Veer Surendra Sai University of Technology, Burla
Department of Electrical Engineering
Master of Technology in Power Electronics Control & Drives (Two Years Regular Course) 2010-11

1st. Semester							
Sl.No.	Subject Code	Subject	Hours			Credit	Total Contact Hours
			L	T	P		
1		Power Electronics Devices-I	4	0	0	4	
2		Advanced Control Systems	4	0	0	4	
3		Dynamics of Electrical Machines	4	0	0	4	
4		Advanced Digital Signal Processing	4	0	0	4	
5		**Elective -I(Any one)**	4	0	0	4	
		Power Semiconductor Devices & Modelling					
		Embedded Systems					
		Microprocessor & Microcontroller Based System					
		Data acquisition & Signal Condidtioning					
6		Power Electronics & Drives Lab.I	0	0	6	4	
7		Seminar-I	0	0	3	2	
8		Comprehensive Viva Voce	0	0	3	2	
		Total	20	0	12	28	32

2nd. Semester							
Sl.No.	Subject Code	Subject	Hours			Credit	Total Contact Hours
			L	T	P		
1		Power Electronics Devices-II	4	0	0	4	
2		Machines Drives	4	0	0	4	
3		FACTS Modelling, Control & Applications	4	0	0	4	
4		Digital Simulation of Power Electronic Systems	4	0	0	4	
5		**Elective-II (Any one)**	4	0	0	4	
		Power Quality					
		Nonlinear System Theory					
		Advanced Control of Drives					
		Switch Mode & Resonant Converters					
6		Power Electronics & Drives Laboratory-II	0	0	6	4	
7		Seminar-II	0	0	3	2	
8		Comprehensive Viva Voce	0	0	3	2	
		Total	20	0	12	28	32

3rd. Semester							
Sl.No.	Subject Code	Subject	Hours			Credit	Total Contact Hours
			L	T	P		
1		Dissertation Interim Evaluation	0	0	0	10	
2		Comprehensive Viva Voce	0	0	0	2	
3		Seminar on Dissertation	0	0	0	3	
		Total	0	0	0	15	

4th. Semester							
Sl.No.	Subject Code	Subject	Hours			Credit	Total Contact Hours
			L	T	P		
1		Dissertation Open Defence	0	0	0	5	
2		Dissertation Evalaution	0	0	0	20	
		Total	0	0	0	25	

(1ST SEMESTER)

MEE-201 POWER ELECTRONICS DEVICES-I (3-1-0)

MODULE-I (10 HOURS)

Line Frequency Diode Rectifiers . Single-Phase Diode Bridge Rectifiers with Capacitor Filter . Voltage Doubler Rectifiers. Effect of Single Phase Rectifiers on Neutral Currents in a Three Phase Four-Wire System. Three Phase half wave rectifier with resistive load . Three phase full wave rectifier. Double Y type rectifier. Single Phase rectifiers with LC filter . Cascaded LC Filter . LC Filter Design. Three Phase Rectifier Circuits. Design of Power Transformers for Rectifiers . Inrush Currents and Overvoltages at turn on in Rectifier Circuits Input Line Current Harmonics and power factor.

MODULE-II (10HOURS)

Line Frequency Phase-Controlled Rectifiers and Inverters. Single Phase - Half Wave Controlled Rectifier with R , RL , RL with Flywheel diode loads . Full Wave Controlled Rectifier with various kinds of loads . Half Controlled and Full Controlled Bridges with passive and active loads - Input Line Current Harmonics and Power Factor- Inverter Mode of Operation - Three Phase . Half Wave Controlled rectifier with RL Load . Half Controlled Bridge with RL Load . Fully Controlled Bridge with RL Load. Input Side Current Harmonics and Power Factor - Dual Converters . Circulating Current Mode and Non-Circulating Current Mode.

