M.TECH. POWER ELECTRONICS (EPE)
I SEMESTER

12MAT11 APPLIED MATHEMATICS

Subject Code	12MAT11	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Numerical Methods: Solution of algebraic and transcendental equations- iterative methods based on second degree equation – Muller method,(no derivation) Chebyshev method, general iteration method (first order),acceleration of convergence, system of non-linear equations, and complex roots – Newton-Raphson method, polynomial equations – Birge – Vieta method and Bairstow's method.

Numerical Solution of Partial Differential Equations: Classification of second order equations, parabolic equations- solution of one dimensional heat equation, explicit method,Crank-Nicolson method and Du Fort-Frankel method, hyperbolic equations- solution of one dimensional wave equation.

System of Linear Algebraic Equations and Eigen Value Problems: Iterative methods - Gauss-Seidal method, SOR method, Eigen value problems – Gerschgorian circle, Eigen values and Eigen vectors of real symmetric matrices -Jacobi method, Givens method.

Interpolation: Hermite interpolation, spline interpolation, numerical solution of differential equations – Numerov method.

Optimization: Linear programming- formulation of the problem, graphical method, general linear programming problem, simplex method, artificial variable technique -M-method.

Graph Theory: Basic terminologies, types of graphs, sub graphs, graphs isomorphism, connected graphs-walks, paths, circuits, connected and disconnected graphs, operations on graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, applications of graphs.

Linear Algebra: Vector spaces, linear dependent, independence, basis and dimension, elementary properties, examples.

Linear Transformations: Definition, properties, range and null space, rank and nullity, algebra of linear transformations- invertible, singular and non-singular transformations, representation of transformations by matrices.

REFERENCE BOOKS

1. M K Jain, S R K Iyengar and R K Jain, "Numerical Methods for Scientific and Engineering Computations", New Age International, 2004.
2. M K Jain, "Numerical Solution of Differential Equations", 2nd Edition, New Age International, 2008.
3. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999.
4. Dr. B.S. Grewal, "Higher Engineering Mathematics", 41st Edition, Khanna Publishers, 2011.
5. Narsingh Deo, "Graph Theory with Applications to Engineering and Computer Science", PHI, 2012.
6. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 2011.

12EPE12 POWER SEMICONDUCTOR DEVICES

Subject Code	12EPE12	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Power Diodes: Basic structure and V-I characteristics, breakdown voltages and control, on-state losses, switching characteristics-turn-on transient, turn-off transient and reverse recovery transient, Schottky diodes, snubber requirements for diodes, diode snubber, modeling and simulation of power diodes.

Thyristors:- Basic structure, V-I characteristics, turn-on process, on-state operation, turn -off process, switching characteristics, turn-on transient and di/dt limitations, turn-off transient, turn-off time and reapplied dv/dt limitations, gate drive requirements, ratings of thyristors, snubber requirements and snubber design, modeling and simulation of thyristors.

Triacs: Basic structure and operation-I characteristics, ratings, snubber requirements, modeling and simulation of triacs**.**
Gate Turnoff Thyristor (GTO): Basic structure and operation, GTO switching characteristics, GTO turn-on transient, GTO turn -off transient, minimum on and off state times, gate drive requiremen**ts,** maximum controllable anode current, overcurrent protection of GTO'S, modelling and simulation of GTO'S.

Power BJT'S: Basic structure and V-I characteristics, breakdown voltages and control, secondary breakdown and it's control- FBSOA and RBSOA curves - on state losses, switching characteristics, resistive switching specifications, clamped inductive switching specifications, turn-on transient, turn-off transient, storage time, base drive requirements, switching losses, device protection- snubber requirements for BJT'S and snubber design - switching aids, modeling and simulation of power BJT'S.

