



**M.E. POWER ELECTRONICS AND DRIVES  
 (TWO YEAR FULL TIME)  
 CURRICULUM 2008  
 SEMESTER I**

Code No	Course Title	L	T	P	C
<b>THEORY</b>					
YPE101	Applied Mathematics for Electrical Engineers	4	1	0	4
YPE102	Controllers for Power Electronics System	3	1	0	4
YPE103	Advanced Power Semiconductor Devices	3	1	0	4
YPE104	Power Converters	3	1	0	4
YPE105*	Elective – I	3	1	0	3
YPE106*	Elective – II	3	1	0	3
<b>PRACTICAL</b>					
YPE107	Power Electronic Devices Laboratory	0	0	3	3
YPE108	Power Electronic Circuits Laboratory	0	0	3	3

**Total Hours :31**

**Total Credits:28**

**SEMESTER II**

Code No.	Course Title	L	T	P	C
<b>THEORY</b>					
YPE201	Flexible AC Transmission Systems	4	0	0	4
YPE202	Solid State DC Drives	4	0	0	4
YPE203	Solid State AC Drives	4	1	0	4
YPE204	Embedded controllers	4	0	0	4
YPE205*	Elective – III	4	0	0	3
YPE206*	Elective – IV	4	0	0	3
<b>PRACTICAL</b>					
YPE207	Solid state drives Laboratory	0	0	3	3
YPE208	Simulation of Power Electronic Circuits Laboratory	0	0	3	3

**Total Hours :31**

**Total Credits :28**

### SEMESTER III

Code No.	Course Title	L	T	P	C
<b>PRACTICAL</b>					
YPE301	Project Work (Phase I)	0	0	25	10

**Total Hours :25**

**Total Credits:10**

### SEMESTER IV

CodeNo.	Course Title	L	T	P	C
<b>PRACTICAL</b>					
YPE401	Project Work (Phase II)	0	0	25	12

**Total Hours :25**

**Total Credits :12**

**Over all Credits:78**

## LIST OF ELECTIVES

Code No.	Course Title	L	T	P	C
<b>Elective – I (SEMESTER I)</b>					
YPE105A	Digital Signal Processing	3	0	0	3
YPE105B	Spécial Electrical Machines	3	0	0	3
YPE105C	System Theory	3	0	0	3
YPE105D	Computer Communication and Networks	3	0	0	3
<b>Elective – II (SEMESTER II)</b>					
YPE106A	Advanced Object Oriented Programming	3	0	0	3
YPE106B	Energy Auditing Conservation and Management	3	0	0	3
YPE106C	Digital Simulation of Power Electronics Systems	3	0	0	3
YPE106D	Switched mode and Resonant Converters	3	0	0	3
<b>Elective – III (SEMESTER III)</b>					
YPE205A	Soft Computing Techniques	3	0	0	3
YPE205B	Power Quality	3	0	0	3
YPE205C	Computer Aided Design of Electrical Machines	3	0	0	3
YPE205D	Advanced Control Of Inverter fed Induction Motor Drives	3	0	0	3
<b>Elective – IV (SEMESTER IV)</b>					
YPE206A	Fuzzy Logic and Neural Networks	3	0	0	3
YPE206B	High Voltage Direct Current Transmission	3	0	0	3
YPE206C	Static VAR Controllers and Harmonic Filtering	3	0	0	3
YPE206D	Electro Magnetic Interferences and Harmonic Elimination	3	0	0	3

## SYLLABUS

**YPE101 - APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS 4 1 0 4**

**UNIT-1 ADVANCED MATRIX THEORY 12**

Matrix norms – Jordan canonical form – Generalised eigenvectors – Singular value decomposition – Pseudo inverse – Least square approximations – QR algorithm.

**UNIT-II CALCULUS OF VARIATIONS 12**

Variation and its properties – Euler's equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Some applications – Direct methods: Ritz and Kantorovich methods.

**UNIT-III LINEAR PROGRAMMING 12**

Basic concepts – Graphical and Simplex methods –Transportation problem – Assignment problem.

**UNIT-IV DYNAMIC PROGRAMMING 12**

Elements of the dynamic programming model – optimality principle – Examples of dynamic programming models and their solutions.

**UNIT-V RANDOM PROCESSES 12**

Classification – Stationary random processes – Auto Correlation – Cross Correlations – Power spectral density – Linear system with random input – Gaussian Process.

**L:60; T:15; Total:75**

### REFERENCES:

1. Lewis.D.W.,Matrix Theory ,Allied Publishers, Chennai 1995.
2. Bronson, R, Matrix Operations, Schaums outline Series, McGraw Hill, New York. 1989.
3. Elsgoltis, " Differential Equations and Calculus of Variations ", MIR Publishers, Moscow (1970)
4. Gupta.A.S.,Calculus of Variations with Applications ,Prentice Hall of India, New Delhi, 1999.

**YPE102 - CONTROLLERS FOR POWER ELECTRONICS SYSTEM 3 1 0 4**

**UNIT-I REVIEW OF MICROPROCESSORS 9**

Architecture and Programming of 8085 and 8086, A/D and D/A converters. Interfacing of 8253, 8255, 8155 and other important interfacing ICs.

**UNIT-II MICROPROCESSOR BASED FIRING SCHEME FOR CONVERTERS 9**

Firing schemes for single phase and three phase rectifiers-3-phase AC choppers, Firing at variable frequency environments, Firing scheme for DC choppers, voltage and current communication, Inverters, types of pulse width modulation techniques, their implementation. Using microprocessors, Application of these firing schemes to the control of DC drive, induction motors, synchronous motors and other special machines, Application in Electrical Traction.

**UNIT-III MICROPROCESSORS IN CLOSED LOOP CONTROL SCHEMES 9**

Importance of measurement and sensing in closed loop control, Measurement of voltage, current, speed, power and power factor using microprocessors, Implementation of various types of controllers using microprocessors.