MODULE-III (8 HOURS)

AC Voltage Regulators and DC choppers-Types of ac voltage regulators -Single phase full wave ac voltage controller - Single phase transformer tap changer - Multistep transformer tap changer. D.C.chopper circuits, Type-A, B, C, D and E configurations, Analysis of Type-A chopper with R-L load. -Voltage and current commutated Choppers

MODULE-IV (13 HOURS)

Switch-Mode dc-ac Inverters. Basic Concepts . Single Phase Inverters . Push Pull , Half Bridge and Full Bridge Square Inverters .Blanking Time .Single Pulse Modulation of Single Phase Square Wave Inverters . Multi pulse modulation .- PWM Principles . Sinusoidal Pulse Width Modulation in Single Phase Inverters . Choice of carrier frequency in SPWM . spectral Content of output . Bipolar and Unipolar Switching in SPWM - Maximum Attainable DC Voltage Switch Utilization .Reverse Recovery Problem and Carrier Frequency Selection . Output Side Filter Requirements and Filter Design - Ripple in the Inverter Output - DC Side Current. - Three Phase Inverters -Three Phase Square Wave /Stepped Wave Inverters . Three Phase SPWM Inverters . Choice of Carrier Frequency in Three Phase SPWM Inverters . Output Filters . DC Side Current . Effect of Blanking Time on Inverter Output Voltage.

BOOKS

[1]. Ned Mohan et.al : *"Power Electronics"*, John Wiley and Sons

[2]. P.C. Sen : *"Power Electronics"*, Tata McGraw Hill

[3]. G.K.Dubey et.al , *"Thyristorised Power Controllers"*, Wiley Eastern Ltd.

[4]. B. K Bose : *"Modern Power Electronics and AC Drives"*, Pearson Education (Asia)

(1ST SEMESTER)

MEE-202 ADVANCED CONTROL SYSTEM (3-1-0)

MODULE-I (10 HOURS)

SISO Control Analysis and Design Analysis of SISO Control Loops, Classical PID Control, Synthesis of SISO Controllers, Fundamental Limitations in SISO Control, Model error Limitations, Structural Limitations, Frequency Domain design limitations, Architectural Issues in SISO Control, Internal Model Principle , Feedforward and Cascade Control, Anti-wind-up scheme, Introduction to Model Predictive Control

MODULE-II (10 HOURS)

Digital Computer Control, Models for sampled Data Systems, Sample Data Design, Internal Model Principle for Digital Control, Models for hybrid Control, Systems, Analysis of Intersample behaviour

MODULE-III (10 HOURS)

Advanced SISO Control. SISO CONTROLLER Parametrisations, Control Design Based on Optimisation, Synthesis via state space methods, Introduction to Nonlinear Control

MODULE-IV (10 HOURS)

MIMO Control Essentials, Analysis of MIMO Control Loops, Exploiting SISO Techniques in MIMO Control, MIMO Control Design: Design via Optimal control techniques, Model Predictive Control MIMO Controller Parametrisations, Decoupling

BOOKS

[1]. Graham C. Goodwin, Stefan F.Graebe, Mario E.Salgado, "*Control System Design*", PHI-2002.

[2]. M. Athans and P. Falb, "*Optimal control*", MGH

[3]. K. Astrom, and B.wittenmark, "*Computer Control Systems: Theory and design*", Prentice Hall

(1ST SEMESTER)

MEE-203 DYNAMICS OF ELECTRICAL MACHINES (3-1-0)

MODULE-I (10 HOURS)

Electro dynamical Equations and their Solution . A Spring and Plunger System- Rotational Motion System . Mutually Coupled Coils . Lagrange.s Equation . Application of Lagrange.s Equation to Electromechanical Systems . Solution of Electrodynamical Equations by Euler.s method and Runge-Kutta method . Linearisation of the Dynamic Equations and Small Signal Stability . Differential Equations of a smooth air-gap two winding machine . Conditions for Conversion of Average Power in such a Machine . A two phase machine with current excitation - Interpretation of the Average Power Conversion Conditions in terms of air-gap Magnetic Fields. The Primitive 4 Winding Commutaor Machine- The Commutator Primitive Machine . The Brush Axis and its Significance . Self and Mutually induced voltages in the stationary and commutator windings . Speed e.m.f induced in Commutator Winding . Rotational Inductance Coefficients . Sign of Speed e.m.f terms in the Voltage Equation . The Complete Voltage Equation of Primitive 4 Winding Commutator Machine . The Torque Equation . Analysis of Simple DC Machines using the Primitive Machine Equations.

