JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

Course Structure and Detailed Syllabi for

M.Tech., Power Electronics and Electrical Drives (PE&ED)
Power Electronics (PE) & Power Electronics & Drives (PED),
Power & Industrial Drives (PID)
Offered by Department of EEE
for affiliated Engineering Colleges 2012-13

I YEAR I SEMESTER

S. No	Course code	Subject	Theory	Lab.	Credits
1.	9D49101	Modern Control Theory	4		4
2.	9D49102	Microprocessor and Microcontrollers	4		4
3.	9D54103	Principles of Machine modeling Analysis	4		4
4.	9D54104	Analysis of Power Electronic Converters	4		4
5.	9D54105	Power Electronic Control of DC Drives	4		4
6.	9D49106a 9D49106b	**Elective-I** a. Advanced Digital Signal Processing b. Neural Networks and Fuzzy Systems	4		4
7.	9D54107	Power Converters Lab		3	2
		contact periods/week	24	3	26
			Total 27		

I YEAR II SEMESTER

S. No	Course Code	Subject	Theory	Lab.	Credits
1.	9D49201	Flexible AC Transmission Systems	4		4
2.	9D49202	HVDC Transmission	4		4
3.	9D54203	Power Electronic Control of AC Drives	4		4
4.	9D54204	Advanced Power Semiconductor Devices & Protection	4		4
5.	9D54205	Modern Power Electronics	4		4
6.	9D49206a 9D49206b	**Elective-II** a. Programmable Logic Controllers b. Energy Auditing, Conservation And Management	4		4
7.	9D54207	Electrical Systems Simulation Lab		3	2
		contact periods/week	24	3	26
			Total 27		

II YEAR (III & IV Semesters)

S. No	Course code	Subject		credits
1	9D54401	Seminar		2
2	9D54202	Project work		16

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M.Tech. I SEMESTER (PEED) **Th 4** **C 4**

(9D49101) MODERN CONTROL THEORY

UNIT –I MATHEMATICAL PRELIMINARIES - Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigen values, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Nonuniqueness of state model – State diagrams for Continuous – Time state models –

UNIT – II STATE VARIABLE ANALYSIS - Linear Continuous time model for physical systems – Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – State transition matrix and it's properties

UNIT – III CONTROLLABILITY AND OBSERVABILITY - General concept of Controllability - General concept of Observability Controllability tests for Continuous – Time Invariant systems - Observability tests for Continuous - Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model

Unit – IV NON LINEAR SYSTEMS – I - Introduction – Non Linear Systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc; - Singular Points – Introduction to Linearization of nonlinear systems, properties of Non Linear Systems – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions

UNIT – V NON LINEAR SYSTEMS – II - Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT - VI STABILITY ANALYSIS - Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

UNIT – VII STATE FEEDBACK CONTROLLERS AND OBSERVERS - State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order

UNIT – VIII OPTIMAL CONTROL - Introduction to optimal control – Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear quadratic regulator

REFERENCE BOOKS:

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Optimal control by Kirk

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M.Tech. I SEMESTER (PEED) **Th** **C**
4 **4**

(9D49102) MICROPROCESSORS AND MICROCONTROLLERS

Unit I Intel 8086/8088 - Architecture, its register organization, Pin diagram, Minimum and Maximum Mode System and Timings, Machine language instruction formats, Addressing modes, Instruction set, Assembler directives.

Unit II Hardware description - Pin diagram, Minimum and Maximum Mode and Bus Timings, Ready and Wait states and 8086 based micro-computing system

Unit III ALP Programming & special features - ALP, programming with an assembler, stack structure, Interrupts, Service subroutines and Interrupt programming and Macros.

Unit IV Advanced Processors - Architectural features of 80386, 486 and Pentium Processors their memory management, Introduction to Pentium Pro Processors their features, RISC Vs CISC Processors.

