADVANCED DIGITAL SIGNAL PROCESSING

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19EE6173 | 3 | 0 | 0 | 3 |

**Prerequisite:**Digital Signal Processing

**Course Objectives:**

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

**Course Outcomes:**After taking this course, student will be able to:

- Knowledge about the time domain and frequency domain representations as well analysis ofdiscrete timesignals and systems
- Study the design techniques for IIR and FIR filters and their realization structures.
- Acquire knowledge about the finite word length effects in implementation of digital filters.
- Knowledge about the various linear signal models and estimation of power spectrum ofstationaryRandomsignals
- Design of optimum FIR and IIR filters

**UNIT-I**

Fundamental concept of signals, classification of signals, classification of systems, Discrete time signals, Linear shift invariant systems-Stability and causality, Sampling of continuous time signals-Discrete time Fourier transform- Discrete Fourier series-DiscreteFouriertransform, Z transform-Properties of different transforms

**UNIT-II**

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

**UNIT-III**

FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIRand FIR filter realization structures, Signal flow graph representations Quantization process anderrors, Coefficient quantisation effects in IIR and FIR filters

**UNIT-IV**

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillationsand zeroInput limit cycles in IIR filters, Linear Signal Models.

**UNIT-V**

All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis ofdeterministic signals, Estimation of power spectrum of stationary random signals. Optimumlinear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIRFilters.

**TEXT BOOKS**

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

**REFERENCE BOOKS**

1. S Salivahanan. A. Vallavaraj C. Gnanapriya, Digital Signal Processing – TMH – 2nd reprint2001.
2. Lourens R RebinarandBernold, Theory and Applications of Digital Signal Processing.
3. Auntoniam, Digital Filter Analysis and Design, TMH.Dept.

# EHV AC TRANSMISSION

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19EE6174 | 3 | 0 | 0 | 3 |

**Prerequisite:** Power Systems –II

**Course objectives:**

- To identify the different aspects of Extra High Voltage A.C and D.C Transmission design andAnalysis
- To understand the importance of modern developments of E.H.V and U.H.V transmission systems.
- To demonstrate EHV ac transmission system components, protection and insulation level forover voltages.

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- List the necessity of EHV AC transmission, choice of voltage for transmission, line losses andpower handling capability.
- Estimate the Statistical procedures for line designs, scientific and engineering principles inpower systems.
- Construct commercial transmission system.

**UNIT- I**

EHV AC. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters-Bundle conductor systems-Inductance and Capacitance of EHV lines – positive, negative and zero sequence impedance – Line Parameters for Modes ofPropagation.

**UNIT- II:**

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect of highelectrostatic field on biological organisms and human beings - surface voltage gradients andmaximum gradients of actual transmission lines – voltage gradients on sub conductor.

**UNIT- III**

Electrostatic induction in unenergized lines – measurement of field and voltage gradients for threephase single and double circuit lines – un energized lines. Power Frequency Voltage control andover-voltages in EHV lines: No load voltage – charging currents at power frequency-voltage control shunt and series compensation.

**UNIT - IV**

Corona in EHV lines – Corona loss formulae- attention of traveling waves due to Corona – Audionoise due to Corona, its generation, characteristic and limits. Measurements of audio noise radiointerference due to Corona - properties of radio noise – frequency spectrum of RI fields –Measurements of RI and RIV.

**UNIT- V**

Design of EHV lines based on steady state and transient limits - EHV cables and their characteristics.

**TEXT BOOKS**

1. R. D. Begamudre, "EHVAC Transmission Engineering", New Age International (p) Ltd. 3rd Edition.
2. K. R. Padiyar, "HVDC Power Transmission Systems" New Age International (p) Ltd. 2nd revised Edition, 2012.

**REFERENCE BOOKS**

1. S. Rao "EHVAC and HVDC Transmission Engg. Practice" Khanna publishers.
2. Arrillaga. J"High Voltage Direct Current Transmission" 2nd Edition (London) peter Peregrines,IEE, 1998.
3. Padiyar. K.R, "FACTS Controllers in Power Transmission and Distribution" New Age Int.Publishers, 2007.
4. Hingorani H G and Gyugyi. L "Understanding FACTS-Concepts and Technology of FlexibleAC Transmission Systems" New York, IEEE Press, 2000.

# FACTS AND CUSTOM POWER DEVICES

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19EE6182 | 3 | 0 | 0 | 3 |

**Course Objectives:**

Students will be able to:

- To learn the active and reactive power flow control in power system
- To understand the need for static compensators
- To develop the different control strategies used for compensation

**Course Outcomes:** Upon the completion of the course the student will be able to

- Understand the concepts of FACTS
- Apply the knowledge of static var and UPFC concepts
- Analyze the concept of voltage sag and swell

**UNIT I**

Reactive power flow control in Power Systems – Control of dynamic power unbalances in Power System, Power flow control -Constraints of maximum transmission line loading – Benefits of FACTS Transmission line compensation. Uncompensated line -Shunt compensation - Series compensation –Phase angle control. Reactive power compensation, Shunt and Series compensation principles – Reactive compensation at transmission and distribution level.

**UNIT II**

Static versus passive VAR compensator, Static shunt compensators: SVC, and STATCOM - Operation and control of TSC, TCR and STATCOM -Compensator control, Comparison between SVC and STATCOM, Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators – TCVR and TCPAR Operation and Control –Applications, Static series compensation – GCSC, , TCSC and Static synchronous series compensators and their Control.

**UNIT III**

SSR and its damping Unified Power Flow Controller: Circuit Arrangement, Operation and control of UPF, Basic Principle of P and Q control- Independent real and reactive power, flow control-Applications.

**UNIT IV**

Introduction to interline power flow controller. Modeling and analysis of FACTS Controllers – Simulation of FACTS controllers Power quality, problems in distribution systems, harmonics. Loads that create harmonics, modeling, harmonic propagation, series and parallel resonances, mitigation of harmonics, passive filters, active filtering, – shunt, series and hybrid and their control.

**UNIT V**

Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners-IEEE standards on power quality.

**TEXT BOOKS**

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New AgeInternationalPublishers, 2007**.**

2. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control",Springer Verlag, Berlin, 2006.
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K.S.Sureshkumar, S.Ashok , "FACTS Controllers & Applications", E-book edition, Nalanda Digital Library, NIT Calicut, 2003.
5. G. T.Heydt, "Power Quality", McGraw-Hill Professional, 2007.
6. T. J. E. Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

# MODERN CONTROL THEORY

| M.Tech (EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19EE6183 | 3 | 0 | 0 | 3 |

**Prerequisites:** Linear control systems

**Course Objectives:**

- To explain the concepts of basic and modern control system for the real time analysis anddesign of control systems.
- To explain and apply concepts of state variables analysis.
- To study and analyze non linear systems.
- To analyze the concept of stability of nonlinear systems and categorization.
- To apply the comprehensive knowledge of optimal theory for Control Systems.

**Course Outcomes:** Upon the completion of the course the student will be able to

- Understand the concepts of state variable analysis
- Apply the knowledge of basic and modern control system for the real time analysis anddesign of control systems.
- Analyze the concept of stability of nonlinear systems and optimal control

## UNIT–I

**Mathematical Preliminaries:** Fields, Vectors and Vector Spaces – Linear combinations and Bases Linear Transformations and Matrices – Scalar Product and Norms – Eigen-values, Eigen Vectors anda Canonical form representation of Linear operators – The concept of state – State Equations forDynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagramsfor Continuous-Time State models.