MODULE-II (10 HOURS)

The Three Phase Induction Motor . Equivalent Two Phase Machine by m.m.f equivalence . equivalent two phase machine currents from three phase machine currents . Power Invariant Phase Transformation . Voltage Transformation . Voltage and Torque Equations of the Equivalent Two Phase Machine . Commutator Transformation and its interpretation . Transformed Equations . Different Reference Frames for Induction Motor Analysis . Nonlinearities in Machine Equations . Equations under Steady State - Solution of Large Signal Transients in an Induction Machine . Linearised Equations of Induction Machine . Small Signal Stability . Eigen Values . Transfer Function Formulation.

MODULE-III (10 HOURS)

The Three Phase Salient Pole Synchronous Machine . Three Phase to Two Phase Transformation . Voltage and Torque Equations in stator, rotor and air-gap field reference frames . Commutator Transformation and Transformed Equations . Parks Transformation . Suitability of Reference Frame Vs kind of Analysis to be Carried out . Steady State Analysis . Large Signal Transient Analysis . Linearisation and Eigen Value Analysis . General Equations for Small Oscillations . Small Oscillation Equations in State Variable form . Damping and Synchronizing Torques in Small Oscillation Stability Analysis. Application of Small Oscillation Models in Power System Dynamics.

MODULE-IV (10 HOURS)

Dynamical Analysis of Interconnected Machines . Machine Interconnection Matrices . Transformation of Voltage and Torque Equations using Interconnection Matrix . Large Signal Transient Analysis using Transformed Equations . Small Signal Model using Transformed Equations .

The DC Generator/DC Motor System . The Alternator /Synchronous Motor System . The Ward-Leonard System . Hunting Analysis of Interconnected Machines Selection of proper reference frames for individual machines in an Interconnected System.

BOOKS

[1]. D.P. Sengupta & J.B. Lynn, "*Electrical Machine Dynamics*", The Macmillan Press Ltd.

[2]. C.V. Jones, "*The Unified Theory of Electrical Machines"*, Butterworth, London.

[3]. Woodson & Melcher, "*Electromechanical Dynamics*", John Wiley & Sons

[4]. P.C. Kraus, "*Analysis of Electrical Machines*", McGraw Hill Book Company

[5]. I. Boldia & S.A. Nasar, "*Electrical Machine Dynamics*", The Macmillan Press Ltd.

(1ST SEMESTER)

MEE-204 ADVANCED DIGITAL SIGNAL PROCESSING (3-1-0)

MODULE-I (10 HOURS)

Discrete time signals, systems and their representations: Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform- Z- transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT

MODULE-II (10 HOURS)

Digital filter design and realization structures Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear transformation method- FIR filter design using window functions- Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures- Signal flow graph representations

MODULE-III (10 HOURS)

Analysis of finite word-length effects Quantization process and errors- Coefficient quantization effects in IIR and FIR filters- A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters

MODULE-IV (10 HOURS)

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

BOOKS

[1]. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,Tata Mc Grow-Hill edition .1998

[2]. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, Statistical and Adaptive Signal Processing, Mc Grow Hill international editions .-2000

[3]. Alan V . Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997

[4]. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing (third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997

[5]. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital Signal Processing-A practical Approach, Addison. Wesley, 1993

[6]. Abraham Peled and Bede Liu, Digital Signal Processing, John Wiley and Sons, 1976

(1ST SEMESTER)

(ELECTIVE-I)

MEE-205 POWER SEMICONDUCTOR DEVICES & MODELING (3-1-0)

MODULE-I (10 HOURS)

Solid State Power Devices: Construction and switching characteristics of Gate Turnoff Thyristor (GTO), .Power BJTs, Power MOSFETs, Insulated Gate Bipolar Transistors (IGBTs), Design of above devices drive circuits, switching and aid circuits. Methods of cooling and Protection

MODULE-II (10 HOURS)

Resonant DC-DC Converters: Operation, characteristics and design equations, Control techniques and application. Three Phase Square Wave /Stepped Wave Inverters. Three Phase SPWM Inverters. Effect of Blanking Time on Inverter Output Voltage. Selective Harmonic Elimination Method. Current controlled PWM, Bang-bang and space vector modulation techniques.