Power MOSFET'S:- Basic structure, V-I characteristics, turn-on process, on state operation, turn-off process, switching characteristics, resistive switching specifications, clamped inductive switching specifications - turn-on transient and di/dt limitations, turn-off transient, turn off time, switching losses, effect of reverse recovery transients on switching stresses and losses - dv/dt limitations, gating requirements, gate charge - ratings of MOSFET'S, FBSOA and RBSOA curves, device protection -snubber requirements, modeling and simulation of Power MOSFET'S.

Insulated Gate Bipolar Transistors (IGBT'S): Basic structure and operation, latch up IGBT, switching characteristics, resistive switching specifications, clamped inductive switching specifications - IGBT turn-on transient, IGBT turn off transient- current tailing - gating requirements - ratings of IGBT'S, FBSOA and RBSOA curves, switching losses - minimum on and off state times - switching frequency capability - overcurrent protection of IGBT'S, short circuit protection, snubber requirements and snubber design.

New Power Semiconductor Devices : MOS gated thyristors, MOS controlled thyristors or MOS GTO'S, base resistance controlled thyristors, emitter switched thyristor, thermal design of power electronic equipment, modeling and simulation, heat transfer by conduction, transient thermal impedance - heat sinks, heat transfer by radiation and convection - heat sink selection for power semiconductor devices.

REFERENCE BOOKS

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition. Wiley India Pvt Ltd, 2011.
2. G. Massobrio, P. Antognetti, "Semiconductor Device Modeling with Spice", McGraw-Hill, 2nd Edition, 2010.
3. B. Jayant Baliga, "Power Semiconductor Devices", 1st Edition, International Thompson Computer Press, 1995.
4. V. Benda, J. Gowar, and D. A. Grant, "Discrete and Integrated Power Semiconductor Devices: Theory and Applications", John Wiley & Sons, 1999.

12EPE13 MODELING & SIMULATION OF POWER ELECTRONIC SYSTEMS

Subject Code	12EPE13	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Computer Simulation of Power Electronic Converters and Systems: Challenges in computer simulation, simulation process, Types of analysis, mechanics of simulation, circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers.

Modeling of Systems: Input-Output relations, differential equations and linearization, state space representation, transfer function representation ,modeling of an armature controlled DC Motor, poles and zeros circuit averaging method of modeling approach for switched power electronic circuits, space vector modeling, space vectors, representation of space vectors in orthogonal co-ordinates, space vector transformations, modeling of induction motor, state space representation of the d-q model of the induction motor.

Digital Controller Design: Controller design techniques, Bode diagram method, PID controller, design, root locus method, state space method. tracker, controller design, controlling voltage, controlling current.

Discrete Computation Essentials: Numeric formats, fixed -point numeric format, floating -point numeric format, tracking the base point in the fixed point system, addition of numbers, subtraction of numbers, multiplication of numbers, normalization and scaling, multiplication algorithm, arithmetic algorithm reciprocal, square root, reciprocal of square root, sine and cosine exponential, logarithm, implementation examples, pi controller, sine and cosine, pulse width modulation, space vector pwm, over-modulation.

REFERENCE BOOKS

1 .Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, John Wiley & Sons, 2009.

2. L.Umanand,"Power Electronics Essentials and Applications",1st Edition, John Wiley & Sons, 2009.

12EPE14 SOLID STATE POWER CONTROLLERS

Subject Code	12EPE14	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Line Commutated Converters: Phase control, single phase semi-converter & fully controlled converter, three phase semi controlled & fully controlled converter, dual converters, power factor improvement methods, effect of source inductance, single phase series converters, twelve pulse converter and design of converter circuits.

Inverters: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters.

Voltage Control of Single Phase Inverters: Single/multiple, pulse/SPWM/ modified SPWM methods, voltage control of three phase inverter, SPWM/third harmonic PWM/Space vector modulation, harmonic reduction, current source inverter, comparison between VSI & CSI.

Multilevel Inverters: Introduction, types, diode clamped multi-level inverters, features & applications.

DC-DC Converters: Principle of operation, analysis of step-down and step-up converters, classification of chopper & chopper circuit design.