## UNIT-II

**State Variable Analysis:** Linear Continuous time models for Physical systems– Existence andUniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time InvariantContinuous-Time State Equations – State transition matrix and its properties. General concept ofcontrollability – General concept of Observability – Controllability tests for Continuous-Time InvariantSystems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and ObservabilityCanonicalforms of State model.

## UNIT-III

**Non Linear Systems:** Introduction – Non Linear Systems - Types of Non-Linearities – Saturation –Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization ofnonlinear systems, Properties of Non-Linear systems – Describing function–describing functionanalysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions .Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singularpoints, phase-plane analysis of nonlinear control systems.

## UNIT-IV

**Stability Analysis:** Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instabilitytheorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method . Generation of Lyapunov functions – Variable gradient method – Krasooviski's method. State feedback controller design through Pole Assignment – State observers: Full order and Reducedorder.

**UNIT-V**

**Optimal Control:** Introduction to optimal control - Formulation of optimal control problems – calculusof variations – fundamental concepts, functional, variation of functional – fundamental theorem oftheorem of Calculus of variations – boundary conditions – constrained minimization – formulationusing Hamiltonian method – Linear Quadratic regulator.

**TEXT BOOKS:**

1. Modern Control System Theory by M.Gopal – New Age International -1984
2. Control System Engineering, Nagrath and Gopal - New Age International – Fourth Edition.

**REFERENCE BOOKS**

1. Optimal control by Kirck , Dover Publications
2. Advanced Control Theory A. Nagoor Kani, RBA Publications, 1999
3. Modern Control Engineering by Ogata. K – Prentice Hall – 1997

# ELECTRICAL POWER DISTRIBUTION AND AUTOMATION

| **M.Tech (EPS) IYear Isemester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code: 19EE6184** | **3** | **0** | **0** | **3** |

**Prerequisite:**Power Systems

**Course Objectives:**Students will be able to
- Learning about power distribution system
- Learning of SCADA System
- Understanding Distribution Automation

**Course Outcomes:** Students will be able to
- Knowledge of power distribution system
- Study of Distribution automation and its application in practice
- To learn SCADA system

**UNIT-I**

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Longterm,Power System Loading, Technological Forecasting.

**UNIT-II**

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

**UNIT-III**

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching DevicePlacement in Radial, Distribution Systems, Sectionalizing Switches – Types, Benefits,Bellman's Optimality Principle, Remote Terminal Units, Energy efficiency in electricaldistribution & Monitoring

**UNIT-IV**

Maintenance of Automated Distribution Systems, Difficulties in ImplementingDistribution. Automation in Actual Practice, Urban/Rural Distribution, EnergyManagement, AI techniques applied to Distribution Automation

**UNIT-V**

Interconnection of Distribution, Control & Communication Systems, Remote Metering,Automatic Meter Reading and its implementation. SCADA: Introduction, BlockDiagram, SCADA Applied To Distribution Automation. Common Functions of SCADA,Advantages of Distribution Automation through SCADA.

**TEXT 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 DistributionAutomation",University Science Press, New Delhi.

**REFERENCE BOOKS**

1. Anthony J Panseni, "Electrical Distribution Engineering", CRC Press
2. James Momoh, "Electric Power Distribution, automation, protection & control",CRC Press

# POWER SYSTEMS COMPUTATION LAB-I

| M.Tech(EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19PS6151 | 0 | 0 | 4 | 2 |

**Prerequisite:** power systems

**Course Objectives:**Students will be able to:
- Construction of Y-bus, z-bus for a n-bus system.
- Analyze various Load flow studies .
- Steady state, transient stability analysis.
- Economic load dispatch problem.
- Unit commitment problem.
- State estimation of power system.

**Course Outcomes:**Students will be able to:
- Construct Y-bus and Z-bus
- Compare the different load flow methods
- Analyze the different stability analysis of variety of power systems
- Understood Economic load dispatch and Unit commitment problems.
- Understood State estimation of power system.

**List of Experiments**

1. Develop Program for YBUS formation by direct inspection method.
2. Develop Program for YBUS formation by Singular Transformation method.
3. Develop Program for G-S Load Flow Algorithm.
4. Develop Program for N-R Load Flow Algorithm in Polar Coordinates.
5. Develop Program for FDLF Algorithm.
6. Develop Program for DC load Flow Algorithm.
7. Develop Program for ZBUS Building Algorithm.
8. Develop Program for Short Circuit Analysis using ZBUS Algorithm.
9. Develop Program for Transient Stability Analysis for Single Machine connected to Infinite Bus
10. Develop Program for Economic Load Dispatch Problem using Lambda Iterative Method.
11. Develop Program for Unit Commitment Problem using Forward Dynamic Programming Method.
12. Develop Program for State Estimation of Power System.

**Note:** From the above list minimum 10 experiments are to be conducted

# POWER SYSTEMS LAB I

| **M.Tech(EPS) I Year I semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code: 19PS6152** | **0** | **0** | **4** | **2** |

**Prerequisite:** Power systems protection

**Course Objectives:** Upon successful completion of the lab students will be familiar with:

- Different types of Faults occurring in power systems
- Characteristics of different types of relays
- Protection schemes

**Course Outcomes:** At the end of the course, the student should be able to:

- Calculate various faults
- Analyze the various time-current characteristics of protective relays
- Know the Performance and Testing of various electrical models and systems

**List of Experiments**

1. Characteristics of Electromechanical Non-Directional over current relay
2. Characteristics of Electromechanical Directional Over Current Relay
3. Characteristics of Electromechanical differential protection relay
4. Testing of transformer protection system
5. Characteristics of Integrated Numerical over Voltage Relay
6. Characteristics of Numerical over current Relay
7. Characteristics of static negative sequence relay
8. Differential protection on Single Phase Transformer
9. Performance and Testing of Feeder Protection System
10. Performance and Testing of Generator Protection System.
11. Measurment of insulator string efficiency

**Note:** From the above list minimum 10 experiments are to be conducted

# RESEARCH METHODOLOGY AND IPR

| M.Tech(EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: | 2 | 0 | 0 | 2 |

**Prerequisite:**Research theory

**Course Objectives:**

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology,buttomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals&nation, it is needless to emphasis the need of information about Intellectual Property
- Rightto be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research
- Workand investment in R & D, which leads to creation of new and better products, and inturnbrings about, economic growth and social benefits.

**UNIT-I:**

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 researchproblem.Approaches of investigation of solutions for research problem, data collection, analysis,interpretation, Necessary instrumentations.Effective literature studies approaches, analysis Plagiarism, Research ethics.

**UNIT-II:**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Formatof research proposal, a presentation and assessment by a review committee.

**UNIT-III:**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting andDevelopment: technological research, innovation, patenting, development. International Scenario:International cooperation on Intellectual Property. Procedure for grants of patents, Patentingunder PCT.

**UNIT-IV:**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patentinformationand databases. Geographical Indications.

**UNIT-V:**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR ofBiological Systems, Computer Software etc.Traditional knowledge Case Studies, IPR.