Unit V Basic Peripherals & Their Interfacing:- Memory Interfacing (DRAM), PPI- Modes of operation of 8255, interfacing to ADC & DAC

Unit VI Special Purpose of Programmable Peripheral Devices and Their Interfacing:
Programmable timer- 8253, PIC 8259A, Display controller, Programmable Communication Interface 8251-USART and their interfacing.

Unit VII Micro Controllers - Introduction to Intel 8-bit and 16-bit Micro controllers, 8051-Architecture, memory organization, Addressing modes .

Unit VIII Hardware Description of 8051 - Instruction formats, Instruction sets, Interrupt structure and interrupt priorities, Port structures and Operation Linear Counter functions, Different modes of operation and programming Examples.

REFERENCE BOOKS:

1. "The Intel Microprocessors", Architecture, Programming and interfacing by Barry b Brey
2. 8086 Micro Processors by Kenrith J Ayala, Thomson Publishers.
3. Microcontrollers by K.J.Ayala - Thomson Publishers.
4. Micro Processors and Interfacing Programming and Hardware by Douglas V. Hall.
5. The 8088 and 8086 Microprocessor- W.A. Triebel & Avtar Singh- PHI, 4th Edn, 2002.

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M.Tech. I SEMESTER (PEED) **Th C**
4 4

(9D54103) PRINCIPLES OF MACHINE MODELING AND ANALYSIS

Unit I: Basic concepts of Modeling

Basic Two-pole Machine representation of Commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

Unit II: DC Machine Modeling

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations

Unit III Modeling of Three Phase Induction Machine - I

Transformation from Three phase to two phase and Vice Versa - Transformation from Rotating axes to stationary axes and vice versa –Park's Transformation and it's physical concept –The Inductance matrix-Mathematical model of Induction machine –Steady State analysis.

UNIT IV Modeling of Three Phase Induction Machine - II

D-Q model of induction machine in Stator reference Frame, Rotor reference Frame and Synchronously rotating reference Frame -Small signal equations of induction machine-d-q flux linkages model derivation- Signal flow graph of the induction machine-Per unit model -Dynamic simulation of induction machine.

Unit V Modeling of Single Phase Induction Machine

Comparison between single phase and poly-phase induction motor - Cross field theory of single-phase induction machine, steady state analysis – steady state torque

Unit VI Modeling of Synchronous Machine

Synchronous machine inductances –The phase Co-ordinate model-The Space phasor (d-q) model-Steady state operation-Mathematical model of PM Synchronous motor.

Unit VII Modeling of Special Machines –I

Modelling of Permanent Magnet Brushless DC Motor – Operating principle-Mathematical modeling of PM Brushless DC motor-PMDC Motor Drive Scheme.

Unit VIII Modeling of Special Machines –II

Mathematical model of Switched Reluctance Motor-Operating principle-Construction and functional Aspects-Average torque and Energy Conversion Ratio-The Commutation windings-SRM modeling-The flux current position curve fitting.

Reference Books:

1. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995
2. The Unified Theory of Electrical Machines by C.V.jones, Butterworth- London, 1967
3. Electric Motor Drives Pearson Modeling, Analysis& control -R.Krishnan- Publications-1st edition -2002
4. Electrical Drives- I. Boldea & S.A. Nasar-The Oxford Press Ltd.
5. Electrical Machine Dynamics- D.P. Sengupta & J.B. Lynn- The Macmillan Press
6. Electromechanical Dynamics- Woodson & Melcher -John Wiley & Sons
7. Analysis of Electrical Machinery – P.C.Krause – McGraw Hill- 1980

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M.Tech. I SEMESTER (PEED) **Th 4** **C 4**

(9D54104) ANALYSIS OF POWER ELECTRONIC CONVERTERS

Unit-I Single Phase AC voltage Controllers

Single Phase AC Voltage Controllers with resistive, resistive-inductive and resistive-inductive-induced emf loads-ac voltage controller's wit PWM control-Effects of source and load inductances –synchronous tap changers –Application- numerical problems

Unit-II Three Phase AC Voltage Controllers

Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application- numerical problems.

