APPROVED SYLLABUS OF

M. TECH. COURSE

POWER ELECTRONICS

(From Academic Year 2009-2010)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

KAKINADA-533 003

COURSE STRUCTURE

Name of the subject	Hrs/Week			Credits	Evaluation (marks)			
	Lecture	Tutorial	Practical		Internal	External		Total
						Theory	Practical	
I Semester								
1.Electrical Machine Modeling and Analysis	4	-	-	8	40	60	-	100
2. Analysis of Power Electronic Converters	4	-	-	8	40	60	-	100
3. Power Electronic Control of DC Drives	4	-	-	8	40	60	-	100
4. Microcontrollers & Applications	4	-	-	8	40	60	-	100
5. Elective-I	4	-	-	8	40	60	-	100
6. Elective-II	4	-	-	8	40	60	-	100
7. Power Electronic Systems Simulation Lab	-	-	3	4	40	-	60	100

Elective-I

i. Modern Control Theory

ii. Power Semiconductor Devices & Protection

Elective-II

i. Special Machines and controls

ii. Renewable Energy sources

COURSE STRUCTURE

Name of the subject	Hrs/Week			Credits	Evaluation (marks)			
	Lecture	Tutorial	Practical		Internal	External		Total
						Theory	Practical	
II Semester								
1.Switched Mode Power Conversion	4	-	-	8	40	60	-	100
2.Power Electronics Control of AC Drives	4	-	-	8	40	60	-	100
3.Flexible AC Transmission Systems	4	-	-	8	40	60	-	100
4.Digital Signal Processing and Applications	4	-	-	8	40	60	-	100
5. Elective-III	4	-	-	8	40	60	-	100
6.Elective-IV	4	-	-	8	40	60	-	100
7.Power Electronics and Drives Lab	-	-	3	4	40	-	60	100

Elective-III

i. Digital Control Systems

ii. Intelligent Control

Elective-IV

i. Power Quality Management

ii. Energy Auditing, Conservation and Management

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER ELECTRONICS)
M. Tech- I Semester

ELECTRICAL 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: Reference frame theory
Real time model of a two phase induction machine- Transformation to obtain constant matrices-three phase to two phase transformation-Power equivalence-

Unit IV: Dynamic modeling of three phase Induction Machine
Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-Equations in flux linkages-per unit model-Dynamic Simulation

Unit V: Small Signal Modeling of Three Phase Induction Machine
Small signal equations of Induction machine-derivation-DQ flux linkage model derivation-control principle of Induction machine.

Unit VI: Symmetrical and Unsymmetrical 2 phase Induction Machine
Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine-voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine- single phase induction motor - Cross field theory of single-phase induction machine.

Unit VII: Modeling of Synchronous Machine
Synchronous machine inductances –voltage equations in the rotor's dq0 reference frame-electromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Unit VIII: Dynamic Analysis of Synchronous Machine
Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria.

Reference Books:

1. Electric Motor Drives - Modeling, Analysis& control -R.Krishnan- Pearson Publications-1st edition -2002 (For chapter III, IV, V)
2.Analysis of Electrical Machinery and Drive systems – P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff – Second Edition-IEEE Press (for Chapters VI, VII,VIII)
3. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995(For chapter I,II)
4. Dynamic simulation of Electric machinery using Matlab / Simulink –Chee Mun Ong-Prentice Hall

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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M. Tech- I Semester

ANALYSIS OF POWER ELECTRONICS CONVERTERS

Unit-I Single Phase AC voltage Controllers
Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with 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 Single phase ac-dc converters
Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems

Unit-IV Three Phase ac-dc Converters
Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– 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- numerical problems

Unit-V Power Factor Correction Converters
Single-phase single stage boost power factor corrected rectifier, power circuit principle of operation, and steady state- analysis, three phase boost PFC converter

Unit –VI Single phase PWM Inverters
Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems

Unit VII: Three Phase PWM Inverters
Voltage Control of Three-Phase Inverters- Sinusoidal PWM- 60^0 PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems

Unit VIII: Multi level inverters

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Switching Device Currents- DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters

Textbooks

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2nd Edition.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- I Semester

POWER ELECTRONIC CONTROL OF DC DRIVES

Unit-I Speed Torque characteristics of DC Motors

Separately excited DC motors, Shunt motor, series motor and compound motor

Unit-II: 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-III: 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-IV: 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-V: Closed loop control of phase controlled DC motor Drives

Open loop Transfer function of DC Motor drive- Closed loop Transfer function of DC Motor drive – Phase-Locked loop control.