**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.
3. Mayall , "Industrial Design", McGraw Hill, 1992.
4. Niebel , "Product Design", McGraw Hill, 1974.
5. Asimov , "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in NewTechnological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

# STRESSMANGEMENTBYYOGA

| M.Tech(EPS) I Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19AD6MC1 | 2 | 0 | 0 | 0 |

**Prerequisite:-** Yoga and its Benefits

**CourseObjectives:**

- To achieve overall health of body and mind
- To overcome stress
- Course Outcomes:Students will be able to
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

**UNIT-I**
DefinitionsofEightpartsofyog.(Ashtanga)

**UNIT-II**
YamandNiyam.

**UNIT-III**
Do`sandDon't'sinlife.
i)Ahinsa,satya,astheya,bramhacharyaandaparigrahaii)Shaucha,santosh,tapa,swadhyay,ishwarpranidhan

**UNIT-IV**
AsanandPranayam

**UNIT-V**
i)Variousyogposesandtheirbenefitsformind&body
ii)Regularizationofbreathingtechniquesanditseffects-Typesofpranayam

## TEXTBOOKS

1. Yogic AsanasforGroupTarining-Part-I":JanardanSwamiYogabhyasiMandal,Nagpur.
2. "RajayogaorconqueringtheInternalNature"bySwamiVivekananda,AdvaitaAshramaPublicationDepartment),Kolkata

## REFERENCE BOOKS

1. Stress and Its Mangaement by Yoga": by K.N. Udupa and R.C Prasad

# POWER SYSTEM DYNAMICS AND CONTROL

| **M.Tech (EPS) I Year II semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code: 19PS6211** | **3** | **0** | **0** | **3** |

**Prerequisite:** Computer Methods in Power Systems

**Course objectives:**

- To remember the dynamic characteristics of power system equipment,
- To recognize dynamic performance of power systems
- To illustrate the system stability and controls.

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- Choose the fundamental dynamic behavior and controls of power systems to perform basic stability analysis.
- Comprehend concepts in modeling and simulating the dynamic phenomena of power systems
- Interpret results of system stability studies
- Analyze theory and practice of modeling main power system components, such as synchronous machines, excitation systems and governors

**UNIT-I** Basic Concepts Power system stability states of operation and system security - system dynamics - problems system model analysis of steady State stability and transient stability - simplified representation of Excitation control.

**UNIT-II** Modeling of Synchronous Machine: Synchronous machine - park's Transformation-analysis of steady state performance per - unit quantities-Equivalent circuits of synchronous machine-determination of parameters of equivalent circuits.

**UNIT-III** Excitation System Excitation system modeling-excitation systems block Diagram - system representation by state equations- Dynamics of a synchronous generator connected to infinite bus - system model Synchronous machine model-stator equations rotor equations - Synchronous machine model with field circuit - one equivalent damper winding on q axis (model 1.1) - calculation of Initial conditions.

**UNIT-IV** Analysis of Single Machine System Small signal analysis with block diagram - Representation Characteristic equation and application of Routh Hurwitz criterion-synchronizing and damping torque analysis-small signal model - State equations.

**UNIT-V** Application of Power System Stabilizers Basic concepts in applying PSS - Control signals - Structure and tuning of PSS - Washout circuit - Dynamic compensator analysis of single machine infinite bus system with and without PSS.

## TEXT BOOKS

1. K.R. PADIYAR," Power system dynamics "- B.S. Publications. 2. P.M. Anderson and A.A. Fouad, "Power system control and stability",IEEE Press

## REFERENCE BOOKS

2. R. Ramanujam, "Power Systems Dynamics"- PHI Publications.

# POWER SYSTEM OPERATION AND DEREGULATION

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19PS6212 | 3 | 0 | 0 | 3 |

**Prerequisite:** Power System Operation and Control

**Course objectives:**

- To find OPF with security constraints.
- To generalize modeling of load frequency control of a power system
- To compute reactive power control of a power system.
- To apply the concept of deregulation and ATC.

**Course Outcomes**: Upon the completion of the subject, the student will be able to

- Know the optimal scheduling of power plants
- Outline the modeling of turbine and generator
- Compute the steady state behavior of the power system for voltage and frequencyfluctuations.
- Analyze ATC and the cost of transmission

**UNIT- I**

**Optimal Power Flow:**

Introduction- Solution to the optimal power flow-gradient method-Newton's method-Linear sensitivityanalysis- Linear programming methods- Security constrained OPF-Interior point algorithm- Busincremental costs.

**UNIT-II**

**Power System Security:**

Introduction –Factors affecting power system security-Contingency analysis-Detection of networkproblems-Linear sensitivity analysis-AC power flow methods-contingency selection-concentricrelaxation-Bounding area method, MVAR control-Application of voltage regulator-synchronous condensers, transformer tap, static VAR compensator

**UNIT-III**

**State Estimation in Power Systems:**

Introduction- Power system state estimation- Maximum likelihood Weighted Least squares estimation-Matrix formulation- State estimation of AC network- State estimation by orthogonal decompositiondetectionand identification of Bad measurements- Estimation of quantities not being measured-Network observability and pseudo measurements.

**UNIT-IV**

**Power System Deregulation:**

Introduction- motivation for restructuring of power systems- Electricity market entities model-benefitsof deregulation- terminology-deregulation in Indian power sector-Operations in power markets-powerpools-transmission networks and electricity markets.

**UNIT-V**

**Available Transfer Capability:**

Introduction methods: of determination of ATC - ATC calculation considering the effect of contingencyanalysis- Transmission open access and pricing-cost components of transmission systemtransmissionpricing methods-Incremental cost based transmission pricing.

**TEXT BOOKS**

1. A.J.Wood & B.F.Woollenberg- John Wiley Power Generation, "Operation and Control"-2nd edition.
2. P.Venkatesh. B.V.Manikandan, S.Charles Raja- A.Srinivasan, "Electrical power systems:Analysis, security, Deregulation"– PHI 2012

**REFERENCE BOOKS**

1. Bhattacharya, Kankar, Bollen, Math, Daalder, Jaap E. "Operation of Restructured PowerSystem", 2001, Springer.
2. Venkatesh P. , Manikandan B. V., Raja S. Charles , Srinivasan A. Electrical Power Systems:Analysis, Security And Deregulation, Phi Learning Pvt Ltd

# REACTIVE POWER COMPENSATION AND MANAGEMENT

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19EE6271 | 3 | 0 | 0 | 3 |

**Prerequisite:**Power Systems

**Course Objectives:**

- To identify the necessity of reactive power compensation
- To describe load compensation
- To select various types of reactive power compensation in transmission systems
- To illustrate reactive power coordination system
- To characterize distribution side and utility side reactive power management.

**Course Outcomes:**

- Upon the completion of this course, the student will be able to
- Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads
- Observe various compensation methods in transmission lines
- Construct model for reactive power coordination
- Distinguish demand side reactive power management & user side reactive powermanagement

**UNIT-I**

**Load compensation:**

Objectives and specifications – reactive power characteristics – inductive and capacitiveapproximate biasing – Load compensator as a voltage regulator – phase balancing andpower factor correction of unsymmetrical loads- examples.

**UNIT-II**

**Steady–state reactive power compensation in transmission system:**

Uncompensated line – types of compensation – Passive shunt and series and dynamicshunt compensation – examples.

**transient state reactive power compensation in transmission systems:**

Characteristic time periods – passive shunt compensation – static compensations - series capacitor compensation – compensation using synchronous condensers – examples.