Unit-III Cycloconverters

Single phase to single phase cycloconverters –analysis of midpoint and bridge configurations-three phase to three phase cycloconverters-analysis of Midpoint and bridge configurations-Limitations-Advantages-Applications-numerical problems

Unit –IV Single phase converters

Single phase cycloconverters- Half controlled and fully controlled Converters – Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Single phase dual converters-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters–Application- numerical problems

Unit-V Three Phase Converters

Three Phase Converters- Half controlled and fully controlled Converters – Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual

converters-Power factor improvements-three phase PWM-twelve pulse converters–Application-numerical problems

Unit-VI D.C. to D.C Converters

Analysis of step-down and step up dc to dc converters with resistive and resistive –inductive loads-Switched mode regulators- Analysis of Buck regulators-Boost Regulators-Buck-Boost Regulators-Cuk Regulators- Condition for continuous inductor and capacitor voltage-Comparison of regulators-Multi output boost regulators –advantages –Application- numerical problems

Unit –VII Pulse Width Modulated Inverters (Single Phase Inverter)

Principle of operation- Performance parameters- Single Phase bridge Inverters-Evaluation of output voltage and current with resistive, inductive and capacitive loads-Voltage control of single phase inverters – Single PWM-Multiple PWM-Sinusoidal PWM-modified PWM-phase displacement control-Advanced Modulation techniques for improved performance , Trapezoidal, staircase ,stepped, harmonic injection and delta modulation – Advantage–Application- numerical problems

Unit VIII Pulse Width Modulated Inverters (Three Phase Inverter)

Three Phase inverters-analysis of 180 degree condition of output voltage and current with resistive, inductive loads-analysis of 120 degree conduction-Voltage control of three phase inverters-sinusoidal PWM-third harmonic PWM-60 degree PWM –space vector modulation-comparison of PWM techniques-Space vector modulation-Comparison of PWM techniques-harmonic reduction –current source inverters-Variable dc link inverter –boost inverters- buck and boost inverter – inverter circuit design – Advantage-–Application- numerical problems

REFERENCES:

1. Power Electronics-Md.H.Rashid –Pearson Education 3rd Edition, 2004
2. Power Electronics- N.Mohan, Tore.M.Undeland, W.P.Robbins –John Wiley,s -2nd Edition.

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M.Tech. I SEMESTER (PEED) **Th 4** **C 4**

(9D54105) POWER ELECTRONIC CONTROL OF DC DRIVES

Unit-1 Controlled Bridge Rectifier (1-Φ) with DC Motor Load - Separately excited DC motors with rectified single phase supply- single phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor.

Unit-II Controlled Bridge Rectifier (3-Φ) with DC Motor Load - Three phase semi converter and three phase full converter for continuous and discontinuous modes of operation – power and power factor – Addition of Free wheeling diode – Three phase double converter.

Unit-III Three phase naturally commutated bridge circuit as a rectifier or as an inverter - Three phase controlled bridge rectifier with passive load impedance, resistive load and ideal supply – Highly inductive load and ideal supply for load side and supply side quantities, shunt capacitor compensation, three phase controlled bridge rectifier inverter.

Unit-IV Phase Controlled DC Motor Drives - Three phase controlled converter, control circuit, control modeling of three phase converter – Steady state analysis of three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive – DC motor and load, converter.

Unit-V Current and Speed controlled DC Motor drives - Current and Speed controllers - current and speed feedback — Design of controllers - Current and Speed controllers – Motor equations – Filter in the speed feedback loop speed controller – current reference generator – current controller and flow chart for simulation – Harmonics and associated problems – sixth harmonics torque.

Unit-VI Chopper controlled DC motor drives - Principle of operation of the chopper – Four quadrant chopper circuit – Chopper for inversion – Chopper with other power devices – model of the chopper –input to the chopper – Steady state analysis of chopper controlled DC motor drives – rating of the devices – Pulsating torque.

