DEPARTMENT OF ELECTRICAL ENGINEERING
AU COLLEGE OF ENGINEERING (A), ANDHRA UNIVERSITY, VISAKHAPATNAM-530003, A.P.

M.Tech. (POWER ELCTRONIC DRIVES AND CONTROL)

SCHEME OF INSTRUCTION AND EXAMINATION (2015 Admitted batch onwards)
Under Choice Based Credit System

I-Year

Semester – I:

Subject Code	Subject Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Duration of Exam. (Hrs)	Theory/Lab/Viva	Sess.		
EPE 1.1	Optimization Techniques	4	--	4	3	70	30	100	4
EPE 1.2	Power Semiconductor Devices and Controllers	4	--	4	4	70	30	100	4
EPE 1.3	Power Electronic Control of DC Drives	4	--	4	4	70	30	100	4
EPE 1.4	Advanced Control System Design	4	--	4	4	70	30	100	4
EPE 1.5	Elective-I a)HVDC Transmission b) Power Electronics for Renewable Energy Systems c) Embedded Control of Electrical Drives	4	--	4	3	70	30	100	4
EPE 1.6	Power Electronics Drives Lab-I	--	3	3	Viva-Voce	50	50	100	2
EPE 1.7	Seminar -I	--	3	3	Viva-Voce	50	50	100	2
	Total	20	6	26		450	250	700	24

Semester –I I:

Subject Code	Subject Title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec.	Tut.	Total	Duration of Exam. (Hrs)	Theory/Lab/Viva	Sess.		
EPS 2.1	Power Electronic Control of AC Drives	4	--	4	3	70	30	100	4
EPS 2.2	Switched Mode Power Conversion	4	--	4	4	70	30	100	4
EPC 2.3	Intelligent Control of Drives	4	--	4	4	70	30	100	4
EPC 2.4	Digital Control Systems	4	--	4	4	70	30	100	4
EPS 2.5	Elective-II a) Power Electronic Applications in Power Systems b) Design of power electronic systems c) Digital signal processing & its applications	4	--	4	3	70	30	100	4
EPS 2.6	Power Electronics Drives Lab -II	--	3	3	Viva-Voce	50	50	100	2
EPS 2.7	Seminar -II	--	3	3	Viva-Voce	50	50	100	2
	Total	20	6	26		450	250	700	24

II-Year

Semester_III

Subject code	Subject title	Scheme of examination	Total	credits
EPE 3.1	Dissertation(preliminary)	Viva-voce	100	12

Semester_IV

Subject code	Subject title	Scheme of examination	Total	credits
EPE 4.1	Dissertation(Final)	Viva-voce	100	12

SEMESTER III and IV : THESIS WORK

Work load : 6 Periods/Week/Student

Credits per Semester : 12

Total Credits : 24

The valuation of the thesis credits should be allotted but for the calculation of CGPA these credits will not be taken into consideration.

Candidates can do their work in the department or in any industry/research organization for two semesters (ie 3rd and 4th semesters). In case of thesis work to be done in an industry/research organization, the advisor/advisors should be from the industry/research organization.

It is mandatory that two seminars at least one per semester related to thesis work in III and IV semesters and publication of a paper in conference proceeding/communicated to Journal for the submission of the Thesis at the end of 4th Semester.

At the end of 4th semester, four bound copies of the thesis are to be submitted to the department, out of which 2 to be retained by the department for evaluation purpose. The thesis is to be evaluated by an examiner external to the University with minimum M.E./M.Tech qualification with relevant specialization and must have minimum 5 years of experience in service.

A Viva-voce examination is to be conducted by a Committee consisting of Head of the department of respective college, Chairman, Board of Studies, the External Examiner who evaluates the thesis and the Advisor of the thesis, after receiving the evaluation report from the External Examiner.

In case the advisor happens to be HOD or Chairman, Board of Studies or from industry/research organization one more member from the department with relevant specialization is to be recommended as examiner by Chairman, Board of Studies for Viva-voce examination.