**UNIT-III**

**Reactive power coordination:**

Objective – Mathematical modeling – Operation planning – transmission benefits – Basicconcepts of quality of power supply – disturbances- steady –state variations – effects ofunder voltages – frequency –Harmonics, radio frequency and electromagneticinterferences.

**UNIT-IV**

**Demand side management:**

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penaltiesfor voltage flickers and Harmonic voltage levels

**Distribution side reactive power management:**

System losses –loss reduction methods – examples – Reactive power planning –objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

**UNIT-V**

**User side reactive power management:**

KVAR requirements for domestic appliances – Purpose of using capacitors – selection ofcapacitors – deciding factors – types of available capacitor, characteristics andLimitations

Reactive power management in electric traction systems and arc furnaces:Typical layout of traction systems – reactive power control requirements – distributiontransformers- Electric arc furnaces – basic operations- furnaces transformer –filterrequirements – remedial measures –power factor of an arc furnace

**TEXT BOOKS**

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley andsons, 1982.
2. Reactive power Management by D.M.Tagare, Tata McGraw Hill, 2004.

**REFERENCE BOOKS**

1. Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just “Reactive Power
2. Compensation: A Practical Guide, April, 2012, Wiley publication

# RENEWABLE ENERGY SYSTEMS

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19EE6272 | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To recognize the awareness of energy conservation in students
- To identify the use of renewable energy sources for electrical power generation
- To collect different energy storage methods
- To detect about environmental effects of energy conversion

**Course Outcomes:** Upon the completion of this course, the student will be able to

- find different renewable energy sources to produce electrical power
- estimate the use of conventional energy sources to produce electrical energy
- role-play the fact that the conventional energy resources are depleted
- arrange Store energy and to avoid the environmental pollution

**UNIT-I**

Photo voltaic power generation ,spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.

**UNIT-II**

Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology. Wind Energy conversion:Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

**UNIT-III**

Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation.

**Wave energy conversion:** properties of waves and power content, vertex motion of Waves, device applications. Types of ocean thermal energy conversion systems Application of OTEC systems examples.

**UNIT-IV**

**Miscellaneous energy conversion systems:** coal gasification and liquefaction, biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, description of fuel cells, Co-generation and energy storage, combined cycle co-generation, energy storage.

**Global energy position and environmental effects:** energy units, global energy position.

**UNIT-V**

Types of fuel cells, H2-O2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power. Environmental effects of energy conversion systems, pollution from coal and preventive measures steam stations and pollution, pollution free energy systems.

**TEXT BOOKS**

1. "Energy conversion systems" by Rakosh das Begamudre, New age International publishers, New Delhi - 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, 2nd Edition, Fspon & Co.

**REFERENCE BOOKS**

1. "Understanding Renewable Energy Systems" , by Volker Quaschning, 2005, UK.
2. "Renewable Energy Systems Advanced energy conversion Technologies & Applications" by Faner Lin Luo Honer Ye, CRC press, Taylor & Francis group

## RESTRUCTURED POWER SYSTEMS

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19EE6273 | 3 | 0 | 0 | 3 |

**Prerequisite:**Power Systems

**Course Objectives:**Students will be able to

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

**Course Outcomes:** Students will be able to

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

**UNIT-I**

Fundamentals of restructured system, Market architecture, Load elasticity,Social welfaremaximization

**UNIT-II**

OPF: Role in vertically integrated systems and in restructured markets, congestionmanagement.

**UNIT-III**

Optimal bidding, Risk assessment, Hedging, Transmissionpricing, Tracing of power

**UNIT-IV**

Ancillary services,Standard market design,Distributed generation in restructured markets

**UNIT-V**

Developments in India, IT applications in restructured markets, working of restructuredpower systems, PJM, Recent trends in Restructuring

**TEXT BOOKS**

1. LorrinPhilipson, H. Lee Willis, "Understanding electric utilities and deregulation",Marcel Dekker Pub.,1998.
1. Steven Stoft, "Power system economics: designing markets for electricity", JohnWiley and Sons, 2002.

**REFERENCE BOOKS**

1. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation ofrestructured power systems", Kluwer Academic Pub., 2001.
2. Mohammad Shahidehpour, MuwaffaqAlomoush, "Restructured electrical powersystems: operation, trading and volatility", Marcel Dekker.

## ENERGY AUDITING CONSERVATIONAND MANAGEMENT

| **M.Tech(EPS) I Year II semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code:19EE6281** | **3** | **0** | **0** | **3** |

**Course Objectives:-**Students will be able to:

- To understand the need for energy auditing
- Understanding of various loads involved based on power consumption for auditing
- To know about different audit instruments used in practice

**Course Outcomes**:-Students will be able to:

- Acquire the background required for engineers to meet the role of energy managers and toacquire the skills and techniques required to implement energy management
- Identify and quantify the energy intensive business activities in an organization
- Able to perform Basic Energy Audit in an Organization

**UNIT I**

System approach and End use approach to efficient use of ElectricityElectricity tariff types-Energy auditing: Types and objectives - audit instruments-ECO assessment and Economic methods-Specific energy analysis-Minimum energy paths-consumption models-Case study

**UNIT II**

Electric motors-Energy efficient controls and starting efficiency-MotorEfficiency and Load-Analysis Energy efficient /high efficient Motors-Case studyLoad Matching and selection of motors-Variable speed drives; Pumps and Fans-Efficient Control strategies-Optimal selection and sizing-Optimal operation and Storage; Case study

**UNIT III**

Transformer Loading/Efficiency analysis-Feeder/cable loss evaluation, case studyReactive Power management-Capacitor-Sizing-Degreeof Compensation-Capacitor losses-Location-Placement-Maintenance,Case study.

**UNIT IV**

Peak Demand controls- Methodologies-Types of Industrial loads-Optimal Load-scheduling-case study-Lighting- Energy efficient light sources-Energy conservation inLightingSchemesElectronic ballast-Power quality issues-Luminaries, case study.

**UNIT V**

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case studyElectric loads of Air conditioning &RefrigerationEnergy conservation measures- Cool storage-Types-Optimal operation case studyElectric water heating-Geysers-Solar Water

Heaters-Power Consumption in Compressors-Energy conservation measures-Electrolytic Process

**TEXTBOOKS**

1. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub;(1998)
2. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp;2ndedition (1994)
3. Giovanni Petrecca, .Industrial Energy Management: Principles and Applications., TheKluwerinternational series -207,1999

## POWER SYSTEM RELIABILITY

| **M.Tech(EPS) I Year II semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code:19EE6282** | **3** | **0** | **0** | **3** |

**Prerequisite:**Reliability Engineering

**Course Objectives:**At the end of the course the student will be able to:

- To describe the generation system model and recursive relation for capacitivemodel building
- To explain the equivalent transitional rates, cumulative probability andcumulative frequency
- To develop the understanding of risk, system and load point reliability indices
- To explain the basic and performance reliability indices

**Course Outcomes:** At the end of the course the student will be able to:

- Understand the importance of maintaining reliability of power systemcomponents.
- Apply the probabilistic methods for evaluating the reliability of generation andtransmission systems.
- Assess the different models of system components in reliability studies.
- Assess the reliability of single area and multi area systems.

**UNIT-I**

Basic Reliability Concepts:The general reliability function. The exponential distribution – Mean time to failures –series and parallel systems. Markov process – continuous Markov process – Recursivetechniques – Simple series and parallel system models.