MODULE-III (10 HOURS)

Current Regulated Inverter -Current Regulated PWM Voltage Source Inverters. Hysteresis Control - Areas of application of Current Regulated VSI. Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode. Control Principles. Special Inverter Topologies - Current Source Inverter. Analysis of Single Phase Capacitor Commutated CSI. Resonant DC-link VSI, Its operation characteristics design and control.

MODULE-IV (10 HOURS)

Power Factor Control - Shunt Reactive Power Compensators. Switched Capacitors. Static Reactor Compensators based on thyristors. Static Reactive VAr Generators using PWM Current Regulated VSIs. Active power line conditioners, Active Power Filtering. Harmonic Generation by PE Equipment. Harmonic Pollution Standards. PWM Current Regulated VSI based implementation of a Single Phase Active Power Filter. Vector controlled and slip-power controlled Induction motor drives. Application of PC, DSP and microprocessor in machine drives

BOOKS

[1]. Ned Mohan Tora M. Undeland , William P.Robbins , " *Power Electronics* " John Wiley & Sons .

[2]. M H Rashid, "*Power Electronics*, Prentice Hall India,1993

[3]. B. K Bose, *Modern Power Electronics and AC Drives"*, Pearson Education (Asia), 1992.

[4]. Cyril W Lander, "*Power Electronics"*,1993

(1ST SEMESTER)

(ELECTIVE-I)

MEE-206 EMBEDED SYSTEM (3-1-0)

MODULE-I (10 HOURS)

Introduction: An embedded system, Processor in the system, Other hardware units, Software embedded into a systems, exemplary system-in-chip, Devices and Device Drivers : I/O devices, Timer and counting devices, serial communication using the IC, CAN and advance I/O buses between the networked multiple devices. Host system or computer parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X and advance buses. Device drivers, Parallel port devices drivers in a system, Serial port device drives in a system, Interrupt servicing (Handling) mechanism.

MODULE-II (10 HOURS)

Software and Programming Concept : Processor selection for an embedded system, memory selection for an embedded system, Embedded programming in C++, Embedded programming in JAVA, Unified modeling language (UML), Multiple processes and application, problem of sharing data by multiple tasks and routines, Inter process communication.

MODULE-III (10 HOURS)

Real time Operating System: Operating system services, I/O subsystem, Network operating system, Real Time and embedded system, Need of well tested and debugged Real Time operating system (RTOS), Introduction to C/OS-II.Case studies of programming with RTOS : Case study of an embedded system for a smart card

MODULE-IV (10 HOURS)

Hardware and Software Co-design : Embedded system project management, Embedded system design and co-design issues in system development process, design cycle in the development phase for an embedded system, Use of software tools for development of an embedded system, Issues in embedded system design.

BOOKS

[1]. Embedded System Architecture, Programming and Design, Raj Kamal, TMH

[2]. Hardware Software Codesign of Embedded System, Ralf Niemann, Kulwer Academic

[3]. Embedded Real time system Programming, Sriram V. lyer and Pankaj Gupat, TMH

(1ST SEMESTER)

(ELECTIVE-I)

MEE-207 MICROPROCESSOR AND MICROCONTROLLER BASED SYSTEMS (3-1-0)

MODULE-I (10 HOURS)

(Prerequisite: A basic course on 8 bit ups such as 8085), 16-bit microprocessor(one well known processor, say 8086 to 68000 to be taken as case study)-quick overview of the instruction set, Assembly language programming. Interrupt structure, Interfacing memory and IO devices. Memory organizations. Standard peripherals and their interfacing-(sw and hw aspects) color graphic terminals and ASCII keyboards, mouse, floppy and hard disc drive, other storage media (optical disks, Digital Audio Tapes etc.)

MODULE-II (10 HOURS)

Data transfer techniques-Asynchronous and synchronous. Serial and parallel interface standards. Communication media and adapters. Modems and their interfacing. Bus structures and standards-basic concepts. Example of a bus standard (PC-VME bus). Salient features of other processors (80286386486 or 680206803068040). Microcontrollers and digital signal processors. IO processors and arithmetic coprocessors. Logic design for microprocessor-based systems-design of state.