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.

Unit- VII:Closed loop control of chopper fed DC motor Drives

Speed controlled drive system – current control loop – pulse width modulated current controller – hysteresis current controller – modeling of current controller – design of current controller

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 Edition, Cambridge University Press
2. Power Electronic Circuits, Devices and Applications – M. H. Rashid – PHI.
3. Electric Motor Drives Modeling, Analysis and Control – R. Krishnan, Prentice Hall India.
4. Fundamentals of Electric Drives – G. K. Dubey – Narosa Publications – 1995.
5. Power Semiconductor drives – G. K. Dubey.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- I Semester

MICROCONTROLLERS AND APPLICATIONS

Unit-I: 8051 Microcontrollers
Introduction to Intel 8 bit & 16 bit Microcontrollers, MCS-51 Architecture, Registers in MCS-51, 8051 Pin Description, 8051 Connections, 8051 Parallel I/O Ports, Memory Organization

Unit II: MCS-51 Addressing Modes and Instructions
8051 Addressing Modes, MCS-51 Instruction Set, 8051 Instructions and Simple Programs, Using Stack Pointer, 8051 Assembly Language Programming, Development Systems and Tools, Software Simulators of 8051

Unit-III: MCS-51 Interrupts, Timer/Counters and Serial Communication
Interrupts, Interrupts in MCS-51, Timers and Counters, Serial Communication, Atmel Microcontrollers (89CXX and 89C20XX), Architectural Overview of Atmel 89C51 and Atmel 89C2051, Pin Description of 89C51 and 89C2051, Using Flash Memory Devices Atmel 89CXX and 89C20XX

Unit-IV: Applications of MCS-51 and Atmel 89C51 and 89C2051 Microcontrollers
Applications of MCS-51 and Atmel 89C51 and 89C2051 Microcontrollers- Square Wave Generation- Rectangular Waves- Pulse Generation- Pulse Width Modulation- Staircase Ramp Generation- Sine Wave Generation- Pulse Width Measurement- Frequency Counter

Unit- V. PIC Microcontrollers
PIC Microcontrollers: Overview and Features, PIC 16C6X/7X, FSR(File Selection Register) [Indirect Data Memory Address Pointer], PIC Reset Actions, PIC Oscillator Connections, PIC Memory Organizations, PIC PIC 16C6X/7X Instructions, Addressing Modes, I/O Ports, Interrupts in PIC 16C61/71, PIC 16C61/71 Timers, PIC 16C71 Analog-to-Digital Converter (ADC)

Unit- VI. PIC 16F8XX Flash Microcontrollers

Introduction, Pin Diagram of 16F8XX, STATUS Register, OPTION_REG Register, Power Control Register (PCON), PIC 16F8XX Program Memory, PIC 16F8XX Data Memory, DATA EEPROM and Flash Program EEPROM, Interrupts in 16F877, I/O Ports, Timers

Unit- VII: Interfacing and Microcontroller Applications- Light Emitting Diodes (LEDs), Push Buttons, Relays and Latch Connections, Keyboard Interfacing, Interfacing 7-Segment Displays, LCD Interfacing, ADC AND DAC Interfacing with 89C51 Microcontrollers

Unit- VIII: Industrial Applications of Microcontrollers - Measurement Applications, Automation and Control Applications

Reference books:

1. Microcontrollers-Theory and Applications by Ajay V Deshmukh, McGraw Hills
2. Microcontrollers by Kennith J ayala, Thomson publishers
3 Microprocessor and Microcontrollers by Prof C.R.Sarma