**UNIT-II**

Generating Capacity – Basic Probability Methods:
The generation system model – Loss of load indices – Capacity expansion analysis – scheduled outages. Load forecast uncertainty Loss of energy indices. The frequency andduration method.

**UNIT-III**

Transmission Systems Reliability Evaluation:Radial configuration – Conditional probability approach – Network configurations –State selection.

**UNIT-IV**

Generation ReliabilityComparative economic assessment of individual generation projects – Investigation andsimulation models – Heuristic and linear programming models – Probabilistic generatorand load models.

**UNIT-V**

Transmission and Distribution ReliabilityDeterministic contingency analysis – Probabilistic transmission system – reliabilityanalysis. Reliability calculations for single area and multi–area power systems. Networkconfiguration design–consisting of schemes – security criteria configuration synthesis.

**TEXT BOOKS**

1. Roy Billinton and Ronald Allan Pitam: Reliability Evaluation of PowerSystems,1996.
2. R.L. Sullivan: Power System Planning, McGraw Hill International, 1977.

**REFERENCE BOOKS**

1. Wheel Wright and Makridakis: Forecasting methods and Applications, JohnWiley, 1992.
2. J. Endremyl: Reliability Modelling in Electric Power Systems, John Wiley,2005.

## AI TECHNIQUES IN ELECTRICAL ENGINEERING

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19EE6283 | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic andgenetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neuralnetworks.
- To practice the concept of fuzziness involved in various systems and comprehensiveknowledge of fuzzy logic control and to design the fuzzy control
- To analyze genetic algorithm, genetic operations and genetic mutations.

**Course Outcomes:** Upon the completion of this course, the student will be able to

- Understand feed forward neural networks, feedback neural networks and learning techniques.
- Analyze fuzziness involved in various systems and fuzzy set theory.
- Develop fuzzy logic control for applications in electrical engineering
- Develop genetic algorithm for applications in electrical engineering.

**UNIT I**

**Artificial Neural Networks:** Introduction-Models of Neural Network - Architectures – Knowledgerepresentation – Artificial Intelligence and Neural networks – Learning process – Error correctionlearning – Hebbian learning – Competitive learning – Boltzman learning – Supervised learning –Unsupervised learning – Reinforcement learning - learning tasks.

**UNIT II**

**ANN Paradigms :** Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map –Radial Basis Function Network – Functional link, network – Hopfield Network.

**UNIT III**

**Fuzzy Logic:** Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic Fuzzy setoperations – Properties of Fuzzy sets – Fuzzy cartesian Product – Operations on Fuzzy relations –Fuzzy logic – Fuzzy Quantifiers - Fuzzy Inference - Fuzzy Rule based system – Defuzzificationmethods.

**UNIT IV**

**Genetic Algorithms:** Introduction-Encoding – Fitness Function-Reproduction operators – GeneticModeling – Genetic operators - Crossover - Single–site crossover – Two-point

crossover – Multi pointcrossover-Uniform crossover – Matrix crossover - Crossover Rate - Inversion & Deletion – Mutationoperator –Mutation – Mutation Rate-Bit-wise operators - Generational cycle-convergence of GeneticAlgorithm.

**UNIT V**

**Applications of AI Techniques:** Load forecasting – Load flow studies – Economic load dispatch –Load frequency control – Single area system and two area system – Small Signal Stability (Dynamicstability) Reactive power control – speed control of DC and AC Motors.

**TEXT BOOK**

1. S. Rajasekaran and G. A. V. Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"- PHI,New Delhi, 2003.

**REFERENCE BOOKS**

1. P. D. Wasserman, Van Nostrand Reinhold, "Neural Computing Theory & Practice" – NewYork, 1989.
2. Bart Kosko, "Neural Network & Fuzzy System" Prentice Hall, 1992.
3. G. J. Klir and T. A. Folger, "Fuzzy sets, Uncertainty and Information"-PHI, Pvt.Ltd,1994.
4. D. E. Goldberg," Genetic Algorithms"- Addison Wesley 1999.

# POWER SYSTEMS COMPUTATION LAB-II

| M.Tech(EPS) I Year II semester | L | T | P | C |
|---|---|---|---|---|
| Course code: 19PS6251 | 0 | 0 | 4 | 2 |

**Prerequisite:** power systems and Artificial Neural Networks

**Course Objectives:**Students will be able to:

- Known Neural network tool box
- Know the various Evolutionary Algorithms
- Apply various Evolutionary Algorithms to power system problems

**Course Outcomes:** At the end of the course the student will be able to:

- Understood Neural network and fuzszy logic tool box
- Understood various Evolutionary Algorithms
- Solved power system problems by applying various Evolutionary Algorithms

**List of Experiments**

1. Load Flow analysis using Neural Network
2. State Estimations using Neural Network
3. Contingency Analysis using Neural Network
4. Power system Security using Neural Network
5. Fuzzy Logic based AGC – Single area system – Two area system
6. Fuzzy Logic based small signal stability analysis
7. Economic Dispatch of Thermal Units using ANN
8. Economic Dispatch of Thermal Units using GA
9. Unit commitment problem by using GA
10. Unit commitment problem by using PSO
11. Optimal location and sizing of capacitor in distribution system using PSO
12. Security constrained optimal power dispatch using GA

13. Optimal Reactive power dispatch using PSO

**Note:** From the above list minimum 10 experiments are to be conducted

## POWER SYSTEMS LAB II

| | L | T | P | C |
|---|---|---|---|---|
| **M.Tech (EPS) I Year II semester** | | | | |
| **Course code: 19PS6252** | **0** | **0** | **4** | **2** |

**Prerequisite:** power systems and FACTS

**Course Objectives:**Students will be able to:

- Determine transmission line parameters
- Determine transmission line regulation and efficiency
- Determine various fault calculations
- Perform load and line compensation
-

**Course Outcomes:**Students will be able to:

- Calculate transmission line parameters
- Calculate transmission line regulation and efficiency
- Calculate various fault parameters
- Compare system parameters with and without compensation

**List of Experiments**

1. Determination of Line Parameters R, L and C.
2. Determination of T/L efficiency and Regulation for a given load.
3. Analysis of Ferranti effect on Transmission Lines under light loadings.
4. Determination of ABDC parameters of a given Transmission Line Network.
5. Fault Analysis:
   I. Single Line to Ground fault (L-G).
   II. Line to Line fault (L-L).
   III. Double Line to Ground fault (L-L-G).
   IV. Triple Line to Ground fault (L-L-L-G).
6. Equivalent circuit of three phase winding transformer
7. Sequence impedance of cylindrical rotor synchronous machine

8. Sub-Transient reactance of salient pole synchronous machine

9. Testing of C.Ts and P.T.s

10. Analysis of Transmission lines under Surge Impedance Loading.

11. Determination of Sequence impedance of Three phase transformer.

**Note:** From the above list minimum 10 experiments are to be conducted

## ENGLISH FOR RESEARCH PAPER WRITING

| **M.Tech(EPS) I Year II semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code:19AD6MC2** | **2** | **0** | **0** | **0** |

**Prerequisite:**English grammar

**Course objectives:**

- Understand that how to improve your writing skills and level of readability
- Learn about what to write in each section
- Understand the skills needed when writing a Title Ensure the good quality of paper at veryfirst-time submission.