REFERENCE BOOKS

1. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition,Wiley India Pvt Ltd, 2011
2. Rashid M.H, "Power Electronics: Circuits Devices and Applications", 3rd Edition, Pearson,2011.
3. B. K. Bose, "Modern Power Electronics & AC Drives", PHI, 2012.

ELECTIVE-1

12EPE151 EMBEDDED SYSTEM DESIGN

Subject Code	12EPE151	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction to Embedded System: An embedded system, processor, hardware unit, software embedded into a system, example of an embedded system, OS services, I/O, N/W, O/S, real time and embedded OS.

Processor and Memory Organization: Structural unit in a processor, processor selection for an embedded systems, memory devices, memory selection for an embedded system, allocation of memory to program statements and blocks and memory map of a system, direct memory accesses.

Real Time System: Types, real time computing, design issues, sample systems, hardware requirements- processor introduction, ARM various system architecture, high performance processors - strong ARM processors, addressing modes, instruction set, basic alp programs, interrupt structure.

Real Time Operating System: Fundamental requirements of RTOS, real time kernel types, schedulers, various scheduling modules with examples, latency (interrupt latency, scheduling latency and context switching latency), tasks, state transition diagram, task control block. Inter-task communication and synchronization of tasks, building real time applications.

REFERENCE BOOKS

1. Rajkamal "Embedded System Architecture: Programming & Design", TMH, 2010.
2. David E. Simon, "An Embedded Software Primer", Pearson Education, 1999.
3. Philip. A. Laplante, "Real-Time Systems Design and Analysis- An Engineer's Handbook"- 2nd Edition, Pearson.
4. Jane W.S. Liu, "Real-Time Systems", Pearson Education Inc, 2012.
5. K.V.K K Prasad, "Embedded Real Time Systems: Concepts Design and Programming", Dreamtech Press New Delhi, 2003.

12EPE152 SOFT COMPUTING

Subject Code	12EPE152	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Learning and Soft Computing: Examples, basic tools of soft computing, basic mathematics of soft computing, learning and statistical approaches to regression and classification.

Single-Layer Networks: Perceptron, adaptive linear neuron (Adaline), and the LMS algorithm.
Multilayer Perceptrons: Error back propagation algorithm, generalized delta rule, practical aspects of error back propagation algorithm.

Radial Basis Function Networks: Ill-posed problems and the regularization technique, stabilizers and basis functions, generalized radial basis function networks.

Fuzzy Logic Systems: Basics of fuzzy logic theory, mathematical similarities between neural networks and fuzzy logic models, fuzzy additive models.

Support Vector Machines: Risk minimization principles and the concept of uniform convergence, VC dimension, structural risk minimization, support vector machine algorithms.
Case Studies: Neural-network based adaptive control, computer graphics.

REFERENCE BOOKS

1. Vojislav Kecman, “Learning and Soft Computing”, Pearson Education (Asia) Pvt. Ltd. 2004.
2. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Pearson Education (Asia) Pvt. Ltd., Prentice Hall of India, 2008.
3. M.T. Hagan, H.B. Demuth and M. Beale, "Neural Network Design", Thomson Learning, 2002.
4. Bart Kosko, "Neural Networks and Fuzzy Systems",Prentice Hall of India, 2010.
5. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Application", PHI, 2012.

12EPE153 MODELING & ANALYSIS OF ELECTRICAL MACHINES

Subject Code	12EPE153	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Basic Concepts of Modeling: Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations.

DC Machine Modeling: Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations.

Reference Frame Theory: Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence.

Dynamic Modeling of Three Phase Induction Machine: Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation.

Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor.

Transformer Modeling: Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis of normal system, regulating transformers for voltage and phase angle control, auto transformers, transmission line and transformers.

Modeling of Synchronous Machines: Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation.

Dynamic Analysis of Synchronous Machines: Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation.

REFERENCE BOOKS

1. P.S.Bimbra, "Generalized Theory of Electrical Machines" Khanna Publications, 5th Edition, 1995.
2. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & Control", PHI Learning Private Ltd, 2009.
3. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive Systems", 2nd Edition, Wiley India, 2010.
4. Arthur R Bergen and Vijay Vittal, "Power System Analysis", Pearson, 2009.
5. Prabha Kundur, "Power System Stability and Control", TMH, 2010.
6. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery using Matlab / Simulink", Prentice Hall, 1998.

M.TECH. POWER ELECTRONICS (EPE)
II SEMESTER

12EPE21 AC-DC DRIVES

Subject Code	12EPE21	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Electric Drives: Introduction – block diagram-classification of electrical drives-choice of electrical drives- fundamental torque equation- components of load torque- steady state stability.

DC Drives: Single Quadrant Drive: 1-Phase semi and half wave converter drives,Two quadrant Drive: 1-phase and 3-phase full converter drive.
Two and Four Quadrant drive: 1-phase and three- phase dual converter drive, different braking methods and closed loop control of DC drives.

AC Drives: Voltage and current source inverter - inverter control-six step and PWM operation, Control of Induction motor drive -V/f and field oriented control – direct and indirect vector control, voltage and current source inverter fed induction motor drives, stator and rotor voltage control methods, slip energy recovery drives.

Closed Loop Control of AC Drives : Stator voltage control ,v/f control, slip regulation, speed control of static Kramer's drive , current control, brushless DC motor, stepper motor and variable reluctance motor drives static excitation schemes of AC generator.

REFERENCE BOOKS

1. Bose B. K, "Modern Power Electronics & AC Drives" PHI, 2011.
2. Murphy JMD, Turnbull F.G., "Thyristor Control of AC Motors" Pergamon Press Oxford, 1998.
3. R.Krishanan "Electric Motor Drives", EEE, PHI, 2010.
4. Mehrdad Ehsani, Yimin Gao, Alin Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicle Fundamentals, Theory and Design" Special Indian Edition, CRC Press 2011.
5. High Performance Control of AC Drives "Haitham Abu-Rub,AtifIqbal, Jaroslaw Guzinski, Wiley, 2012.

12EPE22 SWITCHED MODE POWER CONVERSION

Subject Code	12EPE22	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation,principle of operation and analysis of buck-boost converter analysis, inductors current ripple and output voltage ripple, design considerations, buck-boost converter for discontinuous current operation, principle of operation and analysis of CUK converter , inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC).

Derived Converters: Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations,principle of operation and analysis of forward converter, design considerations, double ended(Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half-bridge DC-DC converters, design considerations, current fed converters, multiple outputs.

Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, design, PSpice simulation of feedback control, Type-3 error amplifier with compensation, design.

Resonant Converters: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter,series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter.
classification, basic resonant circuit concepts, resonant switch converters, zero voltage switching, clamped voltage topologies, resonant DC link converters, and high frequency link integral half cycle converters.
Design of inductor and transformers for SMPC.

REFERENCE BOOKS

1. Daniel W Hart, "Power Electronics", Tata McGraw Hill, 2011.
2. Rashid M.H., "Power Electronics – Circuits Devices and Applications", 3rd Edition, Pearson, 2011.
3. D M Mitchel, "DC-DC Switching Regulator Analysis" McGraw-Hill Ltd, 1988.
4. Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", Wiley Eastern Publication, 2009.
5. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, Wiley India Pvt Ltd, 2010.

12EPE23 POWER ELECTRONICS SYSTEM DESIGN USING ICs

Subject Code	12EPE23	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Measurement techniques for voltages, current, power, power factor in power electronic circuits, other recording and analysis of waveforms, sensing of speed.

Switching Regulator Control Circuits : Introduction, isolation techniques of switching regulator systems, PWM systems.

Commercial PWM Control ICs and their Applications: TL 494 PWM Control IC, UC 1840 Programmable off line PWM controller, UC 1524 PWM control IC, UC 1846 current mode control IC, UC 1852 resonant mode power supply controller.

