Biju Patnaik University of Technology, Orissa

Course for M.Tech. Syllabus

(Power Electronics & Drives / Power Electronics Engineering)

M.Tech (Power Electronics & Drives)

Sem – I

Professional Core	:	PC- 1 Power Converter - I
		PC- 2 Power Apparatus and Systems
		PC- 3 Electric Drives - I
Electives	:	EL- 1 a) Advanced Microprocessor & Micro Controller.
		OR
		b) Soft Computing.
		EL- 2 a) Optimization Techniques
		OR
		b) Power System Transient.
Sessional	:	SE- 1 : Modelling & Simulations
Seminar	:	Seminar-1 : Pre Thesis Work related Seminar

Sem – II

Professional Core	:	PC- 4 Power Converter II.
		PC- 5 Electric Drives II
Electives	:	EL- 3 a) HVDC & FACTS.
		OR
		b) Advanced Digital Signal Processing.
		EL- 4 a) Advanced Control Systems.
		OR
		b) Power System Dynamics.
		EL- 5 a) Power Quality
		OR
		b) Process Control and Instrumentation.
Sessional	:	SE- 2 : Power Electronics Lab
Seminar	:	Seminar - 2 : Pre Thesis Work related Seminar.
Comp. Viva Voce	:	Viva Voce- 1

Sem – III

Open Electives	:	OE-I a) Project Management
		OR
		b) Energy Management
		OR
		b) Industrial Management.
Thesis-Part-I	:	TH – I

Sem- IV

Thesis-Part-II	:	TH – II
Seminar	:	Seminar-3
Comp. Viva Voce	:	Viva Voce- 2

PC-1 Power Converter-I

Module-I (12 hours)

Phase controlled rectifiers– Single phase half wave controlled rectifier with R, R-L, R-L with freewheeling diodes.Full wave controlled rectifier with various kind 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 R,R-L an R-L-E loads.Thre phase semi and full converters with RL and RLE loads.Input side current harmonics and power factor. Dual converters-Circulating current mode and Non circulating current mode.

Module-II (12 hours)

AC voltage regulators and DC Choppers-Types of ac voltage regulators-single phase full wave ac voltage controllers-single phase transformer tap changers-Multistep transformer tap changer. Three phase ac voltage regulators. Output performance analysis of type A chopper, four quadrant chopper operation.

Module-III (14 hours)

Switch-mode dc-ac inverters. Basic concepts, single phase inverters,push pull, half bridge and full bridge square wave inverters, Blanking time, Single pulse modulation of single phase square wave inverters,Multi pulse modulation-PWM principle, Sinusoidal PWM in single phase inverters,Choice of carrier frequency in SPWM,Spectral content in the output,Unipolar and Bipolar 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,Output filters,DC side current, Effect of blanking time on inverter output voltage.

Text/References:

1. Ned Mohan et. al : Power Electronics ,John Wiley and Sons
2. P C Sen : Power Electronics , TMH
3. G K Dubey et. al : Thyristorised Power Controllers , Wiley Eastern Ltd.
4. B K Bose : Modern Power Electronics and AC Drives, Pearson Edn(Asia)

PC-2 POWER APPARATUS AND SYSTEMS

Module-I **(12 Hrs)**

Synchronous Machines: The basis of General Theory and Generalized Equation of A.C machines, Equation in terms of phase variable Park's transformation, Various reference frames, Derivation of two-axis equation, Torque equation, Field and damper windings, Equivalent circuits, Operational impedances and frequency response loci, Modified equation with more accurate coupling between field and damper windings.

Selected topics on prime mover and energy supply systems: Governors for hydraulic and steam turbines, Transient droop, speed governing system.

Module-II **(12 Hrs)**

Synchronous Generator short circuit and system faults: Symmetrical short circuit of unloaded generator, Analysis of short circuit oscillograms, short circuit of loaded synchronous generator, Unsymmetrical short of synchronous generator, system fault calculation, Sudden load changes, Equivalent circuit under transient condition, Constant flux linkage theorem, Simplified phasor diagram for transient changes.