Unit- VII Closed loop operation of DC motor Drives - Speed controlled drive system – current control loop – pulse width modulated current controller – hysterisis current controller – modeling of current controller – design of current

Unit-VIII Simulation of DC motor Drives - Dynamic simulations of the speed controlled DC motor drives – Speed feedback speed controller – command current generator – current controller.

REFERENCES

1. Power Electronics and motor control–Shepherd,Hulley, Liang – II Edn, CU Press
2. Electric motor drives modeling, Analysis and control – R. Krishnan – I Edn, PHI.
3. Power Electronic Circuits, Devices and Applications - M.H.Rashid–PHI, I Edn – Fundamentals of Electric Drives – G. K. Dubey – Narosa Publications – 1995.
4. Power Semiconductor drives – S.B. Dewan and A. Straughen – 1975.

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M.Tech. I SEMESTER (PEED) **Th C**
4 4

ELECTIVE-I
(9D49106a) ADVANCED DIGITAL SIGNAL PROCESSING
(Common for EPS, EPE, PE & PE&ED)

UNIT-I: Short introduction, Analog to digital and Digital to Analog conversion, sampled and Hold circuit, Continuous time Fourier Transforms.

UNIT-II: Discrete-time signals and systems, Discrete-time Fourier transform- its properties and applications, Fast Fourier Transform (in time-domain and Frequency domain) , IDFT and its properties.

UNIT-III: z- Transform: Definition and properties, Rational z-transforms, Region of convergence of a rational z- Transform, The inverse z- Transform, Z-Transform properties, Computation of the convolution sum of finite-length sequences, The transfer function

UNIT-IV: Digital filter structures: Block Diagram representation, Equivalent structures, Basic FIR Digital Filter structures, Basic IIR Digital Filter structures, Realization of Basic structures using MATLAB, All pass filters, Computational complexity of Digital filter structures.

UNIT V: IIR Digital filter design: Preliminary considerations, Bilinear transformation method of IIR Filter design, Design of low pass IIR Digital filters, Design of High pass, Band pass and band stop IIR digital filters, Spectral Transformations of IIR filter, IIR digital filter design using MATLAB, Computer aided design of IIR digital filters.

UNIT VI: FIR digital filter design: Preliminary considerations, FIR filter design based on windowed Fourier series, Computer aided design of Equiripple Linear phase FIR filters, Design of Minimum phase FIR filters, FIR digital filter design using MATLAB, Design of computationally efficient FIR digital filters.

UNIT VII: Analysis of Finite word length effects: The quantization process and errors, quantization of Fixed point numbers, Quantization of floating point numbers, Analysis of coefficient quantization effects, Analysis of arithmetic round off errors, Low sensitivity digital filters, Reduction of product round off errors using error feedback, Round off errors in FFT algorithms.

UNIT VIII: The basic sample rate alteration devices, Multi rate structures for sampling rate conversion, Multistage design of decimator and interpolator, The Polyphase decomposition, Arbitrary-rate sampling rate converter, Nyquist Filters and some applications of digital signal processing.

TEXT BOOKS

1. Digital Signal Processing- S.K. Mitra, Tata McGraw-Hill, Third Edition, 2006.
2. Principle of Signal Processing and Linear Systems- B.P. Lathi, Oxford International Student Version, 2009
3. Continuous and Discrete Time Signals and Systems- M. Mondal and A Asif, Cambridge, 2007

REFERENCES

1. Digital Signal Processing- Fundamentals and Applications- Li Tan, Indian reprint, Elsevier,2008.
2. Discrete- Time Signal Processing- Alan V. Oppenheim, Ronald W. Schafer, and John R.Buck, Pearson Education, 2008.

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M.Tech. I SEMESTER (PEED)	**Th**	**C**
	4	**4**

ELECTIVE –I
(9D49106b) NEURAL NETWORKS & FUZZY SYSTEMS

Unit-I Introduction to Neural Networks

Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.