Switching Power Supply Ancillary, Supervisory & Peripheral Circuits and Components: Introduction, Opto-couplers, self-biased techniques used in primary side of reference power supplies, Soft/Start in switching power supplies, current limit circuits, over voltage protection, AC line loss detection.

Phase – Locked Loops (PLL) & Applications: PLL Design using ICs, 555 timer & its applications, analog to digital converter using IC's, digital to analog converters using ICs, implementation of different gating circuits.

Programmable Logic Controllers (PLC): Basic configuration of a PLC, Programming and PLC, program modification, power converter control using PLCs.

REFERENCE BOOKS

1. G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, "Thyristorised Power Controllers", 2nd Edition, New Age International, 2010.
2. Chryssis "High Frequency Switching Power Supplies", 2nd Edition, MGH, 1989.
3. Unitrode application notes: http://www.smps.us/Unitrode.html

12EPE24 HVDC POWER TRANSMISSION

Subject Code	12EPE24	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

DC Power Transmission Technology: General aspects of DC transmission, comparison with AC transmission, application, advantages and disadvantages of DC transmission, description of DC transmission systems, modern trends in DC transmission.

Analysis of HVDC Converters: Effects of source inductance, equivalent circuits and characteristics of 6 pulse and 12 pulse converters.
Control and Protection Methods: DC link control principles, converter control characteristics, firing angle control, fault development and protection schemes, DC reactor and its design consideration, DC breakers.

Harmonics: Generation of harmonics, design of AC filters and DC filters, reactive power control – discussion on control strategies under steady state and transient state and sources of reactive power in HVDC systems, static VAR systems.

Multi Terminal DC Systems: Introduction, potential applications, types, control and protection.
Models for Analysis of AC-DC Systems: Converter models, converter control model, modeling of DC and AC networks.

Power Flow Analysis in AC/DC Systems: Modeling of DC links, solution of DC load flow, per unit system for DC quantities, solution of AC-DC power flow.

REFERENCE BOOKS

1. K. R. Padiyar, "HVDC Power Transmission Systems: Technology and System Interactions", 2nd Edition, New Age International, 2012.
2. E.W.Kimbark "Direct Current Transmission", Vol.1, Wiley Inter-Science, London, 2006.
3. Arrilaga, "High Voltage Direct Current Transmission", 2nd Edition, The Institute of Engineering and Technology, 2007.
4. S Kamakshaiah and V Kamaraju, "HVDC Transmission", TMH, 2011.

ELECTIVE-II

12EPE251 REAL-TIME DIGITAL SIGNAL PROCESSING

Subject Code	12EPE251	IA Marks	50
No. of LectureHours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Digital Signal Processing Fundamentals: Review of DSP fundamentals ; FIR filter design by windowing; adaptive filtering techniques, Fourier analysis of signal using FFT, introduction to real time DSP and Motorola DS5630X, architecture, instruction set, addressing modes; simple 5630X program, real time digital FIR filter, real time LMS adaptive filters, real time frequency domain processing.

REFERENCE BOOKS

1. Oppenheim and Schafer, "Digital Signal Processing", Prentice Hall, 2011.
2. Philip L Se Leon, "Real Time Digital Signal Processing using the Motorola DSP S63OXEVM", 2002.
3. J G Proakis ,Dimitris G Monolikis, "Digital Signal Processing: Principles, Algorithms and Applications" Pearson Education, 4th Edition, 2012.
4. Samuel Stearns, "Digital Signal Processing with Examples in MATLAB", CRC Press, 2011.

12EPE252 ADVANCED CONTROL SYSTEMS

Subject Code	12EPE252	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Digital Control Systems: Review of difference equations and Z - transforms, Z- transfer function (Pulse transfer function), Z - Transforms analysis, sampled data systems, stability analysis (Jury's Stability Test and Bilinear Transformation), pulse transfer functions and different configurations for closed loop discrete-time control systems.

