SCHEME OF TEACHING AND EXAMINATION

M.TECH. POWER ELECTRONICS (EPE)

I SEMESTER

Subject Code	Name of the Subject	Teaching hours/week			Duration of Exam in Hours	Marks for			Total Marks
						Internal Assessment			
		Lecture	Practical	Field Work / Tutorial		Test	Practical/ Field Work / Tutorial	Exam	
10EPE11	Applied Mathematics	4	--	2	3	30	20	100	150
10EPE12	Power Semi Conductor Devices	4	--	2	3	30	20	100	150
10EPE 13	Digital Measurements	4	2	--	3	30	20	100	150
10EPE14	Solid State Power Controllers	4	2	--	3	30	20	100	150
10EPE15X	Elective-I	4	--	2	3	30	20	100	150
10EPES16	Seminar-I	--	--	3	--	Topic Content-25 Presentation-25		--	50
Total		**20**	**04**	**09**	**15**	**300**		**500**	**800**

Note: The internal assessment marks for core subjects with two hours of practical is 30 marks for theory and 20 marks for practical.

Elective – I	
10EPE151	Embedded system design
10EPE152	Soft Computing
10EPE153	Electrical Machine Dynamics

SCHEME OF TEACHING AND EXAMINATION
M.TECH. POWER ELECTRONICS (EPE)

II SEMESTER

Subject Code	Name of the Subject	Teaching hours/week			Duration of Exam in Hours	Marks for			Total Marks
						Internal Assessment		Exam	
		Lecture	Practical	Field Work / Tutorial		Test	Practical/ Field Work / Tutorial		
10EPE21	AC-DC Drives	4	2	--	3	30	20	100	150
10EPE22	Switched Mode Power Conversion	4	2		3	30	20	100	150
10EPE23	Power Electronics System Design using ICs	4	--	2	3	30	20	100	150
10EPE24	HVDC Power Transmission	4	--	2	3	30	20	100	150
10EPE25X	Elective-II	4	--	2	3	30	20	100	150
10EPEP11	Project Phase-I	6 Weeks Duration and to be Carried out during the intermediate period of II semester and III semester after availing a vacation of 2 weeks						--	--
10EPES26	Seminar - II	--	--	3	--	Topic Content-25 Presentation-25		--	50
Total		**20**	**04**	**09**	**15**	**300**		**500**	**800**

Note: The internal assessment marks for core subjects with two hours of practical is 30 marks for theory and 20 marks for practical.

Elective – II	
10EPE251	Real Time Digital Signal Processing
10EPE252	Advanced Control Systems
10EPE253	Electro Magnetic Compatibility

SCHEME OF TEACHING AND EXAMINATION
M.TECH. POWER ELECTRONICS (EPE)

III SEMESTER

Subject Code	Subject	No. of Hrs./Week			Duration of Exam in Hours	Marks for			
						Internal Assessment		Exam	Total Marks
		Lecture	Practical	Field Work / Tutorial		Test	Practical/ Field Work / Tutorial		
10EPE31	Advanced Topics on Power Electronic Systems	4	–	–	3	30	20	100	150
10EPE32X	Elective-III	4	–	–	3	30	20	100	150
10EPE33X	Elective-IV	4	–	–	3	30	20	100	150
10EPEP22	Project Phase-II	3 days of project work per week for 5 weeks during the academic semester.				--		--	--
10EPE34	Evaluation of Project Phase – I	–	–	3	–	Evaluation of content of project phase-1 -25 Presentation-25		–	50
Total		**12**	**–**	**03**	**09**	**200**		**300**	**500**

Note: Course work is for three days per week.