The Board will submit a report stating whether the thesis is approved or not approved with marks out of 100.

SYLLABUS FOR M.TECH.(POWER ELECTRONIC DRIVES & CONTROL)

SEMESTER – I

EPE 1.1 – OPTIMIZATION TECHNIQUES

INSTRUCTION : 4 Periods per Week
UNIVERSITY EXAMINATION : 3 Hours
UNIVERSITY EXAMINATION MARKS : 70
SESSIONAL MARKS : 30
CREDITS : 4

INTRODUCTION TO OPTIMIZATION: Introduction, Historical Development, Engineering Applications of Optimization, Statement of Optimization Problem.

CLASSICAL OPTIMIZATION TECHNIQUES: Introduction, Single variable optimization, Multivariable optimization with no constraints; Multivariable optimization with Equality constraints – Solution by Direct Substitution method, Method of constrained variation, Method of Lagrangian multipliers; Multivariable optimization with inequality constraints: Kuhn-Tucker conditions.

LINEAR PROGRAMMING: Introduction, Applications of Linear Programming, Standard Form of a Linear Programming, Basic Terminology and Definitions, Exceptional cases, Simplex method, Big-M method, Two-phase method, Revised Simplex method, Duality, Decomposition Principle.

NON-LINEAR PROGRAMMING-I: Unconstrained optimization-Univariate method, Pattern Directions, Hook and Jeeves Method, Powell's method, Gradient of a function, Steepest descent method, Conjugate Gradient Method, Newton's method, Marquardt Method, Quai-Newton Methods, Davidon-Fletcher-Powell Method, Broyden-Fletcher-Goldfarb-Shanno Method.

NON-LINEAR PROGRAMMING-II: Constrained optimization- Characteristics of a Constrained Problem, Sequential linear programming, Basic approach in the methods of feasible directions, Zoutendijk's method of feasible directions, Sequential Quadratic Programming.

TEXT BOOK:

1. **Engineering Optimization: Theory and Applications' By S.S.Rao, New Age International Publishers, Revised Third Edition,2005.**

EPE 1.2 - POWER SEMICONDUCTOR DEVICES AND CONTROLLERS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

REVIEW OF POWER DEVICES: Power Diodes, BJT, Thyristor, Power MOSFET, IGBT and GTOs – Device structure and theory of operation, characteristics, rating and specifications, gate drive requirement circuits, and applications.

LINE COMMUTATED CONVERTERS: Three phase semi controlled & fully controlled converter, Dual converters, power factor improvement methods, effect of source inductance, Rectifier Power Factor and Pulse-Width Modulation Controlled Rectifier Circuits, single phase series converters, and twelve pulse converters.

INVERTERS: Principle of operation, performance parameters, single phase bridge inverters and three phase inverters, harmonic reduction, Three-Phase Naturally Commutated, Controlled Bridge Rectifier, Inverter, Three-Phase Step-Wave Inverter Circuits, Three-Phase Pulse-Width Modulation, Controlled Inverter Circuits

VOLTAGE/CURRENT SOURCE INVERTERS: Voltage source inverters-single/multiple pulse/SPWM/modified SPWM methods. Current Source inverters - single phase and three phase power circuit configuration and analysis, Comparison between VSI & CSI.

MULTILEVEL INVERTERS: Introduction, Types, Diode clamped multi level inverters, features & applications.

CYLCOCONVERTERS: Phase-controlled cycloconverters, envelope cycloconverters, matrix Converters

Text Books

1. Ned Mohan, Tore.M. Undeland and William.P Robbins, "Power Electronics converters, applications and design", John Wiley 2003
2. Rashid M.H. Power Electronics – Circuits Devices and applications, Prentice Hall India Third Edition

References

1. "Power Converter Circuits" by William Shepherd, Li Zhang, Li Zhang Crowther, CRC Press, 2004
2. B.K.Bose, "Modern Power Electronics & AC Drives", Pearson Edition Asia, 2002
3. Jai P Agarwal, " Power Electronic Systems – Theory and Design", Pearson Education, 2001

EPE 1.3 - POWER ELECTRONIC CONTROL OF DC DRIVES

INSTRUCTION : 4 Periods per Week
UNIVERSITY EXAMINATION : 3 Hours
UNIVERSITY EXAMINATION MARKS : 70
SESSIONAL MARKS : 30
CREDITS : 4

REVIEW OF ELECTRIC DRIVE SYSTEMS: Concept, Classification, requirements, selection and rating, Dynamics of Electric Drives- Mechanical system, Fundamental torque equations, components of load torques, Energy loss in transient operations, Steady State Stability, Load equalization.

PHASE CONTROLLED DC MOTOR DRIVES: Principle, Operating modes, Single and Three Phase converter based drives, two and four- quadrant controlled DC motor drive.

CURRENT AND SPEED CONTROLLED DC MOTOR DRIVES: Current and speed controllers ,Current feedback , speed feedback , Design of controllers, Converter Selection and Characteristics, Harmonics and associated problems.

CHOPPER CONTROLLED DC MOTOR DRIVES: Chopper fed drive- Principle of Operation, Four-quadrant chopper circuit , Chopper for inversion , 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 OF DC MOTOR DRIVES: Speed controlled drive system , current control loop, pulse width modulated current controller , hysterisis current controller , modeling of current controller ,design of current controller, Applications.

Text Books:

1. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", PH,1998.
2. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003
3. G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing house

References:

1. V.Subrahmanyam, "Electric Drives-Concepts and Applications", TMH
2. M.H. Rashid, "Power Electronics", Third Edition, PHI

EPE 1.4: ADVANCED CONTROL SYSTEM DESIGN

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

DESIGN OF LINEAR CONTROL SYSTEMS: Review of compensation techniques to obtain desired performance, Reshaping of Bode & Root locus plots to obtain desired response, Initial condition and forced response, lag – lead design.

INTEGRAL-SQUARE ERROR COMPENSATION: parameter optimization using Integral-square error criterion with and without constraints, principles of State variable Feedback compensation of continuous - time and discrete-time systems, simple problems to understand the concept.

MIMO CONTROL DESIGN: Principles of Linear Quadratic Optimal Regulators, Discrete Time Optimal Regulators, Observer Design, Linear Optimal Filters, State Estimate Feedback, Transfer Function Interpretation, simple problems to understand the concept.

PID CONTROLLER: PID controller, Simulation of multi-loop control system using P, PI, PD, PID controller, Standard compensator structures (P, PD, PI and PID control).

DESIGN OF DIGITAL CONTROL SYSTEM: Protocol of Digital controller design, Classical Compensation of Discrete-time control systems: Forward path continuous, Forward-path Digital Z-plane Synthesis approaches, Deadbeat performance.

Text Books:

1. G. C. Goodwin, S. F. Graebe, M. E. Salgado, “Control System Design”, Prentice Hall of India
2. Gupta and Hasdorf, 'Fundamentals of Automatic control Willey Eastern, 1970.
3. B.C.Kuo, Automatic control systems' (5th Edition), Prentice Hall of India, 1988.

Reference Books:

1. M. Gopal, “Digital Control and State Variable Method”, Tata McGraw Hill
2. Hadi Saadat, “Computational Aids in Control System Using MATLAB”, McGraw Hill International
3. Ogata K., “Modern Control Engineering”, 4th Edition, Prentice Hall
4. Norman S. Nise, “Control Systems Engineering”, 3rd Edition, Wiley

EPE 1.5(a): HVDC TRANSMISSION

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

STATIC POWER CONVERSION: Comparison of DC transmission and AC Transmission, Application of DC transmission, Description of DC transmission systems, planning for HVDC transmission, Modern trends in DC transmission, pulse number, analysis of GRAETZ circuit with and without overlap, equivalent circuit, inverter equations, power factor and reactive power management, 12 pulse converter unit.

HVDC SYSTEM CONTROL: Features of control, actual, individual and combined characteristics of rectifier and inverter, constant-minimum-ignition-angle control, constant current control, constant-extinction-angle control, individual phase-control, equidistant firing control, voltage dependent current order limit (VDCOL), basic philosophy of system control, direction of DC power flow, reversal of power flow, starting and stopping of DC link.

POWER FLOW ANALYSIS: DC system model for load flow studies, Load flow study of AC-DC system sequential method, simultaneous method. Reactive power requirements in steady state, conventional control strategies, alternate control strategies, equipment for reactive power.

FAULTS AND PROTECTION: short circuit ratio, Effective short circuit ratio, dynamic over voltages, DC power modulation, commutation failure, disturbances on AC side, disturbances on DC side, Characteristic harmonics, derivation of relevant equations for 12 pulse converter. AC filters-single tuned, doubled tuned filters, brief introduction to DC circuit breakers.

MULTI TERMINAL DC TRANSMISSION: Introduction, potential applications of MTDC systems, Types of MTDC systems, control and protection.

TEXT BOOK:

1. "HVDC Transmission " by K.R. Padiyar.

REFERENCE BOOKS:

1. "Direct current transmission" by E.W. Kimbark. Wiley Interscience 1971.
2. "High voltage Direct current transmission" by J. Arrillaga IEE control engineering series 2000.

EPE 1.5(b)– POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

INTRODUCTION: Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) , Qualitative study of different renewable energy resources-Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION: Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

POWER CONVERTERS: Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

ANALYSIS OF WIND AND PV SYSTEMS: Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system

HYBRID RENEWABLE ENERGY SYSTEMS: Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

TEXT BOOKS:

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.

REFERENCES:

3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

EPE 1.5(c) – EMBEDDED CONTROL OF ELECTRICAL DRIVES

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

INTRODUCTION – embedded systems and their characteristics, review of micro – processors, MPU design options, Instruction sets – CISC and RISC – instruction pipelining, the microcontroller – its applications and environment. 16 bit microcontroller – Intel 8096 CPU structure, register file.

MC68HC11 MICROCONTROLLER: Architecture memory organization - addressing modes - instruction set - programming techniques -simple programs.

PERIPHERALS OF MC68HC11:I/O ports - handshaking techniques - reset and interrupts - serial communication interface – serial peripheral interface - programmable timer - analog / digital interfacing - cache memory.

PIC 16C7X MICROCONTROLLER: Architecture - memory organization - addressing modes - instruction set – programming techniques - simple operation.

PERIPHERAL OF PIC 16C7X MICROCONTROLLER: Timers - interrupts - I/O ports - I2C bus for peripheral chip access - A/D converter – VART

SYSTEM DESIGN USING MICROCONTROLLERS: Interfacing LCD display - keypad interfacing - A.C. load control - PID control of D.C. motor - stepper motor control - brush less D.C. motor control.

TEXT BOOKS

1. John B. Peatman , 'Design with PIC Microcontrollers,' Pearson Education, 2004.
2. Michael Khevi, 'The M68HC11 Microcontroller Applications in Control, Instrumentation and Communication', Prentice Hall, 1997.

REFERENCE

1. John B. Peatman, 'Design with Microcontrollers', McGraw-Hill, 1988.

SEMESTER –I I

EPE 2.1 - POWER ELECTRONIC CONTROL OF AC DRIVES

INSTRUCTION : 4 Periods per Week
UNIVERSITY EXAMINATION : 3 Hours
UNIVERSITY EXAMINATION MARKS : 70
SESSIONAL MARKS : 30
CREDITS : 4

PHASE CONTROLLED IM DRIVES: Introduction, Phase controlled methods - Conventional Stator - Voltage Control, Steady state Analysis, Approximate Analysis, Steady-State Performance. Conventional Slip-Energy Recovery Scheme-Principle of operation-Closed loop control-Static scherbius Drive-Applications.

FREQUENCY CONTROLLED IM DRIVES: Voltage Source Inverter Driven Induction Motor Speed Control-Constant Volts/Hz control, Constant Slip Speed Control, Constant Air Gap Flux Control, Control of Harmonics. Current Source Induction Motor Drives- Steady State Performance- Closed Loop CSIM Drive System.

VECTOR CONTROLLED IM DRIVES: Control Methods for Induction Motor Drive -Principle of Vector Control, Indirect or Feed forward Vector Control, Sensor less Vector Control, Direct Torque and Flux Control.

SYNCHRONOUS MOTOR DRIVES: Introduction, Sinusoidal SPM Machine Drives Sinusoidal IPM machine drives, Trapezoidal SPM machines drives, wound field machine drives, switched reluctance motor drives.

CONTROL STRATEGIES OF SM DRIVES: Constant Torque-angle Control, UPF Control, Flux weakening operation , Maximum speed , Direct flux weakening algorithm ,Constant Torque mode controller ,Flux Weakening controller , Indirect flux weakening , Maximum permissible torque, speed control scheme , Implementation strategy – Speed controller design.

Text Books:

1. R. Krishnan, 'Electric Motor & Drives: Modeling, Analysis and Control', Prentice Hall of India, 2001.
2. Bimal K.Bose, 'Modern Power Electronics and AC Drives', Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.

References:

1. P. Vas, "Sensor less Vector and Direct Torque Control", Oxford Press, 1998
2. V.Subrahmanyam, "Electric Drives-Concepts and Applications", TMH

EPE 2.2 – SWITCHED MODE POWER CONVERSION

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

BASIC CONVERTERS: Basic concepts, Principle of operation and analysis of Buck, Boost, Buck-Boost converter for continuous and discontinuous current mode.

DERIVED CONVERTERS: Principle of operation and analysis forward, Flyback, Pushpull, Half bridge, Full bridge converters, cuk converters.

RESONANT CONVERTERS: Introduction, classification, Basic Resonant circuit concepts, Resonant switch converters, Zero voltage switching, clamped voltage topologies, Resonant DC link converters.

CONVERTER APPLICATIONS: Linear power supplies, Switching dc power supplies and its control; power line disturbances, power conditioners, uninterruptible power supplies.

UTILITY INTERFACE: Generation of current harmonics, current harmonics and power factor, need for improved utility interface, improved single-phase utility interface, improved three-phase utility interface, electromagnetic interface.

Text Books:

1. Ned Mohan, Tore.M. Undeland and William.P Robbins, "Power Electronics converters, applications and design", John Wiley 2003
2. Rashid M.H. Power Electronics – Circuits Devices and applications, Prentice Hall India Third Edition
3. B.K.Bose, "Modern Power Electronics & AC Drives", Pearson Edition Asia, 2002

References:

1. Philip T Krein,' Elements of Power Electronics ',Oxford Press,1998
2. Switched Mode Power Conversion, Course Notes, CCE, IISc, 2004.

EPE 2.3 – INTELLIGENT CONTROL OF DRIVES

INSTRUCTION : 4 Periods per Week
UNIVERSITY EXAMINATION : 3 Hours
UNIVERSITY EXAMINATION MARKS : 70
SESSIONAL MARKS : 30
CREDITS : 4

NEURAL NETWORKS :Introduction – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised learning – perception networks – adaline – madaline – back propagation networks – learning factors – linear separability – Hopfield network – discrete Hopfield networks.

ARCHITECTURE – TYPES: Recurrent auto association memory , bi-directional associative memory – temporal associative memory – Boltzmann machine Hamming networks – self – organizing feature maps – adaptive resonance theory network – Instar – Outsar model – counter propagation network – radial basis function networks.

FUZZY SETS AND SYSTEMS: Crisp set – vaguness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relation – cardinality operations, properties – fuzzy Cartesian product and composition – non – interactive fuzzy sets – tolerance and equivalence relations – fuzzy ordering relations – fuzzy morphism – composition of fuzzy relations.

FUZZY LOGIC CONTROLLER: Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations – definition methods – structure of fuzzy logic controller – database – rule base – Inference engine .

APPLICATION AND DESIGN: Applications of Neural network and Fuzzy system for single phase fully controlled converter, single phase ac voltage controller, DC Drive and AC Drive , Designing of controllers using Simulation Software Fuzzy Logic Toolbox – Modeling of DC Machines using Simulation Software and Simulink Toolbox.

Text Books:

1. Lawrence Fausatt, "Fundamentals of neural networks", Prentice Hall of India, New Delhi, 1994.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill International Edition, USA, 1997.
3. Bart kosko, " Neural Networks and Fuzzy Systems", Prentice Hall of India, New Delhi, 1994

EPE 2.4 – DIGITAL CONTROL SYSTEMS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

DISCRETE –TIME SYSTEMS: The Structure of a Digital Control System ,Analog Systems with Piecewise Constant Inputs, Difference Equations, The Z-Transform, Z-Transform Solution of Difference Equation, Time Response of a Discrete-Time System, Frequency Response of Discrete-Time Systems.
MODELING OF DIGITAL CONTROL SYSTEMS: ADC Model, DAC Model, Transfer Function of the ZOH, Effect of Sampler on Transfer Function of a Cascade, Transfer Function for the DAC, Analog Subsystem, ADC Combination, Closed-Loop Transfer Function, Analog Disturbances in a Digital System, Steady-State Error and Error Constants.
STABILITY OF DIGITAL CONTROL SYSTEMS: Definitions of Stability, Stable Z-Domain Pole Locations, Stability Conditions, Stability Determination, Jury Test.
STATE SPACE REPRESENTATION: Discrete-Time State Space Equations, Solution of Discrete-Time State Space Equations, Z-Transfer from State Space Equations, Similarity Transformation, Stability of State Space Realizations, Controllability and Stabilizability, Observability and Detectability.
STATE FEEDBACK CONTROL: On State and Output Feedback, Pole Placement, Servo Problem, Principles of Observer, State Feedback and Pole Assignment Using Transfer Functions.

Text Books:

1. Digital control systems by B.C.Kuo, Oxford University Press

References

1. Digital Control Engineering: Analysis and Design**,** By M. Sami Fadali, Antonio Visioli, Academic Press; 1 edition (February 16, 2009)
2. Digital control systems by K.Ogata

EPE 2.5(a) - POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

INTRODUCTION: Basics of Power Transmission Networks - Control of Power Flow in AC Transmission Line- Flexible AC Transmission System Controllers , Basic types of FACTS Controllers, Brief Descriptions and Definitions of FACTS Controllers ,Benefits from FACTS technology, HVDC vs. FACTS.

STATIC SHUNT COMPENSATORS: SVC and STATCOM:- Objectives of Shunt compensation, Methods of controllable VAR generation, Static VAR compensators: SVC and STATCOM, comparison between SVC and STATCOM, Static VAR systems.

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

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 SERIES COMPENSATORS: GCSC, TSSC, TCSC and SSSC:- Objectives of series compensation, Variable impedance type series compensators, Switching converter type series compensators, External (System) Control for Series Reactive Compensators, Summary of Characteristics and Features.

Text Books:

1. N.G. Hingorani, 'Understanding Facts', IEEE Press 1999
2. K.R Padiyar, "FACTS Controllers in power transmission and distribution ,New Age International (P) Limited, Publishers,2007"

References:

1. Yomg Hua Song, 'Flexible AC Transmission Systems' (FACTS) IEE Press,1999
2. E. Acha, V. G. Agelidis, O. Anaya-Lara, T. J. E. Miller, 'Power Electronic Control in Electrical Systems' Newnes Power Engineering Series, Oxford, 2002.

EPE 2.5(b) - DESIGN OF POWER ELECTRONIC SYSTEMS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

MODELING OF BASIC POWER ELECTRONIC CIRCUITS AND ELECTRIC DRIVES: Modeling of 1-□, 3- □ rectifiers, DC-DC converters and Inverters using MATLAB/SIMULINK Dynamic modeling of DC and AC machines using SIMULINK/ SCI LAB - Basic concepts .

MODELING OF SMPS: DC transformer model, state-space averaging and linearization, AC Small Signal approximation, voltage mode control of SMPS, transfer function, general control law considerations. Source to State Transfer Function. Source to Output Transfer Function stability, Loop Compensation. Switching function approach for modeling of power electronic circuits.

THERMAL DESIGN AND MODELING: Heat sink design and selection of heat sink.

MAGNETIC COMPONENT DESIGN: Magnetic materials and cores, Copper windings, Thermal considerations, special inductor design and procedure, power and converter transformer design procedure and K-factor transformer design, inductor, magnetic shielding design.

POWER ELECTRONIC CIRCUIT DESIGN: Design of soft starters, design of converters, design of inverters ,Design of complete converter inverter system model.

Text Books

1. "Advanced Electrical Drives- Analysis, control and modeling using SIMULINK", Ned Mohan, 2. MNPERE-2001.
2. "Modern Power Electronics and AC drives", B.K.Bose, Peasron Education Inc., 2002.
3. "Electric Motor Drives- Modeling, Analysis and Control", R.Krishnan, Prentice Hall Inc., 2001.

Reference Books

1. "Fundamentals of Power Electronics", 2nd Edition, Robert W.Erickson, Dragan Maksimovic, Kulwer Academic Publishers, 2001
2. "Pulse width modulation for power converters- principles and practice", D.Grahame Holmes, Thomas A.Lipo, IEEE series on Power Engineering- 2003

EPE 2.5(c) - DIGITAL SIGNAL PROCESSING & ITS APPLICATIONS

INSTRUCTION	**: 4 Periods per Week**
UNIVERSITY EXAMINATION	**: 3 Hours**
UNIVERSITY EXAMINATION MARKS	**: 70**
SESSIONAL MARKS	**: 30**
CREDITS	**: 4**

ANALYSIS OF SIGNALS: Fourier series (Trigonometric and exponential, Fourier Transform (Full Details), Convolution concept, Sampling theorem, Analog to digital Conversion, Discrete time signals, Analysis of Discrete time systems, Z transform, inverse Z transform with properties.

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ANALYSIS OF SIGNALS IN DIGITAL DOMAIN: Discrete Fourier Transform(DFT) and inverse DFT, FFT algorithm, frequency analysis of discrete time signal, power density, energy density, Application, Harmonic Analysis.

FIR FILTER: Symmetric, Anti-symmetric Filter design using windows, frequency sampling techniques, brief idea about alternation theorem and equi-ripple filter, design structure-direct form and cascade form , structure realization. Application : Detection of fault in bearings.

IIR FILTER: Basic concepts of analog filter design using Bufferwortz and chebysheb applications IIR filter design methods such as impulse invariance, bilinear transform filter structures, A)Direct Form B) Parallel form C) Cascade form Application : Detection of filters to remove the noise for detecting commands on power transmission lines.

BASICS OF DSP ARCHITECTURE: Desirable features and architecture of DSP processors, multiplex and multiplier accumulator, modified bus structures and memory access schemes, multiple access memory, multi-ported memory, piping, special addressing modes in DSP, ON-chip peripherals ,Effect of finite word length Study of DSP processors such as TMS320C5X, and others and their applications to power systems.

Text Books:

1. Digital Signal Processing – John Proakis and Manolakis (Prentice Hall of India Pvt. Ltd.)
2. Digital Signal Processing- A Computer based approach – S.K.Mitra (Tata McGraw Hill Publication)

References:

1. Digital Signal Processors- B. Venkat Ramani and Bhasker (Tata McGraw Hill Publishing Co., New Delhi)
2. Discrete – time signal processing – A.V. Oppenheim, Schafer, Buck (Pearson Prentice Hall)
3. Signals and Systems – A.V.Oppenheim, Willisky (Prentice Hall of India Pvt. Ltd.)