**UNIT-I**

Planning and Preparation, Word Order, Breaking up long sentences,Structuring Paragraphs and
Sentences, Being Concise and RemovingRedundancy, Avoiding Ambiguity and Vagueness.

**UNIT-II**

Clarifying Who Did What, Highlighting Your Findings, Hedging andCriticizing, Paraphrasing
and Plagiarism, Sections of a Paper, Abstracts.Introduction.

**UNIT-III**

Review of the Literature, Methods, Results, Discussion, Conclusions, TheFinal Check.

**UNIT-IV**

key skills are needed when writing a Title, key skills are needed whenwriting an Abstract, keyskills are needed when writing an Introduction,skills needed when writing a Review of the Literature.

**UNIT-V**

skills are needed when writing the Methods, skills needed when writing theResults, skills areneeded when writing the Discussion, skills are neededwhen writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be thefirst- time submission.

**TEXT BOOKS**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

**REFERENCE BOOKS**

1. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM.Highman'sbook.
2. Adrian Wallwork , English for Writing Research Papers, Springer New York DordrechtHeidelberg London, 2011.

## POWER QUALITY

| | L | T | P | C |
|---|---|---|---|---|
| **M.Tech (EPS) II Year I semester** | | | | |
| **Course code: 19EE6371** | **3** | **0** | **0** | **3** |

**Prerequisite:** Power Systems and Power Electronics

**Course Objectives**:

- To know different terms of power quality.
- To illustrate power quality issues for short and long interruptions.
- To construct study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- To know the behavior of power electronics loads, induction motors, synchronous motor etc. by the power quality issues
- To know mitigation of power quality problems by using VSI converters.

**Course Outcomes:**

- Upon the completion of this course, the student will be able to
- Know the severity of power quality problems in distribution system;
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage)
- Compute the power quality improvement by using various mitigating custom power devices.

### UNIT-I: INTRODUCTION

Introduction of the Power Quality (PQ) problem: Terms used in PQ - Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

### UNIT-II: LONG & SHORT INTERRUPTIONS

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short interruptions: definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

**UNIT III: SINGLE-PHASE & THREE-PHASE VOLTAGE SAG CHARACTERIZATION**

Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration.

Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

**UNIT-IV: POWER QUALITY CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS**

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

**UNIT-V: MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS**

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

**POWER QUALITY AND EMC STANDARDS:**

Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

**TEXTBOOKS:**

1. Math H J Bollen “Understanding Power Quality Problems”, IEEE Press.
2. R.C. Dugan, M.F. Mc Granaghan and H.W. Beaty, “Electric Power Systems Quality.” New York: McGraw-Hill.1996

**REFERENCES:**

1. G.T. Heydt, ‘Electric Power Quality’, 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994).
2. Power Quality VAR Compensation in Power Systems, R. Sastry Vedam Mulukutla S.Sarma,CRC Press.
3. A Ghosh, G. Ledwich, Power Quality Enhancement Using Custom Power Devices KluwerAcademic,2002

# POWER SYSTEM STABILITY

| M.Tech(EPS) II Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code:19EE6372 | 3 | 0 | 0 | 3 |

**Prerequisite:** Computers Methods in Power Systems

**Course Objectives:**

- To choose SEC Planning and Operational Standards of Security
- To estimate Reactive Power Control in Generation/Transmission Interconnected
- Networks
- To apply sstability/Instability in Generation/Transmission Interconnected Networks
- To analyze design and Operational Solutions
- To characterize voltage Control in Distribution Networks

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- Understand issues related to power system stability and control.
- Demonstrate various load models in voltage stability analysis.
- Detect reactive power compensation techniques & their practical importance

**UNIT–I**

**Power Stability:**

Power system stability considerations, definitions, classifications of stability

**Transient Stability:**

Swing equations, equal area criteria, solution of swing equation, numerical methods, Euler method, Runge kutta method, concept of critical clearing time and angle.

**Introduction to Voltage Stability:**

Definitions: Voltage Stability, Voltage Collapse, Voltage Security; Physical relation indicatingdependency of voltage on reactive power flow.

**UNIT–II**

**Graphical Analysis of Voltage Stability:**

Comparison of Voltage and angular stability of the system; Graphical Methods describing voltagecollapse phenomenon: P-V and Q-V curves; detailed description of voltage collapse phenomenonwith the help of Q-V curves.

**UNIT–III**

**Analysis of Voltage Stability:**

Analysis of voltage stability on SMLB system: Analytical treatment and analysis.

**Voltage Stability Indices:**

Voltage collapse proximity indicator; Determinant of Jacobin as proximity indicators; Voltage stabilitymargin.

**UNIT–IV**

**Power System Loads:**

Loads that influences voltage stability: Discharge lights, Induction Motor, Air-conditioning, heatpumps, electronic power supplies, OH lines and cables.

**Reactive Power Compensation:**

Generation and Absorption of reactive power; Series and Shunt compensation; Synchronous Condensers, SVC s; OLTC s; Booster Transformers.

**UNIT–V**

**Voltage Stability Margin:**

Stability Margin: Compensated and un-compensated systems.

**Voltage Security:**

Definition; Voltage security; Methods to improve voltage stability and its practical aspects.

**TEXT BOOKS**

1. "Performance, operation and control of EHV power transmission system"- A.CHAKRABARTHY,
2. D.P.KOTARI and A.K.MUKOPADYAY, A.H.Wheeler Publishing, I Edition, 1995.
3. "Power System Dynamics: Stability and Control" – K.R.PADIYAR, II Edition, B.S.Publications.

**REFERENCE BOOKS**

1. "Power System Voltage Stability"- C.W.TAYLOR, Mc Graw Hill, 1994.

## ELECTRIC AND HYBRID VECHILES

| | L | T | P | C |
|---|---|---|---|---|
| **M.Tech (EPS) II Year I semester** | | | | |
| **Course code: 19EE6373** | **3** | **0** | **0** | **3** |

**Course Objectives:** Students will be able to

- Understand upcoming technology of hybrid system
- Understand different aspects of drives application
- Learn the electric Traction

**Course Outcomes:** Upon the completion of the subject, the student will be able to

- Understand issues related hybrid vehicles.
- Demonstrate various models ofhybrid vehicles.

### UNIT I

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.

### UNIT II

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies. Fuel efficiency analysis, Basic concepts of electric traction, Introduction to various electric drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis,

### UNIT III

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives.Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency.

### UNIT IV

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.

**UNIT V**

Introduction to energy management and their strategies used in hybrid and electric vehicles, Classification of different energy management strategies, Comparison of different energy management strategies, Implementation issues of energy strategies.

**TEXT BOOKS**

1.Sira -Ramirez, R. Silva Ortigoza, "Control Design Techniques in Power Electronics Devices", Springer.

2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, "Sliding mode control of switching Power Converters"

## BUSINESSANLYTICS

| **M.Tech ( EPS) II Year I semester** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **Course code:** | **3** | **0** | **0** | **3** |

### Courseobjectives:

- Understand the role of business analytics within an organization.
- Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
- To become familiar with processes needed to develop, report, and analyze business data.
- Use decision-making tools/Operations research techniques.
- Mange business process using analytical and management tools.
- Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

### CourseOutcomes:

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

**UNIT-I**

Businessanalytics:OverviewofBusinessanalytics,ScopeofBusiness analytics,BusinessAnalyticsProcess,RelationshipofBusinessAnalytics Processandorganization,competitiveadvantagesofBusinessAnalytics. StatisticalTools:StatisticalNotation,DescriptiveStatisticalmethods,Reviewofprobabilitydistri butionanddatamodelling,samplingandestimationmethodsoverview.