Unit-II Essentials of Artificial Neural Networks

Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN-Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

Unit-III Feed Forward Neural Networks

Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Multilayer Feed Forward Neural Networks -Credit Assignment Problem, Generalized Delta Rule, Derivation of Backporpagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

Unit-IV Associative Memories - Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory), Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem.
Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network.

Unit-V Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART) - Introduction, Competitive Learning, Vector Quantization, Self-Organized Learning Networks, Kohonen Networks, Training Algorithms, Linear Vector Quantization, Stability- Plasticity Dilemma, Feed forward competition, Feedback Competition, Instar, Outstar, ART1, ART2, Applications.

Unit-VI Classical & Fuzzy Sets -Introduction to classical sets – properities, Operations and relations; Fuzzy sets, Membership, Uncertainity, Operations, Properities, fuzzy relations, cardinalities, membedship functions.

Unit-VII Fuzzy Logic System Components - Fuzzification, Membership Value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Unit-VIII Applications - Neural network applications: Process identification, Fraction Approximation, Control and Process Monitoring, Fault diagnosis and Load forecasting.
Fuzzy logic applications: Fuzzy logic control and Fuzzy classification.

TEXT BOOK:

1. Neural Networks, Fuzzy logic , Gnenetic algorithms: synthesis and applications by Rajasekharan and Rai- PHI Publication.
2. Introduction to Artificial Neural Systems- Jacek M.Zurada, Jaico Publishing House, 1997.

REFERENCE BOOKS:

1. Neural and Fuzzy Systems: Foundation, Architectures and Applications, - N. Yadaiah and S. Bapi Raju, Pearson Education
2. Neural Netwroks – James A Freeman and Davis Skapura, Pearson, 2002
3. Neural Netwroks – Simon Hykins, Pearson Education.
4. Neural Engineering by C. Eliasmith and CH. Anderson, PHI.
5. Neural Netwroks and Fuzzy Logic System by Brok Kosko, PHI Publications

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR

M.Tech. II SEMESTER (PEED) **Th 4** **C 4**

(9D49201) FLEXIBLE A.C. TRANSMISSION SYSTEMS

Unit 1:
FACTS concepts: Transmission interconnections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters basic types of FACTS controllers, benefits from FACTS controllers.

Unit 2:
Voltage source converters: Single phase three phase full wave bridge Converters transformer connections for 12 pulse 24 and 48 pulse operation.

Unit 3:
Three level voltage source converter, pulse width modulation converter, basic concept of current source Converters, and comparison of current source converters with voltage source converters.

Unit 4:
Static shunt compensation: Objectives of shunt compensation, mid point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping.

Unit 5:
Methods of controllable var generation, variable impedance type static var generators switching converter type var generators hybrid var generators.

Unit 6:
SVC and STATCOM: The regulation and slope transfer function and dynamic performance, transient stability enhancement and power oscillation damping operating point control and summary of compensator control.

Unit 7:
Static series compensators: concept of series capacitive compensation, improvement of transient stability, power oscillation damping.

Unit 8:
Functional requirements, GTO thyristor controlled series capacitors (GSC), thyristor switched series capacitor (TSSC).and thyristor controlled series capacitor (TCSC) control schemes for GSC TSSC and TCSC.

Text Book:
"Understanding FACTS Devices" N. G. Hingorani and L. Guygi. IEEE Press Publications 2000.

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M.Tech. II SEMESTER (PEED) **Th 4** **C 4**

(9D49202) H.V.D.C. TRANSMISSION

Unit-1 :
H.V.DC Transmission : General consideration , Power Handling Capabilities of HVDC lines , Basic Conversion principles , static converter configuration.

Unit-2:
Static Power Converters: 3 pulse, 6 pulse & 12 pulse converters, converter station and terminal equipment communication process, Rectifier and inverter operation, equivalent circuit for converter- special futures of converter transformers.