MODULE-III (10 HOURS)

Introduction to Microcontrollers - Motorola 68HC11 - Intel 8051 - Intel 8096 - Registers - Memories - I/O Ports - Serial Communications - Timers - Interrupts.

MODULE-IV (10 HOURS)

Instructions in Microcontrollers - Interfaces - Introduction to Development of a Microcontroller Based System - Concept of a Programmable Logic Controller-Features and parts in a PLC unit.

BOOKS

[1]. John.F.Wakerly: Microcomputer Architecture and Programming, John Wiley and Sons.

[2]. Ramesh S.Gaonker: Microprocessor Architecture, Programming and Applications with the 8085, Penram International Publishing (India).

[3]. Yu-Cheng Liu and Glenn A.Gibson: Microcomputer systems: The 8086/8088 Family Architecture, Programming and Design, Prentice Hall of India.

[4]. Raj Kamal: The Concepts and Features of Microcontrollers, Wheeler Publishing.

(1ST SEMESTER)

(ELECTIVE-I)

MEE-208 DATA ACQUISITION AND SIGNAL CONDITIONING (3-1-0)

MODULE-I (10 HOURS)

Transducers & Signal Conditioning Data Acquisition Systems(DAS)- Introduction . Objectives of DAS . Block Diagram Description of DAS- General configurations - Single and multichannel DAS- Transducers for the measurement of motion, force, pressure, flow, level, dc and ac voltages and currents (CTs, PTs for supply frequency as well as high frequency, Hall Effect Current Sensors, High Voltage Sensors , Optosensors, Rogowski Coil, Ampflex Sensors etc.) - Signal Conditioning: Requirements - Instrumentation amplifiers: Basic characteristics . Chopped and Modulated DC Amplifiers-Isolation amplifiers - Opto couplers - Buffer amplifiers .Noise Reduction Techniques in Signal Conditioning- Transmitters .Optical Fiber Based Signal Transmission-Piezoelectric Couplers-Intelligent transmitters.

MODULE-II (10 HOURS)

Filtering and Sampling Review of Nyquist.s Sampling Theorem-Aliasing . Need for Prefiltering-First and second order filters - classification and types of filters - Low -pass, High-pass, Band-pass and Band-rejection and All Pass: Butterworth, Bessel, Chebyshev and Elliptic filters . Opamp RC Circuits for Second Order Sections-Design of Higher Order Filters using second order sections using Butterworth Approximation-Narrow Bandpass and Notch Filters and their application in DAS. Sample and Hold Amplifiers

MODULE-III (10 HOURS)

Signal Conversion and Transmission Analog-to-Digital Converters(ADC)-Multiplexers and demultiplexers - Digital multiplexer . A/D Conversion . Conversion Processes , Speed, Quantization Errors . Successive Approximation ADC . Dual Slope ADC . Flash ADC . Digital-to-Analog Conversion(DAC) . Techniques, Speed, Conversion Errors, Post Filtering- Weighted Resistor, R-2R, Weighted Current type of DACs- Multiplying Type DAC-Bipolar DACs- Data transmission systems-Schmitt Trigger-Pulse code formats- Modulation techniques and systems-Telemetry systems.

MODULE-IV (10 HOURS)

Digital Signal Transmission And Interfacing DAS Boards-Introduction . Study of a representative DAS Board-Interfacing Issues with DAS Boards, I/O vs Memory Addressing, Software Drivers, Virtual Instruments, Modular Programming Techniques for Robust Systems, Bus standard for communication between instruments - GPIB (IEEE-488bus) - RS-232C- USB-4-to-20mA current loop serial communication systems. Communication via parallel port . Interrupt-based Data Acquisition.Software Design Strategies-Hardware Vs Software Interrupts-Foreground/ background Programming Techniques- Limitations of Polling . Circular Queues

BOOKS

[1]. Ernest O Doeblin., "Measurement Systems: Application and Design", McGraw Hill (Int. edition) 1990, ISBN 0-07-100697-4

[2]. George C.Barney, "Intelligent Instrumentation", Prentice Hall of India Pvt Ltd., New Delhi, 1988.