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- I Semester

MODERN CONTROL THEORY (Elective-I)

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 – 1

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 – 11

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 Kirck

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- I Semester

POWER SEMICONDUCTOR DEVICES & PROTECTION

(Elective- I)

Unit I: Overview of Power Switching Devices: Introduction to power switching devices, classification of devices, controlled and un-controlled devices, i-v characteristics of ideal and real switching devices,

Unit-II: Power Diodes: Device structure and i-v characteristics, ratings & specifications, switching characteristics, reverse recovery, classification of various diodes: Schotky diode, line frequency diodes, fast recovery diodes,

Unit-III: Power Transistors: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

Unit-IV: Power MOSFETs: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis, driver circuit.

Unit-V: IGBT: Device structure and i-v characteristics, ratings & specifications, switching characteristics, ON to OFF and OFF to ON state transitions, ON/OFF transition loss analysis,. Comparison of all the above devices with reference to power handling capability, frequency of operation, driver circuit, .emerging power switching devices.

Unit-VI: Protection of the Switching Devices: Device protection against over voltage/currents, di/dt and dv/dt; safe operating area, design of snubbers for power devices.

Unit-VII: Thermal Management: Conduction and transition losses computation, thermal model of the device, steady-state temperature rise, electrical equivalent circuit of thermal model, sizing of the heat sink.

Unit-VIII: Passive Components: Magnetic circuit, review of design of line frequency inductors and transformers, design of high frequency inductors and transformers.

Text book
1. Power Electronics Circuits- B. W. Williams

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: L. Umanand

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M. Tech- I Semester

SPECIAL MACHINES AND CONTROLS (Elective-II)

Unit I: Stepper Motors
Constructional features, Principle of operation, Modes of excitation torque production in Variable Reluctance (VR) stepping motor

Unit II: Characteristics of Stepper Motors
Dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

Unit III: Switched Reluctance Motors
Constructional features, Principle of operation. Torque equation, Characteristics, Control Techniques, Drive Concept.

Unit IV: Permanent Magnet Brushless DC Motors
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-Microprocessors based controller.

Unit V: Permanent Magnet Synchronous Motors
Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power Controllers, Torque speed characteristics, Self control, Vector control, Current control Schemes.

Unit VI: Servomotors
Servomotor – Types – Constructional features – Principle of Operation – Characteristics - Control – Microprocessor based applications.

Unit VII: AC Tachometers
Schematic diagram, Operating principle, numerical problems

Unit VIII: Linear Motors
Linear Motors: Linear Induction Motor (LIM) Classification – Construction – Principle of operation – Concept of Current sheet –Goodness factor – DC Linear Motor (DCLM) types – Circuit equation – DCLM control-applications.

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. Naser A and Boldea I, "Linear Electric Motors: Theory, Design and Practical Application", Prentice Hall Inc., New Jersey,1987
4. Floyd E Saner,"Servo Motor Applications", Pittman USA, 1993.
5. Kenjo, T and Naganori, S "Permanent Magnet and brushless DC motors", Clarendon Press, Oxford, 1989.
6. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition-1995

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M. Tech- I Semester

RENEWABLE ENERGY RESOURCES (Elective-II)

Unit-I
Solar Energy - Availability - Solar radiation data and measurement - Estimation of average solar radiation - Solar water heater types - Heat balance – Flat plate collector efficiency – Efficiency of heat removal - Thermo siphon flow calculation - Forced circulation calculation - Evacuated collectors - Basics of solar concentrators

Unit-II
Solar Energy Applications - Solar air heaters – Solar Chimney - Crop driers - Passive solar system - Active solar systems - Water desalination - Output from solar still – Principle of solar ponds.

Unit-III
Wind Energy – Nature of wind – Characteristics – Variation with height and time – Power in wind – Aerodynamics of Wind turbine – Momentum theory – Basics of aerodynamics – Aerofoils and their characteristics – HAWT – Blade element theory – Prandtl's lifting line theory (prescribed wake analysis)

VAWT aerodynamics – Wind turbine loads – Aerodynamic loads in steady operation – Yawed operation and tower shadow.