Selected topics on excitation systems: Modeling of excitation system components, exciter (D.C and A.C), Amplifier, Stabilizing circuit

Module-III **(12 Hrs)**

Induction machines: Generator equation of the induction motor (equation), Application of equation in primary and secondary reference frames and complex form of equation, Short circuit and fault current due to the induction motor, fault calculation.

Transformers: Transient phenomena in transformer and transformer protection: General characteristics of over voltage and current inrush, Transient over voltage characteristics, Ferro resonant over voltages, protection against surges and insulation co-ordination.

BOOKS RECOMMENDED :

1. *The Generalized theory of electrical machines (Chapters: 1,2,34,5,8 and 11 by B.Adkins and R.H. Hiiley.*
2. *Principle, Operation and Design of power Transformer By S.B Vasciitnsky.*
3. *The J & P transformer Book (Chapter: 22&23) By S. Austen Stigant and A.C Franklin.*
4. *Power System Stability & Control (Chapters: 8&9) By P.Kundur, McGraw Hill-1994.*

PC – 3 Electric Drives- I

Module-I **12hrs**

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.

DC Motor Drives: System model, motor rating, motor-mechanism dynamics-Drive transfer function.

Module- II **14hrs**

Phase controlled D C Motor Drives- Steady state analysis of the 3-phase converter controlled DC motors Drive , Steady state solution including Harmonics, Discontinuous current conduction, Transfer functions of the sub systems, two quadrant dc motor drive with field weakening. Four quadrant dc motor drive.

Chopper- Controlled DC motor drive:
Four quadrant chopper circuit, chopper for inversion. Model of the chopper, steady state analysis of chopper- controlled dc motor drive – continuous and discontinuous conduction operation, closed-loop operation.

Module-III **12hrs**

Induction motor drives: Torque speed characteristics of 3-phase induction motor drive, speed control of 3-phase induction motor by varying stator frequency and voltage – impact of non sinusoidal 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, static Cramer and Scherbius drives.

Text / Reference

1. Ned Mohan etial : Power Electronics , John wiley and sous

2. R.Krishnan :Electric Motor Drives – PHI publication

3. B K Bose :Modern Power Electronics and AC drives, Pearson Education (Asia)

4. P C Sen : Power Electronics TMH Publication

5. Dubey : Power Electronics Drives- Wiley Eastern

ADVANCED MICROPROCESSOR AND MICROCONTROLLER

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 I\O devices. Memory organizations.

Standard peripherals and their interfacing-(s\w and h\w 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 (80286\386\486 or 68020\68030\68040). Microcontrollers and digital signal processors. I\O 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.

Text/References

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.

SOFT COMPUTING

Module-I **12hrs**

Basic tools of soft computing – Fuzzy logic, neural network , evolutionary computing.

Fuzzy Logic System:Basic of fuzzy logic theory , crisp and fuzzy sets, Basic set operation like union , interaction , complement , T-norm , T-conorm , composition of fuzzy relations, fuzzy if-then rules , fuzzy reasoning.

Fuzzy inference System:

Zadeh's compositional rule of inference, defuzzification , Mamdani Fuzzy Model, Sugeno Fuzzy Model,
Introduction to type –II Fuzzy System.

Module-II **20hrs**

Neural Network:

Supervised NN:Single layer network, Perception , Activation function, Adaline , Gradient descent method, least square training algorithm, Multilayer perceptron , error back propagation, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and MLP, Support Vector Machines : Optimal hypeplane for linearly separable patterns, optimal hyperplane for non-linearly separable patterns. Inverse Modeling.

Unsupervised NN and other NN:Competitive learning networks, kohonen self organizing networks, learning vector quantization, Hebbian Learning Hopfield Network: Content addressable nature, binary and continuous valued Hopfield network , simulated annealing NN. Recurrent Neural Network: NARX Model , Simple Neural Network , State – Space Model , Back Propagation Through Time (BPTT) Algorithm , Real-time Recurrent Learning (RTRL) Algorithm.

Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS) , ANFIS architecture , Hybrid Learning Algorithm , modeling of a three input nonlinear function , simulation of on-line identification in control system.

Data Clustering Algorithms-k-means clustering, fuzzy c-means clustering , subtractive clustering.

Module –III **8hrs**

EVOLUTIONARY AND BIO INSPIRED COMPUTING

Evolutionary computing: Genetic algorithm: Basic concept , encoding , fitness function , Reproduction , Basic genetic programming concepts , differences between GA and Traditional optimization methods , Applications, Variants of GA.

Bio Inspired optimization Techniques: Particle Swarm optimization , Ant colony optimization, Bacteria foraging method , Applications.

Text Book

1. *Neuro-Fuzzy and soft computing by J S R Jang, CT Sun and E.Mizutani , PHI PVT LTD.*
2. *Principles of soft computing –by sivandudam and Deepa publisher –John mikey India.*

Reference Book

S.haykins- Neural Networks: A comprehensive foundation.

Optimization Techniques

Module-I **12hrs**

Optimization Fundamentals:
Definition , classification of optimization problems, Unconstrained and constrained optimization, optimality conditions.
Linear Programming:
Simplex Method, Duality, Sensitivity methods.

Module-II **14hrs**

Nonlinear Programming:
Powel's method, steepest descent method, conjugate gradient method, Newton's Method GRG method, Sequential quadratic programming, Penalty function method, Augmented Lagrange multiplier method.

Dynamic Programming and Integer Programming
Interior point methods
Karmakar's algorithm , Dual affine, Primal affine , Barrie algorithm.

Module-III **10 hrs**

Simulated annealing , Evolutionary Programming , Genetic algorithm and Genetic Engineering.
Finite Element Based Optimization.

Reference Books

1. Ashok D.belegundu and Chrandrapatla T. R " Optimization Concept and Application in Engineering " Prentice Hall, 1999.
2. Rao S.S " Engineering Optimization"
3. Gill , Murray and Wright ," Practical Optimization"
4. James A. Memoh." Electic Power System Application of optimization."
5. song Y. , "Modern Optimization Techniques in power System"

POWER SYSTEMS TRANSIENTS

Module-I **(12 Hours)**

INTRODUCTION TO FAST TRANSIENTS:

Origin and nature of power system Transients, traveling waves on transmission system, the line equation, the shape attenuation and distortion of waves, reflection of traveling waves , successive reflections, traveling waves on multi conductor systems, transition points on multi conductor circuits.

LIGHTNING :

Charge formation , mechanism of lightning stroke. Mathematical model of lightning stroke.

Module-II **(12 Hours)**

THEORY OF GROUNDS WIRES :

Direct stoke to a tower, effect of reflection up and down the tower , the counterpoise.

SWITCHING SURGES :

Normal frequency effects, high charging currents, cancellation waves, recovery voltage, restricting phenomena. Protection of transmission systems against surge.

HIGH FREQUENCY OSCILLATIONS AND TERMINAL TRANSIENTS OF TRANSFORMER

Module-III **(12 Hours)**

INSULATION COORDINATION:

Insulation coordination procedures (IEC) for high voltage systems: Design criteria, classification of overvoltages, insulation design for switching, lightning and temporary overvoltages, pollution, application of arresters for protection of lines and stations, statistical methods of insulation coordination, risk of failure, test prescriptions. Insulation coordination procedures (IEC) for low voltage systems: representative overvoltages, selection of clearance and creepage distances, macro and micro environments, testing techniques, transient (switching and lightning) voltage surge suppression in industrial and commercial electrical installations, protection of electronic devices.

REFERENCES

1.Allan Greenwood , Electrical Transients in power Systems , Wiley Iterscience, 1991
2.Lou Van Der Sluis, Transients in power Systems , John Wiley & Sons Ltd, 2001
3.R Rudenterg, Transient Performance of Electric power systems, Phenomenon in Lumped Networks, MGH, 1950
4.R Rudenterg, Electric Stroke waves in power systems, Harvard University press, Cambridge, Massachusetts, 1968
5.Transmission Line Reference Book, EPRI, USA, 1982