[3]. Ibrahim, K.E., "Instruments and Automatic Test Equipment", Longman Scientific & Technical Group Ltd., UK, 1988.

[4]. John Uffrenbeck, "The 80x86 Family ,Design, Programming, And Interfacing", Pearson Education , Asia.

(1ST SEMESTER)

MEE-291 POWER ELCTRONICS & DRIVES LAB-I (0-0-6)

1. Pspice simulation of single phase full converter using RL & E loads & single phase AC voltage controller using RL & E loads
2. Pspice simulation of resonant pulse commutation circuit and buck chopper
3. Pspice simulation single phase inverter with PWM control
4. Simulation of Buck/Boost DC-DC converter using PSPICE
5. Simulation of SMPS using Pspice
6. Simulation of 3-phase bridge converter in MATLAB with R-L-E load
7. Simulation of 1-phase bridge converter in MATLAB

(2ND SEMESTER)

MEE-209 POWER ELECTRONIC DEVICES-II (3-1-0)

MODULE-I (10HOURS)

Converters for Static Compensation . Standard Modulation Strategies - Programmed Harmonic Elimination . Multi-Pulse Converters and Interface Magnetics . Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies -Space Vector Modulation - Minimum ripple current PWM method. Multi-level inverters of Cascade Type. Current Regulated Inverter -Current Regulated PWM Voltage Source Inverters . Methods of Current Control . Hysteresis Control . Variable Band Hysteresis Control . Fixed Switching Frequency Current Control Methods . Switching Frequency Vs accuracy of Current Regulation . Areas of application of Current Regulated VSI .

MODULE-II (10 HOURS)

Switched Mode Rectifier - Operation of Single/Three Phase Bridges in Rectifier Mode . Control Principles . Control of the DC Side Voltage, Voltage Control Loop. The inner Current Control Loop. Special Inverter Topologies - Current Source Inverter . Ideal Single Phase CSI operation, analysis and waveforms - Analysis of Single Phase Capacitor Commutated CSI. Series Inverters . Analysis of Series Inverters . Modified Series Inverter . Three Phase Series Inverter

MODULE-III (10 HOURS)

Buck, Boost, Buck-Boost SMPS Topologies . Basic Operation- Waveforms - modes of operation- Output voltage ripple Push-Pull and Forward Converter Topologies - Basic Operation . Waveforms - Voltage Mode Control. Half and Full Bridge Converters . Basic Operation and Waveforms- Fly back Converter . discontinuous mode operation . waveforms . Control - Continuous Mode Operation . Waveforms

MODULE-IV (10 HOURS)

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

BOOKS

[1]. Ned Mohan et.al: Power Electronics John Wiley and Sons

[2]. Rashid: Power Electronics Prentice Hall India

[3]. G.K.Dubey et.al: Thyristorised Power Controllers, Wiley Eastern Ltd.

(2ND SEMESTER)

MEE-210 MACHINE DRIVES (3-1-0)

MODULE-I (10 HOURS)

Introduction to Motor Drives - Components of Power Electronic Drives - Criteria for selection of Drive components - Match between the motor and the load - Thermal consideration - Match between the motor and the Power Electronics converter - Characteristics of mechanical systems - stability criteria

MODULE-II (10 HOURS)

D.C Motor Drives - System model motor rating - Motor-mechanism dynamics - Drive transfer function - Effect of armature current waveform - Torque pulsations - Adjustable speed dc drives - Chopper fed and 1-phase converter fed drives - Effect of field weakening.

MODULE-III (10 HOURS)

Induction Motor Drives - Basic Principle of operation of 3 phase motor - Equivalent circuit - MMF space harmonics due to fundamental current - Fundamental spatial mmf distributions due to time harmonics - Simultaneous effect of time and space harmonics - Speed control by varying stator frequency and voltage - Impact of nonsinusoidal excitation on induction motors - Variable frequency converter classifications - Variable frequency PWM-VSI drives - Variable frequency square wave VSI drives - Variable frequency CSI drives - Comparison of variable frequency drives - Line frequency variable voltage drives - Soft start of induction motors - Speed control by static slip power recovery. - Vector control of 3 phase squirrel cage motors - Principle of operation of vector control-

MODULE-IV (10 HOURS)

Synchronous Motor Drives - Introduction - Basic principles of synchronous motor operation methods of control - operation with field weakening - load commutated inverter drives.