Unit-IV

Wind Energy Conversion System – Siting – Rotor selection – Annual energy output – Horizontal axis wind turbine (HAWT) – Vertical axis wind turbine (VAWT) – Rotor design considerations – Number of blades – Solidity - Blade profile – Upwind/Downwind – Yaw system – Tower – Braking system - Synchronous and asynchronous generators and loads – Integration of wind energy converters to electrical networks – Inverters – Control system – Requirement and strategies – Noise – Applications of wind energy

Unit-V

Biomass energy - Bio fuel classification – Examples of thermo chemical, Pyrolysis, biochemical and agrochemical systems – Energy farming – Direct combustion for heat – Process heat and electricity – Ethanol production and use – Anaerobic digestion for biogas – Different digesters – Digester sizing – Applications of Biogas - Operation with I.C.Engine

Unit-VI

Ocean Energy - OTEC Principle - Lambert's law of absorption - Open cycle and closed cycle - heat exchanger calculations – Major problems and operational experience.

Unit-VII

Tidal Power - Principles of power generation - components of power plant – Single and two basin systems – Turbines for tidal power - Estimation of energy – Maximum and minimum power ranges - tidal powerhouse.

Wave Energy – Concept of energy and power from waves – Wave characteristics – period and wave velocities - Different wave energy conservation devices (Saltor duck, oscillating water column and dolphin types) – operational experience.

Unit-VIII

Geothermal Energy - Classification- Fundamentals of geophysics - Dry rock and hot aquifier energy analysis - Estimation of thermal power - Extraction techniques - Prime movers.

References:

1. Renewable Energy Resources / John Twidell and Tony Weir / E & F.N.Spon
2. Renewable Energy Resources Basic Principles and Applications / G.N.Tiwari and M.K.Ghosal / Narosa
3. Solar Energy - Principles of thermal collection and storage/ S.P. Sukhatme / TMH
4. Solar Energy Thermal Processes,/Duffie & Beckman
5. Solar Heating and Cooling / Kreith & Kreider
6. Wind Energy Handbook / Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / WileyWind Electrical Systems / S.N.Bhadra, D.Kastha and S.Banerjee / Oxford
7. Biogas Technology - A Practical Hand Book / K.Khendelwal & S.S. Mahdi / McGraw-Hill

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- I Semester

POWER ELELCTRONIC SYTEMS SIMULATION LAB

1. Switching characteristics of Thyristor, MOSFET,IGBT using PSPICE Simulation
2. PSPICE Simulation of Single phase full converter using RL load with and without LC Filter.
3. PSPICE Simulation of Single phase full converter using RL & E load with and without free wheeling diode
4. PSPICE Simulation of Three phase full converter using RL & E Loads.
5. PSPICE Simulation of single phase AC Voltage controller with PWM control for RL load.
6. PSPICE Simulation of three phase AC Voltage controller using RL load.
7. PSPICE Simulation of single phase inverter with sinusoidal PWM control for R- load
8. PSPICE Simulation of Three phase inverter with Sinusoidal PWM control for R-Load.
9. PSPICE Simulation of single phase current source inverter with RL Load.
10. PSPICE Simulation of dc-dc Boost converter.
11. DC motor with controlled ac rectification using Matlab/Simulink
12. Development and Simulation of 3-phase PWM Inverter with sinusoidal pulse-width modulation using Matlab/Simulink
13. Cascade position control of a DC motor drive (PI controller) using Matlab/Simulink
14. Characteristics of induction machines under balanced and symmetrical conditions for the following using Matlab/Simulink
    a. dq model in synchronous reference frame
    b. dq model in stator reference frame
    c. dq model in rotor reference frame
15. Volts/Hz closed-loop speed control of an induction motor drive using Matlab/Simulink
16. Open-loop Volts/Hz control of a synchronous motor drive using Matlab/Simulink
17. Speed control of a permanent magnet synchronous motor using Matlab/Simulink
18. Capacitor-start capacitor-run single-phase induction motor using Matlab/Simulink
19. Single phase IGBT based fully controlled rectifier with PWM control using Matlab-Simpower blockset
20. Three phase IGBT based ac voltage controller with PWM control using Matlab-Simpower blockset

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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M. Tech- II Semester

SWITCHED MODE POWER CONVERSION

Unit –I Single-switch Isolated converters:
Requirement for isolation in the switch-mode converters, transformer connection, Forward and flyback converters, power circuit and steady-state analysis.