**UNIT-II**

TrendinessandRegressionAnalysis:ModellingRelationshipsandTrendsin Data,simpleLinearRegression.

ImportantResources,BusinessAnalyticsPersonnel,DataandmodelsforBusinessanalytics,probl emsolving,VisualizingandExploringData,BusinessAnalyticsTechnology.

## UNIT-III

OrganizationStructuresofBusinessanalytics,Teammanagement, ManagementIssues,DesigningInformationPolicy,Outsourcing,Ensuring DataQuality,MeasuringcontributionofBusinessanalytics,Managing Changes. DescriptiveAnalytics,predictiveanalytics,predicativeModelling,Predictiveanalyticsanalysis, DataMining,DataMiningMethodologies,Prescriptive analyticsanditsstepinthebusinessanalyticsProcess,Prescriptive Modelling,nonlinearOptimization.

## UNIT-IV

ForecastingTechniques:QualitativeandJudgmentalForecasting,Statistical ForecastingModels,ForecastingModelsforStationaryTimeSeries, ForecastingModelsforTimeSerieswithaLinearTrend,ForecastingTime SerieswithSeasonality,RegressionForecastingwithCasualVariables, SelectingAppropriateForecastingModels. MonteCarloSimulationandRiskAnalysis:MonteCarleSimulationUsing AnalyticSolverPlatform,New-ProductDevelopmentModel,Newsvendor Model,OverbookingModel,CashBudgetModel.

## UNIT-V

DecisionAnalysis:FormulatingDecisionProblems,DecisionStrategieswith thewithoutOutcomeProbabilities,DecisionTrees,TheValueof Information,UtilityandDecisionMaking.RecentTrendsin:Embeddedandcollaborativebusines sintelligence,Visual datarecovery,DataStorytellingandDatajournalism.

## TEXTBOOKS:

1.BusinessanalyticsPrinciples,Concepts,andApplicationsbyMarcJ.Schniederjans,Dara G.Schniederjans,ChristopherM.Starkey,PearsonFTPress.

2.BusinessAnalyticsbyJamesEvans,personsEducation.

## REFERENCE BOOKS

1.BusinessAnalyticswithManagementScienceModelsandMethodsbyArbeenAsllani,Pea rson

2.BusinessAnalytics:DataAnalysisAndDecisionMaking,byAlbrightandWinston5ThEd n,Cingage.

3.RforBusinessAnalytics,byA.Ohri

# INDUSTRIALSAFETY

| M.Tech (EPS) II Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: | 3 | 0 | 0 | 3 |

## UNIT-I

**INDUSTRIALSAFETY:**Accident,causes,types,resultsandcontrol,mechanicalandelectrical hazards,types,causesandpreventivesteps/procedure,describesalientpointsoffactoriesact1948 forhealthandsafety,washrooms,drinkingwaterlayouts,light,cleanliness,fire,guarding,pressure vessels,etc,Safetycolorcodes.Firepreventionandfire fighting,equipmentandmethods.

## UNIT-II

**FUNDAMENTALSOFMAINTENANCEENGINEERING:**Definitionandaimofmaintenanceengineering,
Primaryandsecondaryfunctionsandresponsibilityofmaintenancedepartment,Typesof maintenance,Typesandapplicationsoftoolsusedformaintenance,Maintenancecost&itsrelation withreplacementeconomy,Servicelifeofequipment.

## UNIT-III

**WEARANDCORROSIONANDTHEIRPREVENTION**: Wear-types,causes,effects,wearreduction methods,lubricants-typesandapplications,Lubricationmethods,generalsketch,workingand applications,i.Screwdowngreasecup,ii.Pressuregreasegun,iii.Splashlubrication,iv.Gravity lubrication,v.Wickfeedlubricationvi.Sidefeedlubrication,vii.Ringlubrication,Definition, principleandfactorsaffectingthecorrosion.Typesofcorrosion,corrosionpreventionmethods.

## UNIT-IV

**FAULTTRACING:**Faulttracing-conceptandimportance,decisiontree concept,needand applications,sequenceoffaultfindingactivities,showasdecisiontree,drawdecisiontreefor problemsinmachinetools,hydraulic,pneumatic, automotive,thermalandelectricalequipment's like,I.Anyonemachinetool,ii.Pumpiii.Aircompressor,iv.Internalcombustionengine,v.Boiler, vi.Electricalmotors,Typesoffaultsinmachinetoolsandtheirgeneralcauses.

## UNIT-V

**PERIODICANDPREVENTIVEMAINTENANCE:**Periodicinspection-conceptandneed,degreasing,
cleaningandrepairingschemes,overhaulingofmechanicalcomponents,overhaulingofelectrical motor,commontroublesandremediesofelectricmotor,repaircomplexitiesanditsuse,definition, need,stepsandadvantagesofpreventivemaintenance.Steps/procedureforperiodicandpreventive maintenanceof:I.Machinetools,ii.Pumps,iii.Aircompressors,iv.Dieselgenerating(DG)sets, Programandscheduleofpreventivemaintenanceofmechanicalandelectricalequipment, advantagesofpreventivemaintenance.Repaircycleconceptandimportance.

## TEXTBOOKS

1.MaintenanceEngineeringHandbook,Higgins&Morrow,DaInformationServices.2.Maintena nceEngineering,H.P.Garg,S.ChandandCompany.

## REFERENCE BOOKS

1.Pump-hydraulicCompressors,Audels,McgrewHillPublication.

2.FoundationEngineeringHandbook,Winterkorn,Hans,Chapman&HallLondon.

# OPERATIONSRESEARCH

| M.Tech (EPS) II Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: | 3 | 0 | 0 | 3 |

**CourseOutcomes:** Attheendofthecourse,thestudentshouldbeableto

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

## UNIT-I

OptimizationTechniques,ModelFormulation,models,GeneralL.RFormulation,SimplexTechniques,SensitivityAnalysis,InventoryControlModels

## UNIT-II

FormulationofaLPP-Graphicalsolutionrevisedsimplexmethod–dualitytheory–dualsimplexmethod-sensitivityanalysis-parametricprogramming

## UNIT-III

Nonlinearprogrammingproblem-Kuhn-Tuckerconditionsmincostflowproblem–maxflowproblem-CPM/PERT

## UNIT-IV

Schedulingandsequencing-singleserverandmultipleservermodels–deterministicinventorymodels-Probabilisticinventorycontrolmodels-GeometricProgramming.

## UNIT-V

Competitive Models, Single and Multi-channel Problems, Sequencing Models,Dynamic Programming,FlowinNetworks,ElementaryGraphTheory,GameTheorySimulation

## TEXTBOOKS

1.H.A.Taha,OperationsResearch,AnIntroduction,PHI,2008

2.H.M.Wagner,PrinciplesofOperationsResearch,PHI,Delhi,1982.

## REFERENCE BOOKS

1. J.C.Pant,IntroductiontoOptimisation:OperationsResearch,JainBrothers,Delhi,2008.
2. HitlerLibermannOperationsResearch:McGrawHillPub.2009
3. Pannerselvam,OperationsResearch:PrenticeHallofIndia2010
4. HarveyMWagner,PrinciplesofOperationsResearch:PrenticeHallofIndia2010

# COSTMANGEMENTOFENGINEERINGPROJECTS

| | L | T | P | C |
|---|---|---|---|---|
| **M.Tech (EPS) II Year I semester** | | | | |
| **Course code:** | **3** | **0** | **0** | **3** |

**Prerequisite:** Management and science

## UNIT-I

IntroductionandOverviewoftheStrategicCostManagementProcessCostconceptsindecision-making;Relevantcost,Differentialcost,IncrementalcostandOpportunitycost.ObjectivesofaCostingSystem;Inventoryvaluation;CreationofaDatabaseforoperationalcontrol;Provisionofdata forDecision-Making.

## UNIT-II

Project:meaning,Differenttypes,whytomanage,costoverrunscentres,variousstagesofprojectexecution:conceptiontocommissioning.Projectexecutionasconglomerationoftechnicalandnontechnicalactivities.
DetailedEngineeringactivities.PreprojectexecutionmainclearancesanddocumentsProjectteam:Roleofeachmember.ImportanceProjectsite:Datarequiredwithsignificance.Projectcontracts.
Typesandcontents.ProjectexecutionProjectcostcontrol.BarchartsandNetworkdiagram.Project commissioning:mechanicalandprocess

## UNIT-III

CostBehaviorandProfitPlanningMarginalCosting;DistinctionbetweenMarginalCostingandAbsorptionCosting;Break-evenAnalysis,Cost-Volume-ProfitAnalysis.Variousdecision-makingproblems.
StandardCostingandVarianceAnalysis.Pricingstrategies:ParetoAnalysis.Targetcosting,Life CycleCosting.Costingofservicesector. Just-in-timeapproach,MaterialRequirementPlanning,EnterpriseResourcePlanning,TotalQualityManagementandTheoryofconstraints.

## UNIT-IV

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.

## UNIT-V

Quantitativetechniquesforcostmanagement,LinearProgramming,PERT/CPM,Transportation problems,Assignmentproblems,Simulation,LearningCurveTheory.

## TEXTBOOKS

1.CostAccountingAManagerialEmphasis,PrenticeHallofIndia,NewDelhi

2.CharlesT.HorngrenandGeorgeFoster,AdvancedManagementAccounting

## REFERENCE BOOKS

1.RobertSKaplanAnthonyA.Alkinson,Management&CostAccounting

2.AshishK.Bhattacharya,Principles&PracticesofCostAccountingA.H.Wheelerpublisher

3.N.D.Vohra,QuantitativeTechniquesinManagement,TataMcGrawHillBookCo.Ltd

# COMPOSITEMATERIALS

| M.Tech (EPS) II Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: | 3 | 0 | 0 | 3 |

**Prerequisite:** Material and science Engineering

## UNIT–I

**INTRODUCTION:** Definition – Classification and characteristics of Compositematerials. Advantagesandapplicationofcomposites. Functionalrequirementsofreinforcementandmatrix. Effectofreinforcement(size,shape,distribution,volumefraction)onoverallcomposite performance.

## UNIT–II

**REINFORCEMENTS:**Preparation-layup,curing,propertiesandapplicationsofglass fibers,carbonfibers,KevlarfibersandBoronfibers.Propertiesandapplicationsofwhiskers,particl e reinforcements.MechanicalBehaviorofcomposites:Ruleofmixtures,Inverseruleofmixtures. IsostrainandIsostressconditions.

## UNIT–III

ManufacturingofMetalMatrixComposites:Casting–SolidStatediffusiontechnique, Cladding– Hotisostatic pressing. Propertiesandapplications.ManufacturingofCeramicMatrix Composites:LiquidMetalInfiltration–Liquidphasesintering.ManufacturingofCarbon–Carbon composites:Knitting,Braiding,Weaving.Propertiesandapplications.

## UNIT–IV

ManufacturingofPolymerMatrixComposites:PreparationofMouldingcompoundsand prepregs–handlayupmethod–Autoclavemethod–Filamentwindingmethod–Compression moulding–Reactioninjectionmoulding.Propertiesandapplications.

## UNIT–V

Strength:LaminarFailureCriteria-strengthratio,maximumstresscriteria,maximum straincriteria,interactingfailurecriteria,hygro thermalfailure.Laminatefirstplayfailure-in sight strength;Laminatestrength-plydiscounttruncatedmaximumstraincriterion;strengthdesignusing capletplots;stressconcentrations.

## TEXTBOOKS

1.MaterialScienceandTechnology–Vol13–CompositesbyR.W.Cahn–VCH,WestGermany.

2.MaterialsScienceandEngineering,Anintroduction.WDCallister,Jr.,AdaptedbyR.Balasubra maniam,JohnWiley&Sons,NY,Indianedition,2007.

## REFERENCE BOOKS

1.HandBookofCompositeMaterials-ed-Lubin.2.CompositeMaterials–K.K.Chawla.

3.CompositeMaterialsScienceandApplications–DeborahD.L.Chung.

4.CompositeMaterialsDesignandApplications–DanialGay,SuongV.Hoa,andStephenW.Tasi.

# ENERGY FROM WASTE

| M.Tech (EPS) II Year I semester | L | T | P | C |
|---|---|---|---|---|
| Course code: | 3 | 0 | 0 | 3 |

**Prerequisite:-** Energy management and conservation

## UNIT-I

IntroductiontoEnergyfromWaste:Classificationofwasteasfuel–Agrobased,Forest residue,Industrialwaste-MSW–Conversiondevices–Incinerators,gasifiers,digestors

## UNIT-II

BiomassPyrolysis:Pyrolysis–Types,slowfast–Manufactureofcharcoal–Methods-Yieldsandapplication–Manufactureofpyrolyticoilsandgases,yieldsandapplications.

## 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.

## UNIT-IV

BiomassCombustion:Biomassstoves–Improvedchullahs,types,someexoticdesigns, Fixedbedcombustors,Types,inclinedgratecombustors,Fluidizedbedcombustors,Design, constructionandoperation-Operationofalltheabovebiomasscombustors.

## UNIT-V

Biogas:Propertiesofbiogas(Calorificvalueandcomposition)-Biogasplanttechnology andstatus-Bioenergysystem-Designandconstructionalfeatures-Biomassresourcesandtheir classification-Biomassconversionprocesses-Thermochemicalconversion-Directcombustion-biomassgasification-pyrolysisandliquefaction-biochemicalconversion-anaerobicdigestionTypesofbiogasPlants–Applications-AlcoholproductionfrombiomassBiodieselproduction-Urbanwastetoenergyconversion-BiomassenergyprogrammeinIndia.

## TEXTBOOKS

1.NonConventionalEnergy,Desai,AshokV.,WileyEasternLtd.,1990.

2.BiogasTechnology-APracticalHandBook-Khandelwal,K.C.andMahdi,S.S.,Vol.I&II,TataMcGrawHillPublishingCo.Ltd.,1983.

## REFERENCE BOOKS

1.Food,FeedandFuelfromBiomass,Challal,D.S.,IBHPublishingCo.Pvt.Ltd.,1991.

2.BiomassConversionandTechnology,C.Y.WereKo-BrobbyandE.B.Hagan,JohnWiley&Sons,1996.