Unit-3:
Harmonics in HVDC systems, harmonicas elimination, AC & DC filter

Unit-4:
Control of HVDC converter and systems: constant current, constant extinction angle and constant ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control

Unit-5:
Interaction between HVAC & DC systems –voltage interaction, harmonic instability problems and DC power modulation.

Unit-6:
Multi-terminal DC link and systems; series, parallel and series parallel systems, their operation and control.

Unit-7:
Transient over voltage in HVDC systems: Over voltages due to disturbance on DC side, over voltages due to DC and AC side line faults.

Unit-8:
Converter faults and protection in HVDC systems: Converter faults, over current protection- valve group and DC line protection. Over voltage protection of converters, surge arresters.

REFERENCES:
1.E.W.Kimbark: Direct current Transmission, Wiely inter Science- New york.
2.J.Arillaga: H.V.D.C.Tranmission peter peregrilnus ltd., London UK 1983
3.K.R.Padiyar: High Voltage Direct current Transmission, Wiely Eastern Ltd
4.E.Uhlman: Power Transmission by Direct Current Springer Verlag, Berrlin

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M.Tech. II SEMESTER (PEED) **Th 4** **C 4**

(9D54203) POWER ELECTRONIC CONTROL OF AC DRIVES

Unit-I Introduction to AC drives
Introduction to motor drives-torque production- Equivalent circuit analysis-Speed-Torque characteristics with variable voltage operation, variable frequency operation, constant v/f operation-Induction motor characteristics in constant torque and field weakening regions

Unit-II Control of Induction motor drives at stator side
Scalar control-Voltage fed inverter control-Open loop volts/Hz Control-Speed control slip regulation- Speed control with torque and flux control-Current controlled voltage fed inverter drive-Current fed inverter control-Independent current and frequency control-Speed and flux control in current fed inverter drive-Volts/Hertz Control current fed-Inverter drive-Efficiency optimization control by flux program

Unit-III Control of Induction motor at rotor Side
Slip power recovery drives-Static Kramer Drive-Phasor diagram-Torque expression-Speed control of Kramer Drive-Static Scheribus Drive- Modes of operation

Unit-IV Vector control of Induction motor Drives
Principles of Vector Control-Vector Control Methods-Direct method of Vector control-Adaptive control principles-Self tuning regulator-Model referencing control

Unit-V Control of Synchronous motor Drives
Synchronous motor and its characteristics – control strategies – constant torque angle control-Unity power factor control-Constant mutual flux linkage control

Unit-VI Controllers
Flux weakening operation- Maximum speed-Direct flux weakening algorithm – Constant torque mode controller- Flux Weakening controller- Indirect flux weakening – Maximum permissible torque-Speed control scheme- Implementation strategy – Speed controller design

Unit-VII Variable Reluctance motor Drive
Variable reluctance motor drives- Torque Production in the variable reluctance motor- Drive characteristics and control principles- Current control variable reluctance servo drive.

Unit VIII Brushless DC motor Drives
Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor-Current controlled Brushless dc servo drives

REFERENCES

1. Electric Motor Drives modeling, analysis and control R.Krishnan, Pearson Publication,1/e -2002
2. Modern Power Electronics and AC drives-B.K Bose-Pearson Publication -1ST Edition
3. Power Electronic Control of AC motors- MD Murphy & FG Turn Bull Pergman Press(For Chapters II,III, V) – 1st Edition
4. Power Electronics and AC drives-B.K Bose-Prentice Hall Publication -1ST Edition
5. Power Electronics Circuits , Devices and Application- M.H Rashid –PHI 1995
6. Fundamentals of Electric Drives –GK Dubey- Narora Publications -1995
7. Power Electronics and Variable Frequency drives-B.K.Bose-IEEE press-Standard publication-1ST Edition-2002

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M.Tech. II SEMESTER (PEED) **Th C**
4 4