BOOKS

[1]. Ned Mohan, "*Power Electronics*", et. al Wiley.

[2]. G.K.Dubey & C.R.Kasaravada, "*Power Electronics & Drives*", Tata McGraw Hill.

[3]. W.Shephered, L N Hulley Cambride, "*Power Electronics & Control of Motor*", University Press.

[4]. Bubey, "*Power Electronics Drives"*, Wiley Eastern

(2ND SEMESTER)

MEE-109 FACTS MODELING CONTROL & APLLICATION (3-1-0)

MODULE-I (10 HOURS)

FACTS concepts and general system considerations: Power flow in AC system, transint stabiltiy and dynamic stability, basic description of FACTS controllers, brief review of voltage sourced converter and current sourced converter, modeling philosophy

Static var compensator (SVC and STATCOM): objectives of shunt compensation, methods of controllable Var Generation, regulation slope, transfer function, V-I and V-Q characteristics, transient stability enhancement, var reserve control, conventional power flow models, shunt variable susceptance model, firing angle model, transient stability model, voltage magnitude control using SVC & STACOM, Application example

MODULE-II (10 HOURS)

Static Series compensators (TCSC and SSSC): objectives of series compensation, improvements of voltage and transient stability, power oscillation damping, subsynchronous damping, transmittable power and transmittable angle charcteristics, control range, conventional power flow models, variable series impedance model, firing angle model, transient stability model, active power flow control using TCSC & SSSC, Application example

MODULE-III (10 HOURS)

Static voltage and phase angle regulator (TCVR and TCPAR): objectives of voltage and phase angle regulators, approaches to TCVR and TCPAR, switching converter based voltage and pahse angle regulators

Unified power flow controller: Basic operating principles, transmission control, independent real and reactive power flow control, power flow models, transient stability model, control structure, basic control system for P and Q control, dynamic performance, Application example

MODULE-IV (10 HOURS)

Breif control studies such as Steady state analysis and control, EMTP studies, power oscillation stability analysis and control, transient stability control

BOOKS

[1]. Y. H. Songs, A. T. Johns, *"Flexible AC Transmission Systems"*, IEE Press, 1999

[2]. N. G. Hingorani, L. Gyugyi, *"Understanding FACTS"*, IEEE Press, Indian Edition, 2001.

[3]. E. Acha, *"FACTS: modelling and simulation in power networks"*, John Wiley & Sons, 2004.

(2ND SEMESTER)

MEE-211 DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS (3-1-0)

MODULE-I (10 HOURS)

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.

MODULE-II (10 HOURS)

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 - Simple Multi-run Analyses - Statistical Analyses - Simulation Examples of Power Electronic systems.

MODULE-III (10 HOURS)

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.

MODULE-IV (10 HOURS)

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 - 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.

BOOKS

[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.

(2ND SEMESTER)

(ELECTIVE-II)

MEE-112 POWER QUALITY (3-1-0)

MODULE-I (10 HOURS)

PQ Definitions and StandardsGeneral Classification of PQ Phenomena IEEE and IEC PQ Standards, PQ Monitoring and MeasuringAvailable monitoring techniques and their drawbacks Commercial power quality monitors, Power quality monitors sensitivity PQ Problems Identification, PQ Phenomena ClassificationIdentification and localization of PQ problems Different PQ classification techniques and case studies

MODULE-II (10 HOURS)

Harmonic Sources, Effects, Analysis, and Modeling, Harmonic Distortion MitigationVoltage vs. Current Distortion, Harmonics vs. Transients Harmonic Sources from Commercial and Industrial Loads, Time domain versus frequency domain Different Harmonic filters (passive, active and hybrid); and case studies

MODULE-III (10 HOURS)

Voltage Sag, Swell and Interruptions, Transient Over-voltages, Sources of Sags and Interruptions, Fundamental Principles of Protection, Motor-Starting Sags, Utility System Fault-Clearing.Issues, and Case Studies, Sources of Transient Overvoltages; Principles of Overvoltage Protection and Switching Transient Problems with Loads

MODULE-IV (10 HOURS)

Voltage Flicker, Voltage Unbalance, Voltage RegulationSources of voltage flicker; Effects and mitigation techniques Sources of voltage unbalance; Effects and mitigation techniques Devices for Voltage Regulation; Utility Voltage Regulator Application and End-User Capacitor Application

BOOKS

[1]. R. Dugan, M. McGranaghan, S. Santoso and H. Beaty, Electrical Power System Quality, Second Edition, McGraw-Hill, 2002, ISBN 0-07-138622-X.