**UNIT-IV MICROPROCESSORS IN SPECIAL APPLICATIONS OF POWER ELECTRONICS 9**

Static excitation of synchronous generators, Solid State tap-changers for transformers, UPS systems, Induction furnace control.

**UNIT-V BASIC SENSING AND MEASUREMENT 9**

Measurement techniques for on-line measurement of DC and AC voltages, currents and phase angle. Digital implementation of P PI and PID controllers.

**L:45 T:15; Total:60**

**REFERENCES :**

- 1.Gaonkar, R.S., " Microprocessor Architecture ", Programming and Application with 8080/8085 " Wiley Eastern Limited, New Delhi, 2000.
- 2.Hall, D.V. " Microprocessors and Interfacing ", McGraw-Hill Publishing Company, New Delhi,1986.
- 3.Lecture notes on " Microprocessor in power Electronics ", Prepared by Power Electronics division, SEEE, College of Engineering, Chennai.
- 4.William Kleitz,' Microprocessor and Microcontroller Fundamentals of 8085 and 8051 Hardware and Software', Pearson Education,1998.

**UNIT - I INTRODUCTION****9**

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes - Types, forward and reverse characteristics, switching characteristics – rating.

**UNIT - II CURRENT CONTROLLED DEVICES****9**

BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor.

**UNIT III VOLTAGE CONTROLLED DEVICES****9**

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steady state and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and GATT.

**UNIT - IV FIRING AND PROTECTING CIRCUITS****9**

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers.

**UNIT - V THERMAL PROTECTION****9**

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour – phase cooling; Guidance for heat sink selection – Thermal resistance and impedance - Electrical analogy of thermal components, heat sink types and design – Mounting types.

**L: 45; T:15; Total:60****REFERENCES:**

1. B.W Williams ' Power Electronics Circuit Devices and Applications'.1992
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
3. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
4. Mohan, Undcland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

**YPE104 - POWER CONVERTERS** **3 1 0 4**

**UNIT- I DC CONVERTERS** **9**

Single phase and three phase bridge rectifiers, half controlled and Fully controlled converters with RL, RLE loads, free wheeling diodes, Dual Converter.

**UNIT - II AC PHASE CONVERTER** **9**

Principle of phase control, single-phase bi-directional controllers with R, L and R-L loads, 3-phase controllers, different configurations, Analysis with pure R and L loads.

Principle of operation, single phase and three phase cycloconverters Power circuits, gating signals-harmonics power factor.

**UNIT- III ANALYSIS OF CONVERTERS** **9**

Sequence control of converters-inverter operation, Input harmonics and output ripple, smoothing inductance-power factor, effect of source impedance, overlap, inverter limit.

**UNIT - II SCR BASED CLASSICAL INVERTER** **9**

Series Inverters: Basic Series Inverter, Modified Series Inverter, High frequency Series inverter, Three phase Series Inverter-Design examples Parallel Inverter, Forced commutated bridge Inverter: McMurray Inverter, McMurray Bedford Inverter

**UNIT -V MODERN INVERTERS** **9**

BJT/IGBT based modern high switching frequency Inverters, Need for Output voltage control & Harmonic elimination, PWM Inverters: different methodologies Principle of SMPS and UPS, Resonant Inverter: ZCS & ZVS concepts, Series loaded resonant inverter as example

**L:45; T:15; Total:60**

**REFERENCES:**

1. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", PrenticeHall India, Second Edition, New Delhi, 2003
2. P.C Sen., " Modern Power Electronics ", Wheeler publishing Co, First Edition, New Delhi-1998.
3. G.K. Dubey, " Thyristorised Power Controllers ", New Age International Pvt. Ltd., New Delhi, 1996.
4. M. Ramamoorthy, " Introduction to thyristors & and their application " East-west Press, 1977.
5. Ned Mohan, Undeland and Robbin, "Power Electronics:converters,Application and design" John Wiley and sons.Inc,Newyork,2003.

### **YPE107 - Power Electronic Devices Laboratory**

**0 0 3 3**

1. Study of power diode
2. Study of power transistor
3. Study of SCR
4. Study of MOSFET
5. Study of GTO
6. Study of DIAC
7. Study of TRIAC

### **YPE108 Power Electronic Circuits Laboratory**

**0 0 3 3**

1. Single phase semiconverter with R-L load
2. Single Phase Semi-converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
3. Single phase full- converter with R-L and R-L-E loads for continuous and discontinuous conduction modes.
4. Three phase full-converter with R-L-E load.
5. Three phase semi converter with R-L-E Load
6. MOSFET, IGBT based Choppers.
7. IGBT based Single phase inverters.
8. Single phase AC voltage controller.
9. Three phase AC voltage controller

**YPE201- FLEXIBLE AC TRANSMISSION SYSTEMS 4 0 0 4**

**UNIT - I INTRODUCTION 9**

FACTS-a toolkit, Basic concepts of Static VAR compensator, Resonance damper, Thyristor controlled series capacitor, Static condenser, Phase angle regulator, and other controllers.

**UNIT - II SERIES COMPENSATION SCHEMES 9**

Sub-Synchronous resonance, Torsional interaction, torsional torque, Compensation of conventional, ASC, NGH damping schemes, Modelling and control of thyristor controlled series compensators.

**UNIT- III UNIFIED POWER FLOW CONTROL 9**

Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller.

**UNIT - IV DESIGN OF FACTS CONTROLLERS 9**

Approximate multi-model decomposition, Variable structure FACTS controllers for Power system transient stability, Non-linear variable-structure control, variable structure series capacitor control, and variable structure resistor control.