(9D54204) ADVANCED POWER SEMICONDUCTOR DEVICES AND PROTECTION

Unit I BJTs

Introduction- vertical power transistor structures-I-V characteristics-physics of BJT operation switching characteristics-break down voltages-second break down-on-state losses-safe operation areas design of drive circuits for BJTs-snubber circuits for BJTs and darlingtons

Unit-II Power MOSFETs

Introduction-basic structures-I-V characteristics-physics of device operation-switching characteristics-operation limitations and safe operating areas-design of gate drive circuits-snubber circuits

Unit III Gate Turn-Off Thyristors

Introduction-basic structures-I-V characteristics-physics of device operation-GTO switching characteristics-snubber circuits-over protection of GTOs.

Unit IV Insulated Gate Bipolar Transistors

Introduction-basic structures-I-V characteristics-physics of device operation-Latch in IGBTs-switching characteristics-Device limits and safe operating areas-drive and snubber circuits.

Unit V Emerging Devices and Circuits

Introduction-Power junction field effect transistors-field controlled Thyristor-JFET based devices versus other power devices-MOS controlled Thyristors-high voltage integrated circuits-new semiconductor materials

Unit VI Passive Components and Electromagnetic compatibility

Introduction-design of inductor-transformer design-selection of capacitors-resistors current measurements-heat sinking circuit lay out –Electromagnetic Interference (EMI)-Sources of EMI-Electromagnetic Interference in Power Electronic Equipment

Unit VII Noise

Noise sources in SMPS-Diode Storage Charge Noise-Noise generated due to switching-Common noises sources in SMPS-Noises Due to High frequency transformer-How the conducted noise is measured - minimizing EMI-EMI shielding-EMI standards.

UNIT-VIII Protection of Devices & Circuits

Cooling & Heat sinks – Thermal modeling of powerswitching devices- snubber circuits – Reverse recovery transients – Supply and load side transients – voltage protections – current protections.

Reference books

1. Power Electronics Circuits, Devices and Applications – M.H.Rashid-PHI-
2. Power Electronics –Converters, Applications and Design – Mohan and Undeland-John Wiley&Sons
3. Power Electronics Circuits-Vithayathil
4. Power Electronics Circuits-W.C. Lander

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M.Tech. II SEMESTER (PEED) **Th** **C**
4 **4**

(9D54205) MODERN POWER ELECTRONICS

UNIT I: Modern power semiconductor devices

Modern power semiconductor devices- MOS Turn Off Thyristor (MTO) – Emitter Turn Off Thyristor (ETO) – Integrated Gate – Commutated thyristor (IGCTs) – MOS – controlled thyristors (MCTs) – Static induction Thyristors (SITHs) – Power integrated circuits (PICs) – Symbol, structure and equivalent circuit- comparison of their features.

UNIT-II: Resonant pulse inverters:

Resonant pulse inverters – series resonant inverters- series resonant inverters with unidirectional switches – series resonant inverters with bidirectional switches- analysis of half bride resonant inverter- evaluation of currents and Voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverter- for series loaded inverter – for parallel resonant inverters – Voltage control of resonant inverters-class E resonant inverter – class E resonant rectifier- evaluation of values of C's and L's for class E inverter and Class E rectifier – numerical problems.

UNIT-III: Resonant Converters:
Resonant converters- zero current switching resonant converters – L type ZCS resonant converter- M type ZCS resonant converter – zero voltage Switching resonant converters – comparison between ZCS and ZVS resonant converters- Two quadrant ZVS resonant converters – resonant dc – link inverters- evaluation of L and C for zero current switching inverter – Numerical problems.

UNIT-IV Multilevel Inverters:
Multilevel concept- Classification of multilevel inverters – Diode clamped Multilevel inverter- Principle of operation – main features- improved diode clamped inverter – principle of operation – Flying capacitors multilevel inverter – principle of operation – main features.