[2]. J. Arrillaga, B. Smith, N. Watson and A. Wood, Power System Harmonic Analysis, John Wiley, 1997, ISBN 0-471-97548-6.

[3]. Understanding Power Quality Problems by Math H. Bollen

[4]. J. Arrillaga, .Power System Quality Assessment., John wiley, 2000

(2ND SEMESTER)

(ELECTIVE-II)

MEE-113 NON LINEAR SYSTEM THEORY (3-1-0)

MODULE-I (10 HOURS)

Non Linear Systems:

Ordinary differential equation (ODE) systems, Differential & algebraic equation (DAE) systems, Equilibrium points, Limit cycles, pointcare maps, monodromy matrices, dynamic manifolds, region of attraction, Lyapunov stability,

MODULE-II (10 HOURS)

Numerical Methods: Newton Raphson, eigen value computation, initial value problems (IVP) and boundary value problems (BVP)

Definitions of local and global bifurcations saddle node bifurcations, transcritical bifurcations, pitchforks and Hopf bifurcations, Limit induced bifurcations, center manifolds

Normal forms: Lyapunov Schmidt reduction

DAE systems: bifurcations transversality conditions and singularity induced bifurcations

MODULE-III (10 HOURS)

Singular bifurcations computations: continuation methods and direct methods, optimization techniques

Hopf bifurcations computations: continuation methods and direct methods

Bifurcations of limit cycle: definition and computation

MODULE-IV (10 HOURS)

Chaotic Behavior:

Definition and examples of continuous and discrete (fractal) strange attractors.

Mechanisms that lead to chaos: Torus bifurcations period doubling, intermittency, instant chaos, fractal, dimensions, Lyapunov exponents, power spectra.

BOOKS

[1]. R Seydel, "*Practical Bifurcation and Stability Analysis*", Springer Verlag 1994

[2]. M Vidyasagar, "*Nonlinear Systems Analysis*", Prentice Hall

(2ND SEMESTER)

(ELECTIVE-II)

MEE-212 ADVANCED CONTROL OF DRIVES (3-1-0)

MODULE-I (10 HOURS)

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 coordinates. 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

MODULE-II (10 HOURS)

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.

MODULE-III (10 HOURS)

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 .

MODULE-IV (10 HOURS)

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

BOOKS

[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

(2ND SEMESTER)

(ELECTIVE-II)

MEE-213 SWITCHED MODE AND RESONANT CONVERTERS (3-1-0)

MODULE-I (10 HOURS)

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

MODULE-II (10 HOURS)

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.

MODULE-III (10 HOURS)

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

MODULE-IV (11 HOURS)

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.

BOOKS

[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.

[5]. Keith H Billings: Handbook of Switched Mode Power Supplies. McGraw Hill Publishing Company.

(1ST SEMESTER)

MEE-294 POWER ELCTRONICS & DRIVES LAB-II (0-0-6)

1. Analysis of Dual Converter fed DC motor Drive
2. Chopper Fed DC motor Drive
3. Performance study of Stator Voltage controlled Induction Motor Drive
4. Analysis of Vector Controlled Induction Motor D rive
5. IGBT based Three Phase inverter
6. IGBT based single phase PWM Inverter
7. Speed control of DC motor using three phase fully controlled converter
8. Three phase half wave cycloconverter
9. Simulation of power electronics systems using PSPICE
10. Modeling and simulation of electric Drives using MATLAB
11. Operation of Cycloconverter on R-L and Motor Load.
12. Speed control of Induction motor by operation of Cycloconverter on R-L and MotorLoad.