**UNIT V STATIC VAR COMPENSATION 9**

Basic concepts, Thyristor controlled reactor (TCR), Thyristors switched reactor (TSR), Thyristor switched capacitor (TSC), saturated reactor (SR), Fixed Capacitor (FC).

**L:45; Total:45**

**REFERENCES:**

1. Narin G.Hingorani, " Flexible AC Transmission ", IEEE Spectrum, April 1993, pp 40-45.
2. Narin G. Hingorani, " High Power Electronics and Flexible AC Transmission Systems IEEE High Power Engineering Review, 1998.
- 3.Thyristor based FACTS controllers for Electrical Transmission systems,'R.Mohan Mathur,Rajiv .K.Varma'John Willy&Sons publication,2002
4. Einar V.Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, " Concepts for design of FACTS Controllers to damp power swings ", IEEE Trans On Power Systems, Vol.10, No.2, May 1995.
5. Gyugyi L., " Unified power flow control concept for flexible AC transmission ", IEEE Proc-C Vol.139, No.4, July 1992.

**YPE202 - SOLID STATE DC DRIVES** **4 0 0 4**

**UNIT - I REVIEW OF CONVENTIONAL DC DRIVES** **9**

Different techniques of speed control and methods of braking of series and Methods of braking of series and separately excited DC motor. Ward-Leonard Speed control, Inching and jogging, Models and transfer function of series and Separately excited DC motor.

**UNIT - II CONVERTER CONTROL OF DC MOTORS** **9**

Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations, Problems on DC machines fed by converter supplies CLC and TRC strategies.

**UNIT- III CHOPPER CONTROL OF DC MOTORS** **9**

Analysis of series and separately excited DC motors fed from different Choppers, effect of saturation in series motors CLC and TRC strategies.

**UNIT-IV DESIGN OF CONVERTER FED DC DRIVES** **9**

Speed loop, current loop, armature current reversal, field current reversal: Inching, Digital controller and firing circuits, simulation.

**UNIT -V INTELLIGENT CONTROLLER FOR DC DRIVE** **9**

Microcomputer implementation of control function, Fuzzy, Neuro, Fuzzy neuro controllers.

**L:45 Total: 45**

**REFERENCES:**

1. Buxbaum, A.Schierau, K.and Staughen, "A Design of control System for d.c Drives ", Springer-Verlag, berlin, 1990.
2. Dubey, G.K. "Power Semiconductor Controlled Drives ", Prentice Hall International, New Jersey, 1989.
3. Sen, P.C. "Thyristor D.C Drives ", John Wiley & Sons, New York, 1981.
4. Subharamanyam V. "Electric Drives -Concepts and Applications ", Tata McGraw Hill Publishing Co., Ltd, New Delhi, 2003.

**YPE203 - SOLID STATE AC DRIVES** **4 1 0 4**

**UNIT- I STATOR VOLTAGE CONTROL OF INDUCTION MOTOR** **9**

Torque, slip characteristics, Operation with different types of loads, performance, comparison of different ac power controllers, Speed reversal, Closed loop control.

**UNIT - II STATOR FREQUENCY CONTROL** **9**

Operation of induction motor with non-sinusoidal supply waveforms, Variable frequency operation of 3-phase induction motors, Constant flux operation, Current fed operations, Dynamic and regenerative braking of CSI and VSI fed drives, Principle of vector control.

**UNIT- III ROTOR RESISTANCE CONTROL** **9**

Torque, Slip characteristics, Types of rotor choppers, Torque Equations, Constant torque operations, TRC Strategy, Combined stator voltage control and rotor resistance control.

**UNIT -IV SLIP POWER RECOVERY SCHEME** **9**

Torque equation, Torque-slip characteristics-power factor considerations, Sub-synchronous operation and closed loop control.

**UNIT -V SYNCHRONOUS MOTOR DRIVES** **9**

Need for leading pf operation-open loop VSI fed drive and its characteristics-Self control-torque angle control-Power factor control Brushless excitation systems-Starting methods-Principles of Vector control.

**L:45; T:15; Total:60**

**REFERENCES:**

1. Murphy, J.M.D, Turnbull, F.G. " Thyristor control of AC motors ", Pergamon Press, Oxford, 1988.
2. Sheperd, W. and Hully, L.N. " Power Electronics and motor control ", Cambridge University Press, Cambridge, 1987.
3. Dubey, G.K. " Power Semiconductor controlled drives ", Prentice Hall, International New Jersey, 1989.
4. Dewan, S.B Slemon, G.R. Straughen, A. " Power semiconductor drives ", John Wiley and Sons, New York, 1984.
5. Subharamanyam V. "Electric Drives -Concepts and Applications ", Tata McGraw Hill Publishing Co., Ltd, New Delhi, 2003

## **YPE204 - EMBEDDED CONTROLLERS**

**4 0 0 4**

### **1. MC68HC11 MICROCONTROLLER**

**9**

Architecture memory organization - Addressing modes - Instruction set - Programming techniques - simple programs

### **2. PERIPHERALS OF MC68HC11**

**9**

I/O ports - handshaking techniques - reset and interrupts - serial communication interface - serial peripheral interface - programmable timer - analog / digital interfacing - cache memory

### **3. PIC 16C7X MICROCONTROLLER**

**9**

Architecture - memory organization - addressing modes - instruction set - programming techniques - simple operation.

### **4. PERIPHERAL OF PIC 16C7X MICROCONTROLLER**

**9**

Timers - interrupts - I/O ports - I<sup>2</sup>C bus for peripheral chip access - A/D converter - VART

### **5. SYSTEM DESIGN USING MICROCONTROLLERS**

**9**

Interfacing LCD display - Keypad interfacing - AC load control - PID control of DC motor - stepper motor control - brush less DC motor control.

**L:45; Total:45**

#### **REFERENCES:**

1. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004.
2. Michael Khevi, 'The M68HC11 Microcontroller Applications in control, Instrumentation and communication', Prentice Hall, New Jersey, 1997.
3. John B.Peatman, 'Design with Microcontrollers', MCGraw Hill
4. Muhammad Ali M azid & Janice Gilli Mazidi, 'The 8051 Microcontroller and Embedded systems', Pearson Education, 1998.

## **YPE207 - Solid State Drives Laboratory**

**0 0 3 3**

1. Single phase semiconverter fed DC drives
2. Three phase semiconverter fed DC drives
3. Single phase full converter fed DC drives
4. Three phase full converter fed DC drives
5. Single phase AC voltage controller fed AC drives
6. Three phase AC voltage controller fed AC drives
7. Chopper fed DC drives

## **YPE208 - Simulation of Power Electronic Circuits Laboratory**

**0 0 3 3**

1. Simulation of three phase full-converter with R-L-E load.
2. Simulation of MOSFET, IGBT based Choppers
3. Simulation of single phase semiconverter fed DC drives
4. Simulation of three phase semiconverter fed DC drives
5. Simulation of single phase full converter fed DC drives
6. Simulation of single phase AC voltage controller fed AC drives
7. Simulation of Three phase AC voltage controller fed AC drives
8. Simulation of Chopper fed DC drives

## **YPE105A - DIGITAL SIGNAL PROCESSING**

**3 0 0 3**

### **UNIT-I DISCRETE TIME SIGNALS AND SYSTEMS**

**9**

Representation of discrete time signal - classifications - Discrete time - system - Basic operations on sequence - linear - Time invariant - causal - stable - solution to difference equation - convolution sum - correlation - Discrete time Fourier series - Discrete time Fourier transform.

### **UNIT-II FOURIER AND STRUCTURE REALIZATION**

**9**

Discrete Fourier transform - properties - Fast Fourier transform - Z-transform - structure realization - Direct form - lattice structure for FIR filter - Lattice structure for IIR Filter.

### **UNIT-III FILTERS**

**9**

FIR Filter - windowing technique - optimum equiripple linear phase FIR filter - IIR filter - Bilinear transformation technique - impulse invariance method - Butterworth filter - Tchebyshev filter.

### **UNIT-IV MULTISTAGE REPRESENTATION**

**9**

Sampling of band pass signal - antialiasing filter - Decimation by a n integer factor - interpolation by an integer factor - sampling rate conversion - implementation of digital filter banks - sub-band coding - Quadrature mirror filter - A/D conversion - Quantization - coding - D/A conversion - Introduction to wavelets.

### **UNIT-V DIGITAL SIGNAL PROCESSORS**

**9**

Fundamentals of fixed point DSP architecture - Fixed point number representation and computation - Fundamentals of floating point DSP architecture - floating point number representation and computation - study of TMS 320 C 50 processor - Basic programming - addition - subtraction - multiplication - convolution - correlation - study of TMS 320 C 54 processor - Basic programming - addition - subtraction - multiplication - convolution - correlation.

**L:45; Total:45**

### **REFERENCES:**

1. Modern Digital Signal Processing ,Naidu.Prabhakar.S,New Delhi, Narosa Publishing House,2003
2. John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", PHI.
3. S.Salivahanan, A.Vallavaraj and C.Gnanapriya "Digital Signal Processing", TMH,2000.
4. Rabiner and Gold, "Theory and Application of Digital Signal Processing", A comprehensive, Industrial - Strength DSP reference book.
5. B.Venkatramani & M.Bhaskar, "Digital Signal Processors architecture, Programming and Applications", TMH, 2002.

**YPE105B - SPECIAL ELECTRICAL MACHINES** **3 0 0 3**

**UNIT - I SYNCHRONOUS RELUCTANCE MOTORS** **9**

Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – phase or diagram, motor characteristics.

**UNIT - II SWITCHED RELUCTANCE MOTORS** **9**

Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control Microprocessor based controller.

**UNIT- III PERMANENT MAGNET SYNCHRONOUS MOTORS** **9**

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

**UNIT- IV PERMANENT MAGNET BRUSHLESS DC MOTORS** **9**

Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

**UNIT-V STEPPING MOTORS** **9**

Constructional features, principle of operation, modes of excitation torque production in Variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor.

**L:45; Total:45**

**REFERENCES:**

1. Miller, T.J.E. " Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.
2. Kenjo, T, " Stepping motors and their microprocessor control ", Clarendon Press, Oxford, 1989.
3. Kenjo, T and Naganori, S " Permanent Magnet and brushless DC motors ", Clarendon Press, Oxford, 1989.
4. R.Krishnan, " Electric Motor Drives - Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

## **YPE105C - SYSTEM THEORY**

**3 0 0 3**

### **UNIT-I LINEAR SYSTEMS**

**9**

Fundamental concepts about system's state, the input and output – state space modelling of physical systems – solution of state equation – determining of STM – controllability and observability of time invariant linear system.

### **UNIT-II NON-LINEAR SYSTEMS**

**9**

Introduction to non-linear system – different techniques of linearising non-linear systems – Describing functions for various types of non-linearities – describing function analysis of non linear control systems.

### **UNIT-III PHASE PLANE ANALYSIS**

**9**

Method of constructing phase – trajectories – obtaining time solution from phase plane plots – singular points – phase plane analysis of linear and non-linear systems – Bang-bang system.

### **UNIT-IV LIAPUNOV STABILITY ANALYSIS**

**9**

Definitions – First and second methods of Liapunov – Different methods of constructing Liapunov functions for linear and non-linear continuous systems – stability analysis – Estimation of transient response behaviour of dynamic systems – sensitivity analysis.

### **UNIT-V POLE PLACEMENT TECHNIQUE**

**9**

Pole placement technique by state feedback for linear SISO time, invariant system – Theory of high-gain feedback-advantages – Pole placement technique along with high-gain feedback control.

**L:45 T:15 Total:60**

### **REFERENCES:**

1. K.Ogata , 'Modern Control Engineering', 2<sup>nd</sup> Edition, Prentice Hall India, New Delhi, 1992.
2. Benjamin C. Kuo, 'Digital Control Systems', Oxford University Press, 1992.
3. George J. Thaler, 'Automatic Control Systems', Jaico Publishers, 1993
4. I.J. Nagrath and M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2003.
5. Raymond T. Stefani & Co., 'Design of feed back Control systems', Oxford University, 2002.

**UNIT -I COMPUTER NETWORKS****9**

Evolution of data networks, Network architecture, ISO Reference model examples of networks, Application of networks, Physical layer, and communication medium characteristics.

**UNIT- II MEDIUM ACCESS SUB LAYER AND DATA LINK LAYER****9**

Local area networks, conventional channel allocation methods, pure-ALOHA, -ALOHA, Finite population ALOHA, Controlled ALOHA, Reservation ALOHA, Design issues for packet radio networks - IEEE Standard for LAN-Ethernet: CSMA/CD LAN, Token passing ring. Data link layer design issues - Service primitives - Stop and wait Sliding window protocols - Comparison of stop and wait and sliding window protocols.

**UNIT -III NETWORK AND TRANSPORT LAYERS****9**

Network layer design issues Routing algorithm - Congestion control algorithms internetworking. Transport layer design issues - Connection management - A simple transport protocol on top of X.25.

**UNIT-IV QUEUING THEORY AND CAPACITY ASSIGNMENT****9**

M/M/I Queues/G/I Queues, priority queuing capacity assignment for terminal networks and distributed networks, concentration and buffering for finite and infinite buffers ad block storage.

**UNIT-V PRESENTATION LAYER AND APPLICATION LAYER****9**

Design issues - Abstract syntax notation - Data compression techniques - Cryptography - Remote procedure call - Design Issues - File transfer access and management, Electronic mail - Virtual terminals - Other applications.

**L:45; Total:45****REFERENCES:**

1. Andrew S.Tanenbaum, "Computer Networks", 4<sup>th</sup> Edition, Prentice Hall of India,2003.
2. D.Bertsekas and R.Gallager, "Data networks", 2<sup>nd</sup> Edition, Prentice Hall of India, 2003.
3. Godbole and Kahate, "Computer Communication Networks (Ascent Series)", McGraw Hill, 2003.
4. M.Schwartz, "Computer Communications", Tata McGraw Hill, 2002.

**YPE106A - ADVANCED OBJECT ORIENTED PROGRAMMING 3 0 0 3**

**UNIT- I OBJECT ORIENTED PROGRAMMING PARADIGM 9**

Introduction - reusability - security - object oriented programming fundamentals - abstraction - encapsulation - derivation - object oriented languages and packages.

**UNIT- II CLASSES AND OBJECTS 9**

Introduction to C++ - procedural oriented approach to C++ - data types - control structures - problem solving - standard input and output streams - C++ enhancements - function prototypes - default reference variables - constants - classes - constructors - destructors - constraint objects - member objects and the functions.

**UNIT- III ADVANCED FEATURES 9**

Dynamic memory allocation pointers - new and delete operators - classes with pointers - copy constructor - static member - friend classes - friend functions - operator overloading.

**UNIT- IV POLYMORPHISM AND INHERITANCE 9**

Function overloading - connection classes - derived classes - class conversion - protected members – virtual functions - dynamic binding - abstract classes - multiple inheritance - templates - error handling.

**UNIT -V CASE STUDIES 9**

Overview of typical object oriented systems - case studies - application to electrical engineering.

**L:45; TOTAL:45**

**REFERENCES:**

1. Stanley B. Lipman, " C++ primer ", Addison Wesley, 1998.
2. Baarkakati.N,' On object oriented Programming in C++', Prentice Hall, 1997
3. Bertrand Meyar, " Object software construction ", Prentice Hall, 1988.
4. K.R. Dittrich et al, " On object oriented data base system ", Springer verlag, 1991.

**YPE106B - ENERGY AUDITING, CONSERVATION AND  
MANAGEMENT**

**3 0 0 3**

**UNIT - I 9**

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

**UNIT- II 9**

Electric motors-Energy efficient controls and starting efficiency-Motor Efficiency and Load Analysis- Energy efficient /high efficient Motors-Case study; Load Matching and selection of motors.

**UNIT- III 9**

Transformer Loading/Efficiency analysis, Feeder/cable loss evaluation, case study.Reactive Power management-Capacitor Sizing-Degree of Compensation-Capacitor losses-Location-Placement-Maintenance .case study;Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling-case study

**UNIT- IV 9**

Cogeneration-Types and Schemes-Optimal operation of cogeneration plants-case study;Electric loads of Air conditioning & Refrigeration-Energy conservation measures-Cool storage .Types-Optimal operation-case study; Electric water heating-Gysers-Solar Water Heaters- Power Consumption in Compressors, Energy conservation measures; Electrolytic Process; Computer Controls- softwares-EMS

**UNIT- V 9**

Variable speed drives; Pumps and Fans-Efficient Control strategies- Optimal selection and sizing -Optimal operation and Storage; Case study Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study.

**L:45; TOTAL:45**

**REFERENCES:**

1. Giovanni Petrecca, .Industrial Energy Management: Principles and Applications., The Kluwer international series -207,(1999)
2. Anthony J. Pansini, Kenneth D. Smalling, .Guide to Electric Load Management., Pennwell Pub; (1998)
3. Howard E. Jordan, .Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2nd edition (1994)
4. Turner, Wayne C., .Energy Management Handbook., Lilburn, The Fairmont Press, 2001
5. Albert Thumann , .Handbook of Energy Audits., Fairmont Pr; 5th edition (1998)

## **YPE106C - DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS**

**3 0 0 3**

### **UNIT- I**

**9**

Principles of Modeling Power Semiconductor Devices - Macromodels versus Micromodels - Thyristor model - Semiconductor Device modelled as Resistance, Resistance-Inductance and Inductance-Resistance-Capacitance combination - Modelling of Electrical Machines - Modelling of Control Circuits for Power Electronic Switches. Computer Formulation of Equations for Power Electronic Systems - Review of Graph Theory as applied to Electrical Networks - Systematic method of Formulating State Equations - Computer Solution of State Equations - Explicit Integration method - Implicit Integration method.

### **UNIT - II**

**9**

Circuit Analysis Software MicroSim PSpice A/D - Simulation Overview - Creating and Preparing a Circuit for Simulation - Simulating a Circuit with PSpice A/D - Displaying Simulation Results - PSpice A/D Analyses.

### **UNIT- III**

**9**

MicroSim PSpice A/D - Preparing a Schematic for Simulation - Creating Symbols - Creating - Models - Analog Behavioral Modeling - Setting Up and Running analyses - Viewing Results - Examples of Power Electronic Systems.

### **UNIT IV**

**9**

Design Creation and Simulation with SaberDesigner - Placing the Parts - Editing the Symbol - Properties - Wiring the Schematic - Modifying Wire Attributes - Performing a Transient and DC Analysis - Placing Probes in the Design - Performing AC Analysis and Invoking SaberScope.

### **UNIT -V**

**9**

Analysing waveforms with SaberScope - Performing Measurements on a waveform - Varying a Parameter - Displaying the Parameter Sweep Results - Measuring a Multi-Member Waveform - Simulation Examples of Power Electronic Systems. Analyses - Simple Multi-run Analyses - Statistical Analyses - Simulation Examples of Power Electronic systems.

**L:45; TOTAL:45**

### **REFERENCES:**

1. V.Rajagopalan: Computer Aided Analysis of Power Electronic Systems - Marcel Dekker, Inc.
2. MicroSim PSpice A/D and Basics+: Circuit Analysis Software, User's Guide, MicroSim Corporation.
3. MicroSim Schematics: Schematic Capture Software, User's Guide, MicroSim Corporation.
4. Getting Started with Saber Designer (Release 5.1), An Analogy Inc.
5. Guide to Writing MAST Template (Release 5-1), Analogy Inc.

## **YPE106D - SWITCHED MODE AND RESONANT CONVERTERS**

**3 0 0 3**

### **UNIT- I**

**9**

Buck, Boost, Buck-Boost SMPS Topologies . Basic Operation- Waveforms - modes of operation - switching stresses - switching and conduction losses - optimum switching frequency - practical voltage, current and power limits - design relations - voltage mode control principles.

Push-Pull and Forward Converter Topologies - Basic Operation . Waveforms - Flux Imbalance Problem and Solutions - Transformer Design -Output Filter Design - Switching Stresses and Losses -Forward Converter Magnetics --Voltage Mode Control.

### **UNIT II**

**9**

Voltage Mode Control of SMPS . Loop Gain and Stability Considerations . Shaping the Error Amp frequency Response . Error Amp Transfer Function . Transconductance Error Amps . Study of popular PWM Control Ics (SG 3525,TL 494,MC34060 etc.)

Current Mode Control of SMPS . Current Mode Control Advantages . Current Mode Vs Voltage Mode . Current Mode Deficiencies . Slope Compensation . Study of a typical Current Mode PWM Control IC UC3842.

### **UNIT- III**

**9**

Modeling of SMPS . State Space Averaging and Linearisation . State Space Averaging Approximation for Continuity . Discontinuous Conduction Modes . Small Signal Approximation- General Second Order Linear Equivalent Circuits . The DC Transformer . Voltage Mode SMPS Transfer Function . General Control Law Considerations . Source to State Transfer Function . Source to Output Transfer Function . Stability . Loop Compensation

EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS . Techniques to reduce Emissions . Control of Switching Loci . Shielding and Grounding . Power Circuit Layout for minimum EMI . EMI Filtering at Input and Output . Effect of EMI Filter on SMPS Control Dynamics

### **UNIT- IV**

**9**

Introduction to Resonant Converters . Classification of Resonant Converters . Basic Resonant Circuit Concepts . Load Resonant Converter . Resonant Switch Converter . Zero Voltage Switching Clamped Voltage Topologies . Resonant DC Link Inverters with Zero Voltage Switching . High Frequency Link Integral Half Cycle Converter.

Half and Full Bridge Converters . Basic Operation and Waveforms- Magnetic . Output Filter . Flux Imbalance . Switching Stresses and Losses . Power Limits . Voltage Mode Control. Fly back Converter- discontinuous mode operation . waveforms . Control . Magnetic- Switching Stresses and Losses . Disadvantages - Continuous Mode Operation . Waveforms . Control . Design Relations.

**L:45; TOTAL:45**

**REFERENCES:**

1. Abraham I Pressman: Switching Power Supply Design, McGraw Hill Publishing Company.
2. Daniel M Mitchell: DC-DC Switching Regulator Analysis, McGraw Hill Publishing Company.
3. Ned Mohan et.al: Power Electronics, John Wiley and Sons.
4. Otmar Kilgenstein:Switched Mode Power Supplies in Practice, John Wiley and Sons.Supplies. . Van Nostrand Reinhold, New York

## **YPE205A - SOFT COMPUTING TECHNIQUES**

**3 0 0 3**

### **UNIT-I FUZZY SET THEORY**

**9**

Introduction to Neuro – Fuzzy and soft Computing – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic operations – Member Function Formulation and parameterization – Fuzzy Rules and Fuzzy Reasoning - Extension principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models-Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

### **UNIT- II OPTIMIZATION**

**9**

Derivative-based Optimization – Descent Methods – The Method of steepest Descent – Classical Newton’s Method – Step Size Determination – Derivative-free Optimization – Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search.

### **UNIT-III NEURAL NETWORKS**

**9**

Supervised Learning Neural Networks – Perceptrons-Adaline – Backpropagation Multilayer perceptrons – Radial Basis Function Networks – Unsupervised Learning and Other Neural Networks – Competitive Learning Networks – Kohonen Self – Organizing Networks – Learning Vector Quantization – Hebbian Learning.

### **UNIT-IV NEURO FUZZY MODELING**

**9**

Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro-Fuzzy Modeling – Framework – Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

### **UNIT-V APPLICATION OF COMPUTATIONAL INTELLIGENCE**

**9**

Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency prediction – Soft Computing for Color Recipe Prediction.

**L:45; Total:45**

### **REFERENCES:**

1. J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, Pearson Education 2004.
2. Timothy J.Ross, “Fuzzy Logic with Engineering Application”, McGraw Hill, 1977.
3. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning” Addison Wesley, N.Y., 1989.
4. S.Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003.
5. R.Eberhart, P.simpson and R.Dobbins, “Computational Intelligence” PC Tools”, AP Professional, Boston 1996.

## **YPE205B - POWER QUALITY**

**3 0 0 3**

### **UNIT- I**

**9**

Introduction-power quality-voltage quality-overview of power quality phenomena-classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.

### **UNIT-II**

**9**

Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

### **UNIT - III**

**9**

Power factor improvement- Passive Compensation . Passive Filtering . Harmonic Resonance . Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC Based on Bilateral Single Phase and Three Phase Converter. static var compensators-SVC and STATCOM

### **UNIT- IV**

**9**

Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four-wire systems . d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems.

### **UNIT- V**

**9**

Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives

Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

**L:45; TOTAL:45**

### **REFERENCES:**

1. Electric Power Quality by G.T.Heydt
2. Understanding Power Quality Problems by Math H. Bollen
3. J.Arrillaga, .Power System Quality Assessment., John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,.Power system Harmonic Analysis. , Wiley, 1997

**YPE205AC- COMPUTER AIDED DESIGN OF ELECTRICAL  
MACHINES**

**3 0 0 3**

**UNIT -I INTRODUCTION**

**9**

Conventional design procedures – Limitations – Need for field analysis based design.

**UNIT- II MATHEMATICAL FORMULATION OF FIELD PROBLEMS**

**9**

Development of torque/force – Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in field problems – Inductance- Laplace and Poisson's Equations – Energy functional - Principle of energy conversion.

**UNIT- III PHILOSOPHY OF FEM**

**9**

Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques.

**UNIT- IV CAD PACKAGES**

**9**

Elements of a CAD System –Pre-processing – Modelling – Meshing – Material properties- Boundary Conditions – Setting up solution – Post processing.

**UNIT -V DESIGN APPLICATIONS**

**9**

Design of Solenoid Actuator – Induction Motor – Switched Reluctance Motor – Synchronous Machines.

**L:45; Total:45**

**REFERENCES:**

1. Silvester and Ferrari,"Finite for Electrical Engineers" Cambridge University press, 1983.
2. S.R.H.Hoole, Computer – Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London, 1989.
3. D.A.Lowther and P.P Silvester, Computer Aided Design in Magnetics, Springer verlag, New York, 1956.
4. S.J Salon,"Finite Element Analysis of Electrical Machines."Kluwer Academic Publishers, London, 1995.

**YPE205D - ADVANCED CONTROL OF INVERTER FED INDUCTION  
MOTOR DRIVES**

**3 0 0 3**

**UNIT- I**

**9**

Principles for vector and field-oriented control-Complex-valued  $dq$ -model of induction machines. Turns ratio and modified  $dq$ -models. Principles for field-oriented vector control of ac machines. Current controllers in stationary and synchronous co-ordinates .

**UNIT - II**

**9**

Generalized flux-vector control using current- and voltage decoupling networks-Generalized flux-vector oriented control. Current and voltage decoupling networks. Air gap-oriented control. Voltage-fed vector control. Stator-flux oriented vector control.

**UNIT - III**

**9**

Parameter sensitivity, selection of flux level, and field weakening - Parameter detuning in steady-state operation. Parameter detuning during dynamics. Selection of flux level. Control strategies for used in the over-speed region .

**UNIT- IV**

**9**

Principles for speed sensor-less control - Principles for speed sensor-less control. Sensor-less methods for scalar control. Sensor-less methods for vector control Introduction to observer-based techniques

**UNIT-V**

**9**

Rotor-flux oriented control of current-regulated induction machine - Dynamic model of IM in rotor-flux coordinates Indirect rotor-flux oriented control of IM - Direct rotor-flux oriented control of IM.- Methods to estimation of rotor-flux

**L: 45; TOTAL: 45**

**REFERENCES:**

- 1 Extract of D. W. Novotny and T. A. Lipo, Vector Control and Dynamics of AC Drives, Oxford University Press, 1996.
2. P. L. Jansen and R. D. Lorenz, A Physically Insightful Approach to the Design and Accuracy Assessment of Flux Observers for Field Oriented Induction Machine Drives, IEEE Trans. on Industry Applications, Vol. 30, No. 1, Jan./Feb. 1994, pp. 101110.
- 3 Extract of I. Boldea and S. A. Nasar Electric Drives, CRC Press, 1998.
4. J.Holtz, Methods for Speed Sensorless Control of AC Drives, in K. Rajashekara Sensorless Control of AC motors. IEEE Press Book, 1996. Supplementary literature

## **YPE206A - FUZZY LOGIC AND NEURAL NETWORKS**

**3 0 0 3**

### **UNIT-I NEURAL NETWORK**

**9**

Introduction-biological neurons and their artificial models-learning, adaptation and neural network's learning rules types of neural networks-single layer, multiplayer-feed forward, feedback networks; back propagation learning and training-Hopfield network.

### **UNIT- II NEURAL NETWORKS IN CONTROL**

**9**

Neural network for non-linear systems-schemes of neuro control-system identification forward model and inverse model-indirect learning neural network control applications-case studies.

### **UNIT- III FUZZY LOGIC**

**9**

Fuzzy sets-fuzzy operation-fuzzy arithmetic-fuzzy relations-fuzzy relational equations-fuzzy measure-fuzzy functions-approximate reasoning-fuzzy propositions-fuzzy quantifiers-if-then rules.

### **UNIT -IV NEURAL NETWORK IN CONTROL**

**9**

Structure of fuzzy logic controller-fuzzification models-data base-rule base-inference engine defuzzification module. Non-linear fuzzy control-PID like FLC-Sliding mode FLC - Surgeno FLC-adaptive fuzzy control-fuzzy control applications-case studies.

### **UNIT - V ANALYSIS OF NEURAL NETWORKS**

**9**

Analysis of Neural Network for linear and non-linear systems. Analysis of neuro-fuzzy systems. application of neural networks.

**L: 45; Total:45**

#### **REFERENCES:**

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. KOSKO,B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd.,1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Fuzzy Neural Network Theory and Applications by Liu,Puyin &Li,Hongxing,World Scientific Publication,2004

## **YPE206B - HIGH VOLTAGE DIRECT CURRENT TRANSMISSION**

**3 0 0 3**

### **UNIT- I DC POWER TRANSMISSION TECHNOLOGY**

**9**

Introduction-comparison of AC and DC transmission application of DC transmission - description of DC transmission system planning for HVDC transmission-modern trends in DC transmission.

### **UNIT- II ANALYSIS OF HVDC CONVERTERS**

**9**

Pulse number, choice of converter configuration-simplified analysis of Graetz circuit-converter bridge characteristics - characteristics of a twelve pulse converter-detailed analysis of converters.

### **UNIT -III CONVERTER AND HVDC SYSTEM CONTROL**

**9**

General principles of DC link control-converter control characteristics-system control hierarchy-firing angle control-current and extinction angle control-starting and stopping of DC link-power control-higher level controllers-telecommunication requirements.

### **UNIT -IV HARMONICS AND FILTERS**

**9**

Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

### **UNIT- V SIMULATION OF HVDC SYSTEMS**

**9**

Introduction-system simulation: Philosophy and tools-HVDC system simulation-modeling of HVDC systems for digital dynamic simulation.

**L: 45 Total:45**

#### **REFERENCES:**

1. Padiyar, K.R., "HVDC Power Transmission System", Wiley Eastern Limited, New Delhi 1993. Second edition.
2. Allan Greenwood, 'Electrical Transients in power systems', John Willy and Sons, Newyork, 1992.
3. Rakosh Das Begamudre, Extra high voltage AC transmission engineering New Age International (P) Ltd., New Delhi, 1990.
4. Arrillaga, J., High Voltage direct current transmission, Peter Pregrinus, London, 1983.

**YPE206C - STATIC VAR CONTROLLERS AND HARMONIC  
FILTERING**

**3 0 0 3**

**UNIT- I**

**9**

Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems .Power Qulity Issues . Sags, Sweels, Unbalance, Flicker , Distortion, Current Harmonics - Sources of Harmonics in Distribution Systems and III Effects .

**UNIT- II**

**9**

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

**UNIT- III**

**9**

Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation . Current Control of Inverters.

**UNIT- IV**

**9**

Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode .

**UNIT- V**

**9**

Current Harmonics - Sources of Harmonics in Distribution Systems and III Effects, Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode . Dynamic Voltage Restorer and its control . Power Quality Conditioner.

**L :45; TOTAL:45**

**REFERENCES:**

1. Reactive Power Control in Electric Systems by T.J.E Miller
2. Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems. by N.G. Hingorani & L. GyugyiIEEE Press, 2000.
3. Power Electronics by Ned Mohan et.al .

**YPE206D - ELECTRO MAGNETIC INTERFERENCES AND  
HARMONIC ELIMINATION**

**3 0 0 3**

**UNIT- I 9**

Introduction-power quality-voltage quality-overview of power quality phenomena-classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C-message weights-flicker factor-transient phenomena-occurrence of power quality problems-power acceptability curves-IEEE guides, standards and recommended practices.

**UNIT -II 9**

Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-triplex harmonics-important harmonic introducing devices-SMPS-Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads.

**UNIT- III 9**

Converters for Static Compensation . Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM) . GTO Inverters . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM) . Multi-level inverters of Cascade Type and their modulation . Current Control of Inverters.

**UNIT- IV 9**

Passive Harmonic Filtering . Single Phase Shunt Current Injection Type Filter and its Control, Three Phase Three-wire Shunt Active Filtering and their control using p-q theory and d-q modelling . Three-phase four-wire shunt active filters . Hybrid Filtering using Shunt Active Filters . Series Active Filtering in Harmonic Cancellation Mode .

**UNIT -V 9**

Current Harmonics - Sources of Harmonics in Distribution Systems and III Effects, Series Active Filtering in Harmonic Cancellation Mode . Series Active Filtering in Harmonic Isolation Mode . Dynamic Voltage Restorer and its control . Power Quality Conditioner.

**L:45; Total:45**

**REFERENCES:**

1. Reactive Power Control in Electric Systems by T.J.E Miller
2. Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems. by N.G. Hingorani & L. GyugyiIEEE Press, 2000.
3. Electric Power Quality by G.T.Heydt  
Understanding Power Quality Problems by Math H. Bollen J.Arrillaga, .Power System Quality Assessment., John wiley, 2000