Unit-II: Push-Pull Converters:
Power circuit and steady-state analysis, utilization of magnetic circuits in single switch and push-pull topologies.

Unit- III: Isolated Bridge converters:
Half bridge and full-bridge converters**,** Power circuit and steady-state analysis, utilization of magnetic circuits and comparison with previous topologies.

Unit-IV: **Dynamic Analysis of dc-dc converters:**
Formulation of dynamic equation of buck and boost converters, averaged circuit models, linearization technique, small-signal model and converter transfer functions.

Unit-V: Controller Design:
Review of frequency-domain analysis of linear time-invariant systems, concept of bode plot, phase and gain margins, bandwidth, controller specifications, proportional(P), proportional plus integral (PI), proportional plus integral plus integral controller (PID), selection of controller parameters.

Unit-VI: Resonant Converters:
Classification of Resonant converters-Basic resonant circuits- Series resonant circuit-parallel resonant circuits- Resonant switches.

Unit-VII:
Quasi-Resonant Converters-I: Concept of Zero voltage switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

Unit-VIII:
Quasi-Resonant Converters-II: Concept of Zero current switching, principle of operation, analysis of M-type and L-type Buck or boost Converters.

Text Books:

1. Fundamentals of Power Electronics – Robert Erickson and Dragon Maksivimovic, Springer Publications.
2. Power Electronics–Issa Batarseh- John Wiely

Reference Books:

1. Elements of Power Electronics - Philip T.Krein – Oxford University Press
2. Power Electronics, L. Umanand, Tata Mc-Graw Hill

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER ELECTRONICS)
M. Tech- II Semester

POWER ELECTRONIC CONTROL OF AC DRIVES

Unit-I: **Introduction**
Review of steady-state operation of Induction motor, Equivalent circuit analysis, torque-speed characteristics.

Unit II: Voltage Source Inverter Fed Induction motor drives
Scalar control- Voltage fed Inverter control-Open loop volts/Hz control-Speed control with slip regulation-Speed control with torque and Flux control-Current controlled voltage fed Inverter Drive

Unit III Current Source Inverter Fed Induction motor drives
Current-Fed Inverter control-Independent current and frequency control-Speed and flux control in Current-Fed Inverter drive-Volts/Hz control of Current-Fed Inverter drive-Efficiency optimization control by flux program.

Unit IV Slip power recovery schemes
Slip-power recovery Drives-Static Kramer drive-Phasor diagram-Torque expression-Speed control of a Kramer drive-Static scherbius drive-Modes of operation

Unit-V: Vector control of Induction Motor:
Principles of vector control, Direct vector control, derivation of indirect vector control, implementation – block diagram; estimation of flux, flux weakening operation.

Unit-VI: Control of Synchronous motor drives:
Synchronous motor and its characteristics- Control strategies-Constant torque angle control- power factor control, constant flux control, flux weakening operation, Load commutated inverter fed synchronous motor drive, motoring and regeneration, phasor diagrams.

UNIT-VII: PMSM and BLDC Drives:
Characteristics of permanent magnet, synchronous machines with permanent magnet, vector control of PMSM- Motor model and control scheme. Modeling of PM brushless dc motor, drive scheme -Three-phase full wave Brushless dc motor -Sinusoidal type of Brushless dc motor - current controlled Brushless dc motor Servo drive

UNIT-VIII: Variable Reluctance Motor Drive
Variable Reluctance motor drives- Torque production in the variable reluctance motor -Drive characteristics and control principles - Current control variable reluctance motor servo drive

Text Book:

1. Electric Motor Drives Modeling, Analysis & control -R. Krishnan- Pearson Education

Reference Books:

2. Modern Power Electronics and AC Drives –B. K. Bose-Pearson Publications-
3. Power Electronics control of AC motors – MD Murphy & FG Turn Bull Pergman Press - 1st edition-1998

4. Fundamentals of Electrical Drives – G.K. Dubey – Narosa Publications -1995
5. Power Semiconductor drives- G.K. Dubey-Prentice hall

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(POWER ELECTRONICS)
M. Tech- II Semester

FLEXIBLE AC TRANSMISSION SYSTEMS

UNIT-1: Introduction
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-I1: Static Shunt Compensation
Static shunt compensation: Objectives of shunt compensation, mid point voltage regulation voltage instability prevention, improvement of transient stability, Power oscillation damping.

UNIT-I1I: Methods of controllable var generation:
Variable impedance type static var generators: Thyristor Controlled and Thyristor Switched Reactor(TCR and TSR), Thyristor Switched Capacitor(TSC), Fixed Capacitor Thyristor Controlled Reactor Type Var Generator FC-TCR, Thyristor Switched Capacitor- Thyristor Controlled Reactor Type Var Generator; Switching converter type var generators, Hybrid var generators.

UNIT-IV: SVC and STATCOM
Static Var Compensators: SVC and STATCOM-The Regulation Slope, Transfer Function and Dynamic Performance-Transient Stability Enhancement and Power Oscillation Damping; Comparison between STATCOM and SVC: V-I and V-Q Characteristics, Transient Stability, Response Time, Capability to Exchange Real Power, Operation with Unbalanced AC System, Loss Versus Var Output Characteristic.

UNIT-V: Static Series Compensation
Concept of series capacitive compensation, improvement of transient stability, power oscillation damping; Variable Impedance Type Series Compensators-GTO Thyristor-Controlled Series Capacitor-(GCSC), Thyristor-Switched Series Capacitor(TSSC), Thyristor-Controlled Series Capacitor(TCSC), Basic Operating Control Schemes For GCSC,TSSC and TCSC.

UNIT-VI: Switching Converter Type Series Compensators
Static Synchronous Series Capacitor(SSSC), Transmitted Power Versus Transmission Angle Characteristic, Control Range and VA Rating, Capability to Provide Real Power Compensation, Internal Control; External Control for Series Reactive Compensators.

UNIT-VII: Static Voltage and Phase Angle Regulators: TCVR and TCPAR:
Voltage and Phase Angle Regulation, Power Flow Control by Phase Angle Regulators, Real and Reactive Loop Power Flow Control; Approaches to Thyristor –Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs)-Continuously Controllable Thyristor Tap Changers.

UNIT-VIII: Unified Power Flow Controller (UPFC)
Introduction: The Unified Power Flow Controller-Basic Operating Principles, Conventional Transmission Control Capabilities, Independent Real and Reactive Power Flow Control, Control Structure, Basic Control System for P and Q Control.

References books:
1. N.G.Hingorani & L.Gyugyi, *Understanding FACTS*: *Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press, 1999.
2. X.P. Zang, C. Rehtanz and B. Pal, *Flexible AC Transmission Systems: Modeling and Control*, Birkhauser, 2006.
3. Y. H. Song and A. T. Johns, *Flexible AC Transmission Systems*, IET, 1999.

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER ELECTRONICS)
M. Tech- II Semester

DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS

Unit-I: Introduction to Digital Signal Processing

Introduction -Linear time invariant systems- A Digital Signal Processing System, The sampling - quantization – Discrete time sequences – Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT, Digital filters Decimation & Interpolation.

Unit-II: 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 III: 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.

UNIT IV: 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. Design of computationally efficient FIR digital filters.

Unit-V: Finite word Length effects

Introduction- Effects of coefficients on Quantization- Quantization in sampling analog signals- Finite register length effects in realization of Digital Filters- Discrete Fourier transform computations

Unit –VI: Architecture of TMS320LF 2407A

Introduction –Architectural overview – Memory and I/O spaces -Internal architecture – Central Processing Unit (CPU) – Program control.

Unit –VII: Addressing Modes and Assembly Language Instructions of C2xxx

Data formats – Addressing modes – groups of addressing mode – Assembly language instructions

Unit VIII: Peripherals (The Event Managers)

Event Manager (EV) Functional Blocks-Event Manager (EV) Register Addresses- General-Purpose (GP) Timers -Compare Units- PWM Circuits Associated With Compare Units-PWM Waveform Generation With Compare Units and PWM Circuits-Space Vector PWM- Capture Units- Quadrature Encoder Pulse (QEP) Circuit - Event Manager (EV) Interrupts

References

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing: A Practical Approach", Pearson Education India Series, New Delhi, 2nd Edition,2004

2. Sanjit K Mitra, " Digital Signals Processing: A Computer Based Approach", Tata McGraw- Hill Publishing Company Limited, 2nd Edition, 2004.

3. Alan Oppenheim. V and Ronald W.Schafer, "Digital Signal Processing", Prentice Hall of India Private. Limited., New Delhi, 1989.

4. B.Venkatramani, M.Bhaskar "Digital Signal Processors- Architecture, programming and applications", Tata McGraw- Hill Publishing Company Limited.
5. John G. Proakis and Manolakis. D.G, "Digital Signal Processing: Principles Algorithms and Applications," Prentice Hall of India, New Delhi, 2004.

6. TMS320F/C24x DSP Controllers-Reference Guide-CPU and Instruction Set
7. TMS320LF/LC240Xa-DSP Controllers-Reference Guide-System and Peripherals.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- II Semester

DIGITAL CONTROL SYSTEMS (Elective-III)

UNIT-1: Introduction

Advantages of Digital control systems- -Practical aspects of the choice of sampling rate and multirate sampling - Basic discrete time signals - Quantization – Sampling theorem -Data conversion and Quantization- Sampling process- Mathematical modeling- Data reconstruction and filtering of sampled signals – zero-order hold

UNIT-II: Z-Transforms
z- transform and inverse z-transform, Relationship between s- plane and z- plane- Difference equation- Solution by recursion and z-transform- pulse transfer functions of the zero-order Hold and relationship between G(s) and G(z)– Bilinear transformation .

UNIT-III: Z-Plane Analysis
Digital control systems- Pulse transfer function- z transform analysis of open loop, closed loop systems- Modified z- transfer function- Stability of linear digital control systems- Stability tests.

Unit –IV State Space Analysis
State space representation of discrete time systems, pulse transfer function matrix, solving discrete time state space equations, state transition matrix and its properties methods for computation of state transition matrix, discretization of continuous time state-space equations

Unit-V Stability Analysis
Stability analysis of closed loop systems in the Z-plane, Jury stability criterion test-Stability analysis by use of the bilinear transformation and routh stability criterion. Stability analysis using liapumov theorems

Unit-VI Design of Discrete Time control system by conventional methods
Design of digital control systems based on Root locus techniques-Design of digital control based on the frequency response methods-Bilinear transformation and design procedure in the w-plane, lead, lag and Lead-lag compensators and digital PID controllers. Design digital control through dead beat response methods.

Unit-VII State Feed back controllers and Observers
Concept of controllability and observability-Design of state feedback controller through pole placement-Necessary and sufficient conditions, Ackerman's formula, State observers-Full order and Reduced Order observer

Unit-VIII Linear Quadratic Regulators
Min/Max principle, Linear Quadratic Regulators, Kalman Filters, State Estimation through kalman Filters, Introduction to adaptive controls

Textbooks:

1. Discrete Time Control Systems-K.Ogata Pearson Education
2. Digital Control systems and State Variables methods by M.Gopal

Reference Books

1.Digital Control Engineering, Kuo, Oxford University
2.Digital Control Engineering M.Gopal

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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M. Tech- II Semester

INTELLIGENT CONTROL (Elective-III)

UNIT I:
Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

UNIT II
Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network.

UNIT III
Data Pre-Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox.

UNIT IV
Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm.

UNIT V
Concept on some other than GA search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT VI
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to Fuzzy logic modeling and control of a system. Fuzzification, inference and defuzzification. Fuzzy knowledge and rule bases.

UNIT VII
Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox.

Unit-VIII: Fuzzy logic & Neural network applications to Drives
Fuzzy logic applications: Design of Fuzzy PI controller for speed control of DC motor- Flux programming efficiency improvement of three phase induction motor-Induction motor speed control-Slip gain tuning of indirect vector control of induction motor-stator resistance estimation.
Neural network applications:-PWM Controller-Selected harmonic elimination PWM-Space vector PWM-Vector controlled drive-feedback signal estimation-speed estimation and flux estimation of induction motor

Text Books

1. Neural Networks: A comprehensive Foundation – Simon Haykins, Pearson Edition, 2003.
2. Fuzzy logic with Fuzzy Applications – T.J.Ross – Mc Graw Hill Inc, 1997.
3. Genetic Algorithms- David E Goldberg.
4. Modern Power Electronics and AC Drives –B.K.Bose-Pearson Publications
5. Artificial Intelligent based Electrical Machines and Drives- Peter Vas, Oxford University Press

References

1. Neural Network Design-M.T.Hagan, H. B. Demuth and M. Beale, Indian reprint, 2008.
2. Principles of Neurocomputing for science and Engineering,- Fredric M.Ham and Ivica Kostanic, McGraw Hill, 2001.
3. Neural Network Fundamentals with Graphs, Algorithms and Applications, N.K. Bose and P.Liang, Mc-Graw Hill, Inc. 1996.
4. Intelligent System- Modeling, Optimization and Control- Yung C. Shin and Chengying Xu,CRC Press, 2009.
5. Soft computing & Intelligent Systems- Theory & Applications – N.K.Sinha and Modan M Gupta. Indian Edition, Elsevier, 2007.
6. Fuzzy logic Intelligence, Control, and Information- John Yen and Reza Langari, Pearson Education, Indian Edition, 2003.
7. Fuzzy Control and Fuzzy Systms, Witold Pedrycz, Overseas Press, Indian Edition, 2008.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- II Semester

POWER QUALITY MANAGEMENT (Elective-IV)

Unit -I. Introduction To Power Quality

What is Power Quality?, Voltage Quality, Why are we concerned about power quality?, The power quality evaluation procedure-Need for a consistent-Vocabulary, General classes of power quality problems, Transients, Long-Duration voltage variations, Short-Duration voltage variations, Voltage Imbalance, waveform distortion, voltage fluctuation, Power frequency variations, Power quality terms, Ambiguous Terms, CBEMA and ITI curves

Unit- II. Power Frequency Disturbances

Introduction-Common power frequency disturbances-Cures for low frequency disturbances-Voltage tolerance criteria

Unit III: Voltage Sags And Interruptions
Sources of sags and interruptions-Estimating Voltage sag performance-Fundamental principles of protection-Solutions at the End-User level-Evaluating the economics of different ride_ through alternatives-Motor_ starting sags-Utility system fault_ clearing issues

Unit IV. Transient Over Voltages
Sources of transient over voltages-Principles of over voltage protection-Devices for over voltage protection-Utility capacitor_ switching Transients-Utility system Lightning protection-Managing Ferroresonance-Switching Transients problems with loads-Computer tools for transient analysis.

Unit-V. Fundamentals Of Harmonics
Harmonic Distortion-Voltage versus current distortion-Harmonic versus Transients-Power system Quantities under non sinusoidal conditions-Harmonic indices-Harmonic sources from commercial loads-Harmonic sources from industrial loads-Locating harmonic sources-System response characteristics-Effects of harmonic distortion- Inter harmonics

Unit VI.Applied Harmonics
Harmonic distortion evaluations-Principles for controlling harmonics-Where to control harmonics-Harmonic study-Devices for controlling harmonic distortion-Harmonic filter design-Case studies-Standards on harmonics

Unit-VII. Long Duration Voltage Variations
Principles of regulating the voltