MACHINE MODELING AND ANALYSIS

M. Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19PE6111	3	0	0	3

Prerequisite: Electrical Machines

Course Objectives:

- Identifying the methods and assumptions in modeling of all machines.
- Recognize the different frames for modeling of AC machines.
- To write voltage and torque equations in state-space form for different machines.

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

- Develop the mathematical models of various machines like, induction motor and synchronous machines, permanent magnet synchronous motor, and brushless DC motor using modeling equations.
- Analyze the developed models in various reference frames.

UNIT-I

Magnetically coupled circuits, review of basic concepts, magnetizing inductance, electromechanical energy conversion. Basic Two-pole DC machine - primitive 2-axis machine –Voltage and Current relationship –Torque equation. Mathematical model of separately excited DC motor and DC Series motor in state variable form – Transfer function of the motor - Numerical problems. Mathematical model of D.C. shunt motor D.C. Compound motor in state variable form–Transfer function of the motor - Numerical Problems.

UNIT-II

Linear transformation–Phase transformation (a, b, c to α, β, o) – Active transformation (α. β, o to d, q). Circuit model of a 3-phase Induction motor – Linear transformation – Phase Transformation–Transformation to a Reference frame – Two axis models for induction motor-d-q model based DOL starting of Induction Motors

UNIT-III

Voltage and current equations in stator reference frame–equation in rotor reference frame–equations in asynchronously rotating frame–torque equation- Equations in state–space form.

UNIT-IV

Circuits model of a 3-phase synchronous motor–Two axis representation of synchronous motor. Voltage and current equations in state–space variable form–torque equation-dq model based short circuit fault analysis-emphasis on voltage, frequency and recovery time.

UNIT-V

Modeling of Squirrel Cage Induction Machine, Modeling of DFIG.

TEXT BOOKS:

1. Generalized Machine theory - P. S. Bimbhra, Khanna Publishers.
2. Analysis of Electric Machinery and Drives Systems - Oleg Wasynczuk, Paul C. Krause, Scott D. Sudhoff, Steven D. Pekarek.

POWER ELECTRONIC DEVICES AND CONVERTERS

M.Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19PE6112	3	0	0	3

Prerequisite: Power Electronics

Course Objectives:

- To understand the characteristics and principle of operation of modern power semiconductor devices.
- To comprehend the concepts of different power converters and their applications.
- To analyze and design switched mode regulators for various industrial applications.

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

- Choose appropriate device for a particular converter topology.
- Use power electronic simulation packages for analyzing and designing power converters.

UNIT-I

MODERN POWER SEMICONDUCTOR DEVICES: Review of SCR, Modern Power Semiconductor Devices- MOS Turn off thyristor (MTO)-Emitter turnoff thyristor Integrated gate commutated thyristor (IGCTs) MOS-Controlled thyristors (MCTs) Insulated gate bilpolar thyristors (IGBT) - comparison of their features.

UNIT-II

AC VOLTAGE CONTROLLERS: Single phase AC voltage controllers with Resistive, Resistive –inductive and Resistive –inductive – induced e.m.f. loads – ac voltage controllers with PWM Control –Effects of source and load inductances – Synchronous tap changers.
Three-phase AC voltage controllers – Analysis of controllers with star and delta connected Resistive, Resistive-inductive loads – Effects of source and load Inductances–Applications & Problems.

UNIT-III

CYCLO-CONVERTERS: Single-phase to single-phase cyclo-converters – analysis of midpoint and bridge Configurations – Three-phase to three-phase cyclo-converters – analysis of Midpoint and Bridge configurations – Limitations – Advantages – Applications & Problems – Matrix converter.

UNIT-IV

SINGLE-PHASE & THREE-PHASE CONVERTERS: Single-phase converters – Half controlled and Fully controlled converters–Evaluation of input power factor and harmonic factor–continuous and Discontinuous load current – single-phase dual converters – power factor improvements techniques–Extinction angle control–symmetrical angle control, PWM–single-phase sinusoidal PWM–single-phase series converters – overlap analysis – Applications & Problems.
THREE-PHASE CONVERTERS – Half controlled and fully controlled converters–Evaluation of input power factor and harmonic factor – continuous and Discontinuous load current–three phase dual converters – power factor improvements techniques – three-phase PWM-twelve pulse converters – Applications – Problems – Design of converters.

UNIT-V

D.C to D.C CONVERTERS:

Analysis of step-down and step-up dc to dc converters with Resistive and Resistive – inductive loads – Switched mode regulators – Analysis of Buck Regulators – Boost regulators – buck and boost regulators – Cuk regulators – Condition for continuous inductor current and capacitor voltage – comparison of regulators – Multi output boost converters – advantages –Applications – Problems.

TEXT BOOKS:

1. Mohammed H. Rashid "Power Electronics" Pearson Education Third Edition –First Indian reprint 2004.
2. Ned Mohan, Tore M. Undeland and William P.Robbins, "Power Electronics" John Wiley & Sons – Second Edition.

REFERENCE BOOKS:

1. Milliman Shepherd and Lizang – "Power converters circuits"– Chapter14 (Matrix converter) PP-415-444,
2. M. H. Rashid – Power electronics handbook
3. Marian P. Kaźmierkowski, RamuKrishnan, Frede Blabjerg Edition: "Control in power electronics" illustrated Published by Academic Press, 2002.

HVDC TRANSMISSION SYSTEMS

M. Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19EE6171	3	0	0	3

Prerequisite: Power Electronics and Power Systems

Course Objectives:

- Understand state of the art HVDC technology.
- Learn the Methods to carry out modeling and analysis of HVDC system frontier-area power flow regulation.

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

- Expose the students to the state of the art HVDC technology.
- Knowledge of modeling and analysis of HVDC system for inter-area power flow regulation.

UNIT-I

Development of HVDC Technology, DC versus AC Transmission, Comparative advantages, Selection of converter configuration.

UNIT-II

Rectifier and Inverter operation, Digital Simulation of converters, Control of HVDC converters and Systems.

UNIT-III

Individual phase control, Equidistant firing controls, Higher level controls. Characteristics and non characteristics harmonics filter design. Fault development and protection.

UNIT-IV

Interaction between AC-DC power systems. Over voltages on AC/DC side, multi-terminal HVDC systems, control of MTDC systems..

UNIT-V

Modelling of HVDC systems, per unit system, Representation for power flow solution, representation for stability studies.

TEXT BOOKS:

1. J. Arrillaga, “High Voltage Direct Transmission”, Peter Peregrinus Ltd. London, 1983.
2. K. R. Padiyar, “HVDC Power Transmission Systems”, Wiley Eastern Ltd., 1990.

REFERENCE BOOKS:

1. E. W. Kimbark, “Direct Current Transmission”, Vol. I, Wiley Interscience, 1971.
2. Erich Uhlmann, “Power Transmission by Direct Current”, B.S. Publications, 2004

SMART GRID TECHNOLOGIES

M.Tech (PEED/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 & its solution 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 wide area measurements
- 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, Need of Smart Grid, Concept of Robust &Self Healing Grid Present development & International policies in Smart Grid. Introduction to Smart Meters, Real Time Prizing, 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 .

UNIT-II

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).

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 solar cells, Variable speed wind generators, fuel-cells, micro-turbines, Captive power plants, Integration of renewable energy sources.

UNIT-IV

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.

UNIT-V

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

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", CRC Press , 2009.

REFERENCE BOOKS:

1. Janaka Ekanayake, 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 (PEED) 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 of discrete time signals 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 of stationary Random signals
- 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- Discrete Fourier transform, 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 IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters

UNIT-IV

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

UNIT-V

All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals. Optimum linear filters, Optimum signal estimation, Mean square error estimation, Optimum FIR and IIR Filters.

TEXT BOOKS:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",Tata Mc 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.

REFERENCE BOOKS:

1. S Salivahanan. A. Vallavaraj C. Gnanapriya, Digital Signal Processing – TMH – 2nd reprint 2001.
2. Lourens R RebinarandBernold, Theory and Applications of Digital Signal Processing.
3. Auntoniam, Digital Filter Analysis and Design, TMH. Dept.

ELECTRIC TRACTION SYSTEMS

M. Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19EE6181	3	0	0	3

Prerequisite: Electric Drives, Power Systems

Course Objectives:

- To understand various systems of track electrification, power supply system and mechanics of electric train.
- To identify a suitable drive for electric traction.

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

- Understand Traction systems and its mechanics.
- Identify the power supply equipment for traction systems.
- Analyze various types of motors used in traction and differentiate AC and DC traction drives.

UNIT – I

Traction Systems: Electric drives - Advantages & disadvantages - System of track electrification - d.c., 1-Phase low frequency, 3-Phase low frequency and composite systems, Problems of 1-phase traction system - Current unbalance, Voltage unbalance, Production of harmonics, Induction effects, Booster transformer - Rail connected booster transformer comparison between AC and DC system.

UNIT – II

Traction mechanics: Types of services, Speed - time curves - Construction of quadrilateral and trapezoidal speed time curves, Average & schedule speeds. Tractive effort - Speed characteristic, Power of traction motor, specific energy consumption - Factors affecting specific energy consumption, Coefficient of adhesion, slip - Factors affecting slip, magnetically suspended trains.

UNIT – III

Power supply arrangements: High voltage supply, Constituents of supply system - Substations, Feeding post, Feeding & sectioning arrangements, Remote control center, Design considerations of substations, Over Head Equipment (OHE)- principle of design of OHE, Polygonal OHE - Different types of constructions, Basic sag & tension calculations, Dropper design, Current collection gear for OHE.

UN IT – IV

Traction motors: Desirable characteristics, D.C. series motors, A.C. series motors, 3-Phase induction motors, linear induction motors, D.C. motor series & parallel control - Shunt bridge transition – Drum controller, Contact type bridge transition control, Energy saving, Types of braking in a.c. and d.c. drives, Conditions for regenerative braking, Stability of motors under regenerative braking.

UNIT – V

Semi conductor converter controlled drives: Advantages of A.C. Traction - Control of d.c. motors - single and two-stage converters, Control of ac. motors - CSl fed squirrel cage induction motor, PWM VSl induction motor drive, D.C. traction — Chopper controlled d.c. motors, composite braking, Diesel electric traction — D.C. generator fed d.c. series motor, Alternator fed d.c. series motor, Alternator fed squirrel-cage induction motor, Locomotive and axle codes

TEXT BOOKS:

1. Partab.H - Modern Electric Traction, Dhanpat Rai & Sons – 1998.
2. Dubey. G.K. - Fundamentals of Electrical Drives, Narosa Publishing House - 2001.
3. C. L. Wadhwa — Generation, Distribution and Utilization of Electrical Energy, New Age International - 2006.
4. J.B. Gupta - Utilization of Electrical Power and Electric Traction, S. K. Kataria & Sons publications, 9th edition 2004.

FACTS AND CUSTOM POWER DEVICES

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

Prerequisite: Power Systems and Power Electronics

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 (PEED/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 and design 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 and design 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 and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous-Time State models.

UNIT-II

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

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

MACHINE MODELLING SIMULATION LAB

M.Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19PE6151	0	0	4	2

Prerequisite: Electrical Machines, Machine Modelling Analysis

Course Objectives:

- Identifying the methods and assumptions in modeling of machines.
- Recognize the different frames for modeling of AC machines.
- To write voltage and torque equations in state space form for different machines.

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

- Develop the mathematical models of various machines like, induction motor and Synchronous machines, permanent magnet synchronous motor, brushless DC motor using modeling equations.
- Analyze the developed models in various reference frames.

List of experiments

1. Develop a dynamic model of open loop controlled dc motor.
2. Develop a dynamic model of closed loop controlled dc motor.
3. Convert ABC voltages into stationary frame.
4. Convert ABC voltages into synchronous frames.
5. Convert ABC voltages into rotor reference frames.
6. Develop dynamic model of 3-phase Induction motor and generator.
7. Develop a mathematical model for V/f controlled 3-phase Induction motor.
8. Develop a mathematical model for 3-phase Synchronous motor.
9. Develop a mathematical model for3-phase Permanent Magnet Synchronous motor.
10. Develop a mathematical model for Brushless DC Motor.
11. Develop a dynamic model for closed loop control of Induction Motor.
12. Develop a dynamic model for closed loop control of Synchronous motor.

Note: Conduct any 10 experiments from the above using any simulation tool

POWER ELECTRONICS CONVERTERS LAB

M.Tech. (PEED) I Year I Semester	L	T	P	C
Course Code: 19PE6152	0	0	4	2

Prerequisite: Power Electronic Converters

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

- Conduct an experiment of various AC-AC, AC-DC, DC-DC, DC-AC converter topologies

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

- Experimentation of AC-AC Converters.
- Experimentation of AC-DC Converters.
- Experimentation of DC-DC Converters.
- Experimentation of DC-AC Converters.
- Analysis of various converter topologies developed.

List of experiments

1. Single-phase full converter using RL and E loads.
2. Single-phase semi converter using RL and E loads.
3. Three-phase full converter using RL and E loads.
4. Three-phase semi converter using RL and E loads.
5. Single-phase AC Voltage controller using RL load.
6. Single-phase Cyclo-converter using RL load.
7. Three-phase six stepped inverter
8. Three-phase inverter with PWM controller.
9. BUCK, BOOST regulators.
10. CUCK regulators.
11. Space vector PWM converter.
12. Single-phase dual converter.

Note: Conduct any 10 experiments from the above.

RESEARCH METHODOLOGY AND IPR

M.Tech (PEED/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, but tomorrow 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
- Right to be promoted among students in general & engineering in particular.
- 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.

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 research problem. 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, Format of research proposal, a presentation and assessment by a review committee.

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.

UNIT-IV

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and data bases. Geographical Indications.

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.

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 New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

STRESS MANGEMENT BY YOGA

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

Prerequisite: - Yoga and its Benefits

Course Objectives:

- 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
Definitions of Eight parts of yog. (Ashtanga)

UNIT-II
Yam and Niyam.

UNIT-III
Do`s and Don't's in life.
i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT-IV
Asan and Pranayam

UNIT-V
i) Various yog poses and their benefits for mind & body
ii)Regularization of breathing techniques and its effects-Types ofpranayam

TEXT BOOKS:

1. Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama Publication Department), Kolkata

REFERENCE BOOKS:

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

ADVANCED POWER ELECTRONICS

M.Tech (EPS) I Year II semester	L	T	P	C
Course code: 19PE6211	3	0	0	3

Pre-requisites: Analysis of Power Converters, Power Electronics

Course Outcomes:

- Modeling of power converters under steady state and small signal condition.
- Develop power converters with better performance for challenging applications
- Analyze and design power converters & feedback loops, selection of power circuit components
- Analyze power quality problems and suggest solutions

UNIT- I

Resonant Converters: Introduction - Basic resonant circuit concepts - Classification – Load resonant converters - Resonant switch converters - Zero voltage switching clamped voltage converters - Resonant DC link inverters High frequency link integral half cycle converters - Phase modulated resonant converters.

UNIT- II

Modeling of DC-DC Converters: Basic ac modeling approach - State space averaging – Circuit averaging and averaged switch modeling - Canonical circuit modeling - Converter transfer functions for buck - boost and buck-boost topologies.

UNIT- III

Current Mode Control: Introduction - types - advantages and disadvantages – Slope compensation - Determination of duty cycle and transfer functions for buck - boost and buck boost converters.

UNIT- IV

Design of Switching Power Converters: Controller Design: Introduction - mechanism of loop stabilization - Shaping E/A gains vs frequency characteristics - Conditional stability in feed-back loop - Stabilizing a continuous mode forward and fly-back converter - Feed-back loop stabilization with current mode control - right plane zero.

UNIT- V

Design of Power Converters Components: Design of magnetic components-design of transformer - Design of Inductor and current transformer - Selection of filter capacitors - Selection of ratings for devices - input filter design - Thermal design.

TEXT BOOKS:

1. Power Electronics-circuits, Devices & Applications: M.H.Rashid, PHI.

2. Power Electronics: Converters, Applications & Design: N Mohan, T.M.Undeland, W. P.Robbins, J. Wiley& Sons.

REFERENCE BOOKS:

1. Switching Power Supply Design: Abraham I. Pressman, McGraw Hill International.
2. M. D Singh, K B. Kanchandani, Power Electronics, Tata McGraw Hill International
3. IEEE Publications on Power Electronics.

ELECTRIC DRIVES

M.Tech. (PEED) I Year II Semester	L	T	P	C
Course Code: 19PE6212	3	0	0	3

Prerequisite: Power Electronic Converters, Electrical Machines

Course Objectives:

- To understand principle operation of scalar control of ac motor and corresponding speed-torque characteristics
- To comprehend the vector control for ac motor drive (IM and SM)
- To explain the static resistance control and Slip power recovery drive
- To explain synchronous motor drive characteristics and its control strategies
- To comprehend the brushless dc motor principle of operation.

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

- Develop induction motor for variable speed operations using scalar and vector control techniques.
- Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.
- Develop controllers for synchronous motor and variable reluctance motor.

UNIT–I

RECTIFIER CONTROLLED DC MOTOR:

Separately excited DC motors and DC series motors with single phase semi converter and single phase full converter-Three-phase controlled converter, control circuit, control modeling of three phase converter – Steady state analysis of three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive – DC motor and load, converter.

CLOSED LOOP CONTROL OF DC DRIVE:

Current and speed controllers - Current and speed feedback – Design of controllers – Current and speed controllers – Motor equations – filter in the speed feedback loop speed controller – current reference generator – current controller and flow chart for simulation – Harmonics and associated problems – sixth harmonics torque.

UNIT–II

CHOPPER CONTROLLED DC MOTOR DRIVES:

Principle of operation of the chopper – Chopper with other power devices – model of the chopper – input to the chopper – steady state analysis of chopper controlled DC motor drives – Closed loop operation: Speed controlled drive system – current control

loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller.

UNIT–III

CONTROL OF INDUCTION MOTOR:

Introduction to motor drives – Torque production – Equivalent circuit analysis – Speed – Torque Characteristics with variable voltage operation Variable frequency operation constant v/t operation – Variable stator current operation – Induction motor characteristics in constant torque and field weakening regions.

STATOR SIDE CONTROL:

Scalar control – Voltage fed inverter control – Open loop volts/Hz control – speed control slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive –

ROTOR SIDE CONTROL OF INDUCTION MOTOR DRIVES:

Slip power recovery drives – Static Kramer Drive – Phasor diagram – Torque expression – speed control of Kramer Drive – Static Scheribus Drive – modes of operation.

UNIT–IV

VECTOR CONTROL OF INDUCTION MOTOR DRIVES:

Principles of Vector control – Vector control methods – Direct methods of vector control – Indirect methods of vector control – Adaptive control principles – Self tuning regulator Model referencing control – Direct torque control of AC motors.

UNIT–V

CONTROL OF SYNCHRONOUS MOTOR DRIVES:

Synchronous motor and its characteristics – Control strategies – Constant torque angle control – Unity power factor control – Constant mutual flux linkage control – closed loop operation.

TEXT BOOKS:

1. Electric Motor Drives Pearson Modeling, Analysis and control – R. Krishnan –
2. Publications – 1st edition – 2002.
3. Modern Power Electronics and AC Drives B K Bose – Pearson Publications 1st edition.

REFERENCE BOOKS:

1. Power Electronics and Control of AC Motors – MD Murthy and FG Turn Bull Pergman Press 1st edition
2. Power Electronics and AC Drives – BK Bose – Prentice Hall Eagle wood diffs New Jersey 1st edition
3. Power Electronic circuits Deices and Applications – M H Rashid – PHI – 1995.
4. Fundamentals of Electrical Drives – G. K. Dubey – Narosa publications – 1995.

REACTIVE POWER COMPENSATION AND MANAGEMENT

M.Tech (PEED/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 un symmetrical loads
- Observe various compensation methods in transmission lines
- Construct model for reactive power coordination
- Distinguish demand side reactive power management & user side reactive power management

UNIT-I

Load compensation:

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power 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 dynamic shunt 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 – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferences.

UNIT-IV

Demand side management:

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for 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 of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

Reactive power management in electric traction systems and arc furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – 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 and sons, 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 (PEED/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 (PEED/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 entities in the market.

UNIT-I

Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization

UNIT-II

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

UNIT-III

Optimal bidding, Risk assessment, Hedging, Transmission pricing, 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 restructured power systems, PJM, Recent trends in Restructuring

TEXT BOOKS:

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

REFERENCE BOOKS:

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

AI TECHNIQUES IN ELECTRICAL ENGINEERING

M.Tech (PEED/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 and genetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neural networks.
- To practice the concept of fuzziness involved in various systems and comprehensive knowledge 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 – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – 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 set operations – Properties of Fuzzy sets – Fuzzy cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers - Fuzzy Inference - Fuzzy Rule based system – Defuzzification methods.

UNIT -IV

Genetic Algorithms: Introduction-Encoding – Fitness Function-Reproduction operators – Genetic Modeling – Genetic operators - Crossover - Single–site crossover – Two-point crossover – Multi point crossover-Uniform crossover – Matrix crossover - Crossover Rate - Inversion & Deletion – Mutation operator –Mutation – Mutation Rate-Bit-wise operators - Generational cycle-convergence of Genetic Algorithm.

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 (Dynamic stability) 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" – New York, 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.

ADVANCED MICROCONTROLLER BASED SYSTEMS

M. Tech. (PEED) I Year II Semester	L	T	P	C
Course Code: 19EE6284	3	0	0	3

Prerequisite: Microprocessors and Microcontrollers

Course Objectives:

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

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

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

UNIT-I

Basic Computer Organization, Accumulator based processes-Architecture-Memory Organization- I/O Organization

UNIT-II

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication. Timers, Interrupts, Programming. Intel 8051 – Assembly language programming-Addressing-Operations-Stack & Subroutines, Interrupts-DMA.

UNIT-III

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

UNIT-IV

Digital Signal Processor (DSP) - Architecture – Programming, Introduction to FPGA

UNIT-V

Microcontroller development for motor control applications, Stepper motor control using micro controller.

TEXT 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.

REFERENCE BOOKS:

1. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005.
2. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004.
3. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005.
4. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008.
5. Microchip datasheets for PIC16F877.

STATIC VAR CONTROLLER AND HARMONIC FILTERS

M. Tech. (PEED) I Year II Semester	L	T	P	C
Course Code: 19EE6285	3	0	0	3

Prerequisite: Power Systems, Power Quality

Course Objectives: Students will be able to:

- Understand the various static converters.
- Understand the static converter control strategies.
- Understand the active and reactive power compensation and their control.
- Understand harmonic filtering and its control design.

UNIT-I

Fundamentals of Load Compensation.-Steady-State Reactive Power Control in Electric Transmission Systems. Reactive Power Compensation and Dynamic Performance of Transmission Systems.

UNIT-II

Power Quality Issues: Sags, Swells, Unbalance, Flicker, Distortion. Current Harmonics. Sources of Harmonics in Distribution Systems and Ill Effects .

UNIT- III

Static Reactive Power Compensators and their control.Shunt Compensators-SVCs of Thyristor Switched and Thyristor Controlled types and their control,STATCOMs and their control.
Series Compensators of thyristor Switched and Controlled Type and their Control.SSSC and its Control, Sub-Synchronous Resonance and damping. Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power System.

UNIT-IV

Passive Harmonic Filtering.Single Phase Shunt Current Injection Type Filter and its Control.
Three Phase Three-wire Shunt Active Filtering and their control using p-qtheory and d-q modeling. Three phase four wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Dynamic Voltage Restorer and its control.Power Quality Conditioner

UNIT-V

Series Active Filtering in Harmonic Cancellation Mode.Series Active Filtering in Harmonic Isolation Mode.

TEXT BOOKS:

1. Ned Mohan et.al, "Power Electronics",John Wiley and Sons,2006.
2. G. Massobrio, P. Antognet," Semiconductor Device Modeling with Spice", McGraw-Hill, Inc.,1988.
3. B. J. Baliga," Power Semiconductor Devices",Thomson, 2004
4. V. Benda, J. Gowar, D. A. Grant," Power Semiconductor Devices. Theory and Applications",JohnWiley& Sons1994.

ADVANCED POWER ELECTRONICS SIMULATION LAB

M. Tech. (PEED) I Year II Semester	L	T	P	C
Course Code: 19EE6251	0	0	4	2

Prerequisite: Power Electronics, Power Converters

Course Objectives:

- Gate drive circuit configurations for converter circuits
- Advanced converter topologies
- Open loop and closed loop speed control analysis of AC and DC drives.

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

- Perform the open loop and closed loop speed control analysis of AC and DC drives.
- Design the gate driver circuits for converter topologies.
- Know the complete study of advanced converter technologies.

List of Experiments:

1. Closed loop implementation of buck and boost dc-dc converters.
2. Sine-PWM techniques for single-phase half-bridge inverters.
3. Sine-PWM techniques for single-phase full-bridge inverters.
4. Sine-PWM techniques for three-phase two-level inverters.
5. Series resonant converter.
6. Parallel resonant converter.
7. Zero Voltage Switching (ZVS) converter.
8. Zero Current Switching (ZCS) converter.
9. Push pull converter.
10. Fly back converter.
11. Forward converter.
12. Matrix converter.

Note: Conduct any 10 experiments from the above using any simulation tool.

ELECTRIC DRIVES LAB

M. Tech. (PEED) I Year II Semester	L	T	P	C
Course Code: 19EE6252	0	0	4	2

Prerequisite: Power Electronic Devices and Circuits and Electrical Machines

Course Objectives:

- To understand principle operation of scalar control of ac motor and corresponding speed-torque characteristics
- To comprehend the vector control for ac motor drive (IM and SM)
- To explain the static resistance control and Slip power recovery drive
- To explain synchronous motor drive characteristics and its control strategies
- To comprehend the brushless dc motor principle of operation.

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

- Develop induction motor for variable speed operations using scalar and vector control techniques.
- Identify the difference between the rotor resistance control and static rotor resistance control method and significance of slip power recovery drives.
- Develop controllers for synchronous motor and variable reluctance motor.

List of Experiments:

1. Speed control of separately excited DC Motor Drive with 1 quadrant chopper.
2. Speed control of separately excited DC Motor Drive with 4 quadrant chopper.
3. Speed control of BLDC Motor Drive.
4. Multi-level inverter based AC Induction Motor Drive control equipment.
5. Speed control of 3-phase wound rotor Induction Motor Drive.
6. Speed control of 3-phase doubly fed Induction Motor Drive.
7. Speed control of 5-phase Induction Motor Drive.
8. Speed control of 3-phase Induction Motor Drive using V/F control.
9. Speed control of 3-phase Induction Motor Drive using Vector Control technique.
10. Speed Measurement and closed loop control using PMDC Motor Drive.

11. Speed measurement and closed loop control of PMDC Motor Drive with thyristor circuit.
12. Speed measurement and closed loop control of IGBT used single 4 quadrant chopper for PMDC Motor Drive.
13. Isolated Gate Drive circuits for MOSFET / IGBT based circuits.

Note: Any 10 experiments can be conducted.

ENGLISH FOR RESEARCH PAPER WRITING

M.Tech (PEED/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 very first-time submission.

UNIT- I

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

UNIT- II

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

UNIT-III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills 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 the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions, useful phrases, how to ensure paper is as good as it could possibly be the first- 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 Dordrecht Heidelberg London, 2011.

POWER QUALITY

	L	T	P	C
M.Tech (PEED/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

Over view 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

REFERENCE BOOKS:

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

ELECTRIC AND HYBRID VECHILES

M.Tech (PEED/EPS) II Year I semester	**L**	**T**	**P**	**C**
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 of hybrid 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"

DIGITAL CONTROL SYSTEMS

M.Tech (PEED) II Year I semester	**L**	**T**	**P**	**C**
Course code: 19EE6374	**3**	**0**	**0**	**3**

Pre-requisites: Control Systems

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

- Evaluate the output of a digital system for a given input.
- Describe the dynamics of a Linear, Time Invariant and Causal digital systems
- through difference equations.
- Analyze digital systems using the Z-transformation.
- Design digital controllers for Power Electronic Systems.

UNIT- I

Introduction: Digital control systems - Quantizing and quantization error - Data acquisition - Conversion and distribution system.

UNIT-II

Z-Transform: Z-transform - Z-transforms of elementary functions - Important properties and theorems - Inverse z-transform - Z-transform method of solving difference equations

UNIT-III

Z-Plane Analysis Of Discrete-Time Control Systems: Impulse sampling and data hold – Pulse transfer function - Realization of digital controllers and digital filters - Mapping between s-plane and z-plane - Stability analysis of closed loop systems in z-plane - Transient and steady state analyses

UNIT- IV

State Space Analysis: State space representation of digital control systems - Solution of discrete time state space equations - Pulse transfer function matrix – Discritisation of continuous time state space equations - Lyapunov stability analysis

Pole Placement & Observer Design: Controllability - Observability

UNIT-V

Quadratic Optimal Control Systems: Design via pole placement - State observers. – Quadratic optimal control - Steady state quadratic optimal control - Quadratic optimal control of a servo system

TEXT BOOKS:

1. M. Gopal: Digital control engineering, New Age Int. Ltd., India, 1998.
2. K. Ogata:Discrete time control systems, Pearson Education, 2006.
3. K. Ogata, "Modern control engineering"- PHI, 1991.
4. B. C. Kuo, "Digital control systems"- Holt Saunder"s International Edition, 1991.

BUSINESS ANLYTICS

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

Course objectives:

- 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.

Course Outcomes:

- 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

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT-II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data,Business Analytics Technology.

UNIT-III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TEXT BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

REFERENCE BOOKS:

1. Business Analytics with Management Science Models and Methods by ArbeenAsllani, Pearson
2. Business Analytics: Data Analysis And Decision Making, by Albright and Winston 5Th Edn, Cingage.
3. R for Business Analytics, by A.Ohri

INDUSTRIAL SAFETY

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

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 fire fighting, equipment and methods.

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.

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.

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.

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.

TEXT BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.

2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCE BOOKS:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPERATIONS RESEARCH

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

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

- 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

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

UNIT-II

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

UNIT-III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem – max flow problem - CPM/PERT

UNIT-IV

Scheduling and sequencing - single server and multiple server models – deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT-V

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

TEXT BOOKS:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

REFERENCE BOOKS:

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

COST MANGEMENT OF ENGINEERING PROJECTS

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

Prerequisite: Management and science

UNIT-I

Introduction and Overview of the Strategic Cost Management Process 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.

UNIT-II

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 nontechnical 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.

UNIT-III

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.

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

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

TEXT BOOKS:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting

REFERENCE BOOKS:

1. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.
3. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd

COMPOSITE MATERIALS

M.Tech (PEED/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 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.

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.

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.

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.

UNIT – V

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro thermal failure. Laminate first play failure-in sight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

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.

REFERENCE BOOKS:

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.

ENERGY FROM WASTE

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

Prerequisite: - Energy management and conservation

UNIT-I

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

UNIT-II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

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

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.

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.

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley &Sons, 1996.