Modern Control Theory: State model for continuous time and discrete time systems, solutions of state equations (for both continuous and discrete systems), concepts of controllability and observability (for both continuous and discrete systems), pole placement by state feedback (for both continuous and discrete systems), full order and reduced order observes (for both continuous and discrete systems), dead beat control by state feedback, optimal control problems using state variable approach, state regulator and output regulator, concepts of model reference control systems, adaptive control systems and design.

Non Linear Control Systems: Common nonlinearities, singular points, stability of nonlinear systems - phase plane analysis and describing function analysis, Lyapunov's stability criterion, Popov's criterion.

REFERENCE BOOKS

1. Ogata. K. "Modern Control Engineering", 5th Edition, PHI, 2010.
2. Ogata K "Discrete Time Control Systems", 2nd Edition, PHI, 2011.
3. Nagarath and Gopal, "Control Systems Engineering", New Age International Publishers, 2012.
4. M Gopal "Modem Control System Theory", New Age International,2011.
5. M. Gopal, "Digital Control & State Variable Methods", TMH, 2011.

12EPE253 ELECTROMAGNETIC COMPATIBILITY

Subject Code	12EPE253	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Review of EMI Theory: Sources of EMI, noise pick up modes and reduction techniques for analog circuits.

Emissions and Reduction Techniques: Use of co-axial cables and shielding of signal lines, conducted and radiated noise emission in power electronic equipment and reduction techniques, EMI induced failure mechanisms for power electronic equipment, EMC in design of digital circuits.

Electrostatic Discharge: ESD and switching interference reduction, susceptibility aspects of power electronic and digital equipment, shielding of electronic equipment.

EMC Standards and Test Equipments.

REFERENCE BOOKS

1. Otto H. W., "Noise Reduction Techniques in Electronic Systems", 2nd Edition, John Wiley and Sons, 1988.
2. Paul Clayton, "Introduction to Electromagnetic Compatibility", 2nd Edition, Wiley Interscience, 2006.
3. William B. Greason, "Electrostatic Damage in Electronics: Devices and Systems", John Wiley and Sons, 1986.
4. Joseph Di Giacomo, "Digital Bus Hand Book", McGraw Hill Publishing Company, 1990.
5. White, R. J., "Handbook Series of Electromagnetic Interference and Compatibility", Don White consultants Inc. 1981.

M.TECH. POWER ELECTRONICS (EPE)
III SEMESTER

12EPE31 POWER ELECTRONICS IN SMART GRID

Subject Code	12EPE31	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Introduction to smart grid, electricity network, local energy networks, electric transportation, low carbon central generation, fundamental problems of electrical power systems, power flow control, distributed generation and energy storage, attributes of the smart grid, alternate views of a smart grid.

Power Control and Quality Problems: Introduction, general problems and solutions of power control, power quality and EMC, power quality issues, monitoring, legal and organizational regulations, mitigation methods, and EMC related phenomena in smart system, EMC cases in distributed power system.

High frequency AC Power Distribution Platform: Introduction, high frequency in space applications, telecommunications, computer and commercial electronics systems, automotive and motor drives, micro grids.

Integration of Distributed Generation with Power System: Distributed generation past and future, interconnection with a hosting grid, integration and interconnection concerns, power injection principle, injection using static compensators and advanced static devices, distributed generation contribution to power quality problems and current challenges.

Active Power Controllers: Dynamic static synchronous controllers, D – STATCOM, Dynamic static synchronous series controllers, dynamic voltage restorer, AC/AC voltage regulators.

Energy Storage Systems: Introduction, structure of power storage devices, pumped – storage hydroelectricity, compressed air energy storage system, flywheels, battery storage, hydrogen storage, super conducting magnet energy storage, super capacitors, applications of energy storage devices.

REFERRENCE BOOKS

1. Strzelecki Benysek, "Power Electronics in Smart Electrical Energy Networks", Springer, 2008.
2. Clark W Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Side Response", CRC Press, 2009.

ELECTIVES - III

12EPE321 CMOS VLSI DESIGN

Subject Code	12EPE321	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Review of MOS Circuits: MOS and CMOS static plots, switches, comparison between CMOS and BI - CMOS.

MESFETS: MESFET and MOSFET operations, quantitative description of MESFETS.

MIS Structures and MOSFETS: MIS systems in equilibrium, under bias, small signal operation of MESFETS and MOSFETS.

Short Channel Effects and Challenges to CMOS: Short channel effects, scaling theory, processing challenges to further CMOS miniaturization.

Beyond CMOS: Evolutionary advances beyond CMOS, carbon nano tubes, conventional vs. tactile computing, computing, molecular and biological computing, mole electronics-molecular diode and diode- diode logic ,effect tolerant computing,

Super Buffers, Bi-CMOS and Steering Logic: Introduction, RC delay lines, super buffers- an NMOS super buffer, tri-state super buffer and pad drivers, CMOS super buffers, dynamic ratio less inverters, large capacitive loads, pass logic, designing of transistor logic, general functional blocks - NMOS and CMOS functional blocks.

Special Cirit Layouts and Technology Mapping: Introduction, Talley circuits, NAND-NAND, NOR- NOR, and AOI Logic, NMOS, CMOS multiplexers, barrel shifter, wire routing and module lay out.

System Design: CMOS design methods, structured design methods, strategies encompassing hierarchy, regularity, modularity & locality, CMOS Chip design options, programmable logic, programmable inter connect, programmable structure, gate arrays standard cell approach, full custom design.

REFERENCE BOOKS

1. Kevin F Brennan "Introduction to Semi-Conductor Device", Cambridge Publications, 2005.
2. Eugene D Fabricius "Introduction to VLSI Design", MGH, 1990.
3. D.A Pucknell "Basic VLSI Design", 3rd Edition, PHI Publication, 2010.
4. Wayne Wolf, "Modern VLSI Design", 4th Edition, PHI, 2010.

12EPE322 POWER SUPPLY SYSTEMS

Subject Code	12EPE322	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Review: Linear Regulators, control of inverter and converter with special C modules, transformer design by calculation and by monographs.

Switching Type Power Supplies: Theory, noise consideration, switching of AC and DC voltages, voltage references and comparators – switching type regulator.

SMPS- Characteristics – steady state analysis control.

Methods: Design of feedback compression.

UPS: Necessity, types, typical layouts of UPS, stand alone high quality electronics power supplies.

REFERENCE BOOKS

1. Irving M.Gottilieb "Power Supplies, Switching Regulators, Inverters and Converters" BPB Publications,2008.
2. PRK Chetty "Switched Power Supply Design" BPB Publication,2008.
3. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition. Wiley India Pvt Ltd, 2011.
4. UPS Design Guide, International Rectifier.

12EPE323 PWM CONVERTERS AND APPLICATIONS

Subject Code	12EPE323	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

AC/DC and DC/AC Power Conversion: Overview of applications of voltage source converters.

PWM Techniques: Pulse modulation techniques for I – phase bridges, bus clamping PWM, space vector based PWM, advanced PWM techniques.

Loss Calculations : Practical devices in converters, calculation of switching and conduction losses, compensation for dead time and DC voltage regulation.

Modeling: Dynamic model of PWM converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives.

Converters with Compensation: Line-side converters with power factor compensation, reactive power compensation, harmonic current compensation.

REFERENCE BOOKS

1. Mohan, Undeland and Robbins, "Power Electronics: Converter, Applications and Design", Wiley India, 2011.
2. Erickson RW, "Fundamentals of Power Electronics", Chapman Hall, 1997.
3. Joseph Vithyathil, "Power Electronics- Principles and Applications", TMH, 2011.

ELECTIVE-IV

12EPE331 POWER QUALITY ISSUES AND MITIGATION

Subject Code	12EPE331	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Introduction to power quality, overview of power quality phenomena, power quality and EMC standard.

Long Interruptions and Reliability Evaluation: Introduction, observation of system performance, standards and regulations, overview of reliability evaluation, reliability evaluation techniques, cost of interruptions, comparison of observation and reliability evaluation, examples.

Short Interruptions: Introduction, terminology, origin of short interruptions, monitoring of short interruptions, influence on equipment, single phase tripping, stochastic prediction of short interruptions.

Voltage Sags - Characterization: Introduction, voltage sag magnitude, voltage sag duration, three phase unbalance, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, other characteristic of voltage sags, load influence on voltage sags, sag due starting of induction motors.

Voltage Sags – Equipment Behavior: Introduction, computers and consumer electronics, adjustable speed AC drives, adjustable speed DC drives, other sensitive load.

Voltage Sags – Stochastic Assessment: Compatibility between equipment and supply, voltage sag coordination chart**,** power quality monitoring, method of fault positions, method of critical distances.

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods, power system design – redundancy through switching and parallel operation, system equipment interface.

REFERRENCE BOOKS

1. Math H J Bollen, “Understanding Power Quality Problems; Voltage Sags and Interruptions”, Wiley India, 2011.
2. Roger C Dugan, et.al, “Electrical Power Systems Quality”, 3^{rd} Edition, TMH, 2012.
3. G T Heydt, “Electric Power Quality”, Stars in Circle Publications, 1991.
4. Ewald F Fuchs, et.el, “Power Quality in Power System and Electrical Machines”, Academic Press, Elsevier, 2009.

12EPE332 FACTS CONTROLLERS

Subject Code	12EPE332	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Basics of power transmission networks - control of power flow in AC - transmission line- flexible AC transmission system controllers – application of FACTS controllers in distribution systems.

AC Transmission Line and Reactive Power Compensation: Analysis of uncompensated AC Line - passive reactive power compensation - compensation by a series capacitor connected at the midpoint of the line - shunt compensation connected at the midpoint of the line - comparison between series and shunt capacitor - compensation by STATCOM and SSSC - some representative examples.

Static Var Compensator: Analysis of SVC - Configuration of SVC- SVC Controller – voltage regulator design - some issues - harmonics and filtering - protection aspects – modeling of SVC – applications of SVC.

Thyristor and GTO Controlled Series Capacitor: Introduction - basic concepts of controlled series compensation -operation of TCSC - analysis of TCSC- control of TCSC - modeling of TCSC for stability studies - GTO thyristor controlled series capacitor (GCSC) - mitigation of sub synchronous resonance with TCSC and GCSC - applications of TCSC.

Static Phase Shifting Transformer: General - basic principle of a PST - configurations of SPST improvement of transient stability using SPST - damping of low frequency power oscillations - applications of SPST.

Static Synchronous Compensator (STATCOM): Introduction - principle of operation of STATCOM - a simplified analysis of a three phase six pulse STATCOM - analysis of a six pulse VSC using switching functions - multi-pulse converters control of type 2 converters - control of type I Converters - multilevel voltage source converters - harmonic transfer and resonance in VSC, applications of STATCOM.

REFERENCE BOOKS

1. K.R Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International, 2007.
2. Narain G Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems”, Wiley India,2011.
3. Y. H. Song and A. T. Johns, “Flexible AC Transmission System”, Institution of Engineering and Technology, 2009.

12EPE333 DSP APPLICATIONS TO DRIVES

Subject Code	12EPE333	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: To the TMS320LF2407 DSP Controller, C2xx DSP CPU architecture and instruction set.

General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407, Analog-to-Digital Converter (ADC), event managers (EVA, EVB).

DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors, DSP-Based control of permanent magnet brushless DC machines, Park and Clarke's transformations.

Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines.

DSP-based vector control of induction motors.

REFERENCE BOOKS

1. Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control", CRC Press, 2011.
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive Systems", 2nd Edition, Wiley India,2010
3. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery using Matlab / Simulink", Prentice Hall,1998.

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