Elective – III		Elective – IV	
10EPE321	CMOS VLSI Design	10EPE331	Real Time Embedded Systems
10EPE322	Power Supply Systems	10EPE332	FACTs Controllers
10EPE323	Modeling and Simulation of Power Electronic Systems	10EPE333	DSP Applications to Power Electronics

SCHEME OF TEACHING AND EXAMINATION

M.TECH. POWER ELECTRONICS (EPE)

IV SEMESTER

Course Code	Subject	No. of Hrs./Week		Duration of the Exam in Hours	Marks for		Total Marks
		Lecture	Practical / Field Work		I.A.	Exam	
10EPEP41	Evaluation of Project Phase – II	-	3	-	Evaluation of content of project phase-2 -25 Presentation-25	-	50
10EPEP42	Project Phase – III	-	3	-	Evaluation of content of project phase-3 -25 Presentation-25	-	50
10EPEP43	Project work evaluation and Viva-voce	-	-	3	–	100+100	200
Total		**-**	**06**	**03**	**100**	**200**	**300**
Grand Total (I to IV Sem.): 2400							

M.TECH. POWER ELECTRONICS (EPE)
I SEMESTER

10EPE11APPLIED MATHEMATICS

Subject Code	**10EPE11**	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,Given method.
Interpolation: Hermite Interpolation, Spline interpolation, Numerical solution of differential equations – Numerov method.

Integer arithmetic: Eucledian algorithm, the Diaphantine equation, Linear congruence, Fermats little theorem, Euler's Phi- function – properties, Euler's theorem.
Optimization: Linear programming- Formulation of the problem, Graphical method, General linear programming problem, simplex method, Artificial variable techinique -M-method.

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.

REFERENCES:
M K Jain, S R K Iyengar and R K Jain, Numerical methods for Scientific and Engineering Computations, 2003, New Age International.
M K Jain, Numerical Solution of Differential equations, 2nd Edition, Wiley Eastern.
Dr, B.S. Grewal, Numerical methods in Engineering and Science, Khanna Publishers.
David M Burton, Elementary Number Theory, 6th Edition, 2006. Tata McGrawHill publications,
Dr, B.S. Grewal, Higher Engineering Mathematics, 40th Edition, Khanna Publishers.
Linear Algebra, Kenneth Hoffman and Ray Knuze, 2nd Edition, Prentice Hall India.

10EPE12 POWER SEMICONDUCTOR DEVICES

Subject Code	**10EPE12**	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 I-V 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 Snubbers. 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. Ratings of Thyristors. Snubber Requirements and Snubber Design. Modelling and simulation of Thyristors.
Triacs: Basic Structure and operation. V-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. Maximum Controllable Anode Current, Overcurrent protection of GTOs, Modelling and simulation of GTOs.
Power BJTs: Basic Structure and I-V Characteristics. Breakdown Voltages and Control. Second Breakdown and its 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 BJTs and Snubber Design - Switching Aids. Modeling and simulation of Power BJTs. Power MOSFETs - 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 MOSFETs. FBSOA and RBSOA Curves. Device Protection -Snubber Requirements. Modelling and simulation of Power MOSFETS.
Insulated Gate Bipolar Transistors (IGBTs): 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 - Ratings of MOSFETs. FBSOA and RBSOA Curves. Switching Losses - Minimum ON and OFF State times - Switching Frequency Capability - Overcurrent protection of IGBTs. Short Circuit Protection. Snubber Requirements and Snubber Design.

New power semiconductor devices : MOS Gated Thyristors,MOS Controlled Thyristors or MOS GTOs, 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:

Ned Mohan Tore.M. Undeland and William.P Robbins, "**Power Electronics converters", Applications and Design**", John Wiley and Sons, 3rd Edition, 2002.
G. Massobrio, P. Antognetti, "**Semiconductor Device Modeling with Spice**", McGraw-Hill, 2nd Edition, 1998.
B. Jayant Baliga, "**Power Semiconductor Devices**", PWS Publication, 1st Edition, 1995.
V. Benda, J. Gowar, and D. A. Grant, "**Discrete and Integrated Power Semiconductor Devices:Theory and Applications**", John Wiley & Sons, 1999.

10EPE13 DIGITAL MEASUREMENTS

Subject Code	**10EPE13**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Philosophy of digital and microprocessor/microcontroller based instruments

Time measurement techniques: measurement of time interval between events, order of events, vernier technique, very low time, period, phase time constant, capacitance measurements, decibel meter.

Frequency measurement techniques: frequency ratio and product, high and low frequency measurements, deviation meter, tachometer, peak/valley recorder

Programmable circuits,: programmable resistors, amplifiers, filters.

DACs: programmable amplifier as DACs, multistage WRDACs, weighted current, weighted reference voltage, weighted charge, DACs, ladder DACs, design of DACs with respect to spread and total resistance, hybrid multiplier and divider

Voltage measurement techniques: V/f and V/f converters, direct type ADC, ramp, tracking, dual slope, successive approximation and flash type, multistage flash type ADCs, DVM and its design.

Sample based measurement of current, voltage, power and energy.

REFERENCE BOOKS:

Rathore, T.S., "**Digital Measurement Techniques**", Narosa Publishing House, 2003.
Sonde., B.S., "**Monographs on System Design Using Integrated Circuits**", Tata McGraw Hill, 1974

10EPE14 SOLID STATE POWER CONTROLLERS

Subject Code	**10EPE14**	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:

Ned Mohan, Tore. M. Undeland and William. P Robbins, "**Power Electronics: Converters, Applications and Design**", John Wiley and Sons, 3rd Eidition, 2002.
Rashid M.H., "**Power Electronics – Circuits Devices and Applications**, Prentice Hall India, 3rd Edition, 2005.
B. K. Bose, "**Modern Power Electronics & AC Drives**", Pearson Education, Asia, 2002

ELECTIVES-1

10EPE151 EMBEDDED SYSTEM DESIGN

Subject Code	**10EPE151**	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, soft ware 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.

Micro chip PIC Microcontroller: Introduction to 16Fxx controller, CPU Architecture, Addressing modes, Instruction set, Assembly level programming, Timers, Interrupts, ADC, UART, DAC using PWM,I^2C Bus for Peripheral Chip Access,

REFERENCE BOOKS:

Rajkamal "**Embedded System Architecture: Programming & Design"**, TMH Edition, 2007.
John B. Peatman "**Design with PIC Microcontrollers**", Prentice Hall, 1997.
J. W. Valvano " **Embedded Microcomputer System: Real time interfacing**", Cengage-Engineering, 1st Edition, 2000.
Jane W.S. Liu, "**Real Time Systems**", Prentice Hall, 2000.

10EPE152 SOFT COMPUTING

Subject Code	**10EPE152**	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:

Vojislav Kecman, "**Learning and Soft Computing**," Pearson Education (Asia) Pte. Ltd. 2004.
Simon Haykin, "**Neural Networks: A Comprehensive Foundation**," Pearson Education (Asia) Pte. Ltd./Prentice Hall of India, 2003.
M.T. Hagan, H.B. Demuth and M. Beale, "**Neural Network Design**," Thomson Learning, 2002.
Bart Kosko, "**Neural Networks and Fuzzy Systems**," Prentice Hall of India, 2005.
George J. Klir and Bo Yuan, "**Fuzzy Sets and Fuzzy Logic: Theory and Application**," Prentice Hall of India, 2001

10EPE153 ELECTRICAL MACHINE DYNAMICS

Subject Code	**10EPE153**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Dynamic Equation of Motion: Electro mechanical systems-Analytical techniques, Transducers-physical systems, Fundamentals of systems dynamics.
Lagrange's Equations: Applications of Lagrange's equation to electro mechanical system, Solution of electro dynamical equations, Euler's method, Runge-Kutta method.

Generalized Machine Concepts: KRON's machine, performance equation, dynamic variables, machines with uniform gap, machines with Saliency.

Dynamics of Machines: Commutator machines-induction machines-synchronous machines-small oscillations-synchronous machine equation during small oscillations, general equations for small oscillations, representation of the oscillation equations in state variable form. Generalized analysis of N-M winding machines

REFERENCE BOOKS:

Adkins "**Generalized Theory of Machines**".
D.P.Sen Gupta and J.W.Lynn "**Generalized Theory of Machines**".
Seely "**Electro Mechanical Energy Conversion**".
P. C. Krause, "**Analysis of Electrical Machines**", MGH, 1987.
P. C. Krause, Oleg Wasynesuk, Scolt D Sudhoff, "**Analysis of Electrical Machinery and Drive System**", MGH, 2nd Edition, 2002.

M.TECH. POWER ELECTRONICS (EPE)
II SEMESTER

10EPE21 AC-DC DRIVES

Subject Code	**10EPE21**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

DC Drives: Single quadrant, two quadrant, two quadrant and four quadrant drives, closed loop control of DC drives.

AC Drives: Voltage and current source invertors, Inverter control, six step and PWM Operation, v/f, field oriented control for induction motor, voltage source, current source and slip energy recovery drives, closed loop control of AC drives, Brushless DC motor, stepper motor and variable reluctance motor drives, static excitation schemes of AC generator.

REFERENCE BOOKS:

Bose B. K, "**Modern Power Electronics & AC Drives**" IEEE press 1998
Murphy JMD, Turnbull F.G., '**Thyristor Control of AC Motors**" Pergamon Press Oxford, 1998.

10EPE22 SWITCHED MODE POWER CONVERSION

Subject Code	**10EPE22**	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): Principle of operation and analysis of Buck, Boost, Buck-Boost converter for continuous and discontinuous current mode.

Derived converters: Principle of operation and analysis of Forward, Flyback, Pushpull, Half bridge, Full bridge converters, cuk converters.

Control of DC-DC Converter: Modeling of DC-DC converters using state space averaging, current mode control.

Resonant converters: Introduction, classification, Basic Resonant circuit concepts, Resonant switch converters, Zero voltage switching, clamped voltage topologies, Resonant DC link converters, high frequency link integral half cycle converters, Design of inductor and transformers for SMPC.

REFERENCE BOOKS:

D M Mitchel DC-DC Switching Regulator Analysis McGraw-Hill Ltd, 1987
Umanand L and Bhatt S R, Design of Magnetic components for Switched Mode Power Converters, Wiley Eastern Publication.

10EPE23 POWER ELECTRONICS SYSTEM DESIGN USING ICs

Subject Code	**10EPE23**	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, Some commercially available 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, Optocouplers, 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 ICs, 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:

G. K. Dubey, S. R. Doradla, A. Johsi, and R. M. K. Sinha, "**Thyristorised Power Controllers**", New Age International, 1st Edition, 2004.
George Chryssis "**High Frequency Switching Power Supplies**", MGH, 2nd Edition,
Unitrode application notes: http://www.smps.us/Unitrode.html

10EPE24 HVDC POWER TRANSMISSION

Subject Code	**10EPE24**	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: Modelling of DC links,Solution of DC load flow, Per Unit system for DC quantities,Solution of AC-DC powerflow.

REFERENCE BOOKS:

K. R. Padiyar, "**HVDC Power Transmission Systems: Technology and System Interactions**", New age International, 1st Edition, 2008.
E. W. Kimbark, "**Direct Current Transmission",** Vol. I, Wiley Future Science, 1971.
Arrilaga, "**High Voltage Direct Current Transmission",** The Institute of Engineering and Technology, 2nd Edition, 2007.

ELECTIVE-II

10EPE251 REAL-TIME DIGITAL SIGNAL PROCESSING

Subject Code	**10EPE251**	IA Marks	50
No. of Lecture Hours/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 adoptive filers; Real time frequency domain processing

REFERENCE BOOKS:

Oppenheim and Schafer, "**Digital Signal Processing**", Prentice Hall, 1975.
Philip L Se Leon, "**Real Time Digital signal processing using the Motorola DSP S63OXEVM**", 2002.
Proakis J, "**Digital Signal Processing**", Prentice Hall 1996.
Samuel Stearns, "**Digital Signal Processing with examples in MATLAB**", CRC Press, 2001

10EPE252 ADVANCED CONTROL SYSTEMS

Subject Code	**10EPE252**	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: I 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:

Ogata. K. "**Modern Control Engineering**", PHI, 4th Edition.
Ogata K "**Discrete time Control Systems**", PHI, 2nd Edition.
Nagarath and Gopal, "**Control Systems Engineering**", Wiley Eastern Ltd.
M Gopal "**Modem Control System Theory**"; Wiley Eastern Ltd.
M. Gopal, "**Digital Control & State Variable Methods**", TMH, 2006.

10EPE253 ELECTROMAGNETIC COMPATIBILITY

Subject Code	**10EPE253**	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; 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; ESD and switching interference reduction; Susceptibility aspects of power electronic and digital equipment; Shielding of electronic equipment; EMC standards and test equipment.

REFERENCE BOOKS:

Otto H. W., "**Noise Reduction Techniques in Electronic Systems**", 2nd Edition, 1985.
William B. Greason, "**Electrostatic Damage in Electronics: Devices and Systems**", John Wiley and Sons, 1986.
Joseph Di Giacomo, **"Digital Bus Hand Book**", McGraw Hill Publishing Company, 1990.
White, R. J. "**Handbook series of Electromagnetic Interference and Compatibility**", Don White consultants Inc. 1980.

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III SEMESTER

10EPE31 ADVANCED TOPICS ON POWER ELECTRONICS SYSTEMS

Subject Code	**10EPE31**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Pulse width modulation for Electronic Power converters: Introduction, DC-AC power conversion, introduction to space vector, performance criteria, open loop scheme multilevel converter.

Microprocessors & Digital ICs for Control of Power Electronics and Drives: Introduction, Microcomputer control of Power Electronic Systems, Real time control using microcomputers, microcontrollers, advanced microprocessor for control of Power Electronic Systems, ASICS for control of Power Electronic Systems.

Design of Micro-processor Based control System, Development tools Applications: Digital control of permanent magnet synchronous motor drive for Electric vehicle propulsion.

REFERENCES:

Bimal K.Bose, "**Power Electronics & Variable Frequency Drives",** IEEE Press, 2000, Standard Publishers and Distributor, Delhi.
Bimal K.Bose, "**Microcomputer Control of Electric Drives (Part I)",** IEEE Press, 1987.

ELECTIVES-III

10EPE321 CMOS VLSI DESIGN

Subject Code	**10EPE321**	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 MODFET 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 .Defect 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 circuit 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:

Kevin F Brrnnan "**Introduction to Semi Conductor Device**", Cambridge publications, 2005.
Eugene D Fabricius "**Introduction to VLSI Design**", MGH, 1990,
D.A Pucknell "**Basic VLSI Design**", 3rd Edition, PHI Publication, 1994.
Wayne Wolf, "**Modern VLSI Design**" Pearson Education, 2nd Edition , 2002.

10EPE322 POWER SUPPLY SYSTEMS

Subject Code	**10EPE322**	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 suppliers: 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 feed back compression

UPS: Necessity types typical layouts of UPS. Stand alone High quality Electronics Power Supplies

REFERENCE BOOKS:

Irving M.Gottilieb "Power supplies, Switching Regulators, Inverters and Converters" BPB Publications - 1985
PRK Chetty "Switched Power Supply Design" BPB Publication- 1987
Ned Mohan "Power Electronics Converters, Applications and Design" John Wiley & Sons.
Pressman, " High Frequency Power Supplies" McGraw Hill
UPS Design Guide, International Rectifier

10EPE323 MODELLING AND SIMULATION OF POWER ELECTRONIC SYSTEMS

Subject Code	**10EPE323**	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. Solution techniques for time-domain analysis:
Linear differential equations, trapezoidal method of integration, nonlinear differential equations, Widely used circuit oriented simulators, equation solvers.
Modeling of power electronic system components:
a)DC to DC converters: Steady-state equivalent circuit modeling, Losses and efficiency: DC transformer model, Inclusion of Inductor copper loss, Construction of Equivalent Circuit model.
b) Mathematical model of a single phase diode-bridge rectifier with a filter capacitor.
c)Simulation models for single phase and three phase PWM inverters, DC motor, Induction motor.
System level modeling, analysis, design of electrical machines:
Phase controlled Dc Motor Drives, Chopper-Controlled Dc Motor drive. Phase controlled Induction motor drive. Frequency controlled Induction motor drives.

REFERENCE BOOKS:
Ned Mohan, Tore M. Undeland, William P. Robbins, "**Power Electronics Converters, Applications, and Design**", Third Edition., John Wiley & Sons, 2009.

Robert W. Erickson, Dragan Maksimovic, "**Fundamentals of Power Electronics",** Third Edition, Kluwer Academic Publishers

R.Krishnan, **Electric Motor Drives: Modeling, Analysis and Control**, PHI Eastern Economy Edition, 2009.

10EPE331 REAL TIME EMBEDDED SYSTEMS

Subject Code	**10EPE331**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Real Time System, Types, Real Time Computing, Design Issue, Sample Systems, Hardware Requirements- Processor in a system, System Memories, System I/O, Other Hardware Devices (A/D, D/A, USART, Watchdog Timers, Interrupt Controllers). Device Drivers, Interrupt Servicing Mechanism & Interrupt Latency.

Embedded Systems: Introduction, Various System Architecture for Embedded System, High Performance Processors - Strong ARM processors, Programming, Interrupt Structure, I/O architecture.
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.

Memory and File management: Pipelining and Cache Memories, Paging and Segmentation, Fragmentation, Address Translation.

Case Study: Introduction to VX Works/Mucos/pSOS; Example systems.

Development and Verification of Real Time Software: Building Real Time applications; Considerations such as double buffing.

REFERENCE BOOKS:

David E. Simon, "**An Embedded Software Primer**", Pearson Education, 1999.
Philip. A. Laplante, "**Real-Time Systems Design and Analysis- An Engineer's Handbook**"- Second Edition, PHI Publications.
Jane W.S. Liu, "**Real-Time Systems**", Pearson Education Inc., 2000.
Rajkamal, "**Embedded Systems: Architecture, Programming and Design**", Tata McGraw Hill, New Delhi, 2003.
Dr. K.V.K K Prasad, **"Embedded Real Time Systems: Concepts Design and Programming**", Dreamtech Press New Delhi, 2003.
David A. Evesham, "**Developing real time systems – A practical introduction**", Galgotia Publications, 1990

10EPE332 FACTS CONTROLLERS

Subject Code	**10EPE332**	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 1 Converters - Multilevel Voltage Source Converters - Harmonic Transfer and Resonance in VSC Applications of STATCOM

REFERENCE BOOKS:

K.R Padiyar**, "FACTS Controllers in power transmission and distribution",** New Age International, 2007.
Narain G Hingorani and L. Gyugyi, "**Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems**", Standard Publishers, New-Delhi.
Y. H. Song and A. T. Johns, **"Flexible AC Transmission System",** Institution of Engineering and Technology, 2009

10EPE333 DSP APPLICATIONS TO POWER ELECTRONICS

Subject Code	**10EPE333**	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:

Hamid Toliyat and Steven Campbell, **"DSP-Based Electromechanical Motion Control"**, CRC Press, 2004.

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