UNIT-V: Multilevel inverters (continued)
Cascaded multilevel inverter – principle of operation – main features- multilevel inverter applications – reactive power compensation – back to back intertie system – adjustable drives – switching device currents – dc link capacitor voltage balancing –features of Multilevel inverters – comparisons of multilevel converters.

UNIT -VI: DC Power supplies:
DC power supplies – classification- switched mode dc power supplies – fly back Converter- forward converter- push –pull converter –half bridge converter –Full bridge converter – Resonant DC power supplies- bidirectional power supplies- Application.

UNIT -VII: AC Power Supples:
AC power supplies – classification – switched mode ac power supplies Resonant AC power supplies-bidirectional ac power supplies – multistage conversions- control circuits- applications.

UNIT-VIII: Power conditioners and Uninterruptible Power Supplies:
Introduction- power line disturbances – power conditioners- uninterruptible power supplies- applications.

TEXT BOOKS:
1. Power Electronics: Mohammed H.Rashid-Pearson Education- Third Edition –first Indian reprint-2004
2. Power Electronics – Ned Mohan, Tore M.Undeland and William P.Robbind – John wiley & Sons – Second Edition.

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M.Tech. II SEMESTER (PEED) **Th 4** **C 4**

ELECTIVE II
(9D49206a) PROGRAMMABLE LOGIC CONTROLLERS

Unit 1:
PLC basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Unit 2:
PLC programming: Input instructions, Outputs, operational procedures, programming examples using contacts and coils, drill press operation .

Unit 3:
Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram constructions and flow charts for spray process system.

Unit 4:
PLC registers : characteristics of registers module addressing, holding registers,Input registers, Output registers.

Unit 5:
PLC functions: Timer functions and industrial applications, counters, counter function industrial applications, arithmetic functions, number comparison

Unit 6:
Data handling functions: SKIP, master control relay, jump, move, FIFO, FAL, ONS , CLR and SWEEP functions and their applications.

Unit 7:
Bit pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis robots with PLC, matrix functions.

Unit 8:
Analog PLC operation : Analog modules and systems, analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

REFERENCES:

1. Programmable logic controllers-Principle and applications by John W.Webb and Ronald A.Reiss, fifth edition ,PHI.
2. Programmable logic controllers- Programming Method and applications by JR Hackworth and F.D Hackworth Jr.- Pearson, 2004.

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M.Tech. II SEMESTER (PEED) **Th 4** **C 4**

ELECTIVE-II
(9D54207) ENERGY AUDITING, CONSERVATION & MANAGEMENT
(Common to EPS,EPE,PE,PE&ED)

Unit I Basic principles of Energy audit:
Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams , load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential ,energy audit of process industry, thermal power station, building energy audit

Unit II Energy management-I
Principles of energy management, organizing energy management program, initiating, planning , controlling, promoting, monitoring, reporting.

Unit III Energy management-II
Energy manger, Qualities and functions , language ,Questionnaire - check list for top management

Unit IV Energy efficient Motors
Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit

Unit V Power Factor Improvement, Lighting
Power factor – methods of improvement , location of capacitors , Pf with non linear loads, effect of harmonics on p.f. , p.f motor controllers - Good lighting system design and practice , lighting control ,lighting energy audit

Unit VI Energy Instruments
Energy Instruments watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's

Unit VII Economic aspects and analysis
Economics Analysis-Depreciation Methods , time value of money , rate of return , present worth method , replacement analysis , life cycle costing analysis - Energy efficient motors

Unit-VIII Computation of Economic Aspects
Calculation of simple payback method , net present worth method - Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

REFERENCE BOOKS:

1) Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2) Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1/e,1998
3) Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4) Energy management hand book by W.C.Turner, john Wiley and sons
5). Energy management and good lighting practice: fuel efficiency- booklet12-EEO

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M.Tech. IV SEMESTER (PEED) **C**
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(9D54401) SEMINAR

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(9D54402) PROJECT WORK

The Project Work should be on a contemporary topic relevant to the core subjects of the course. It should be original work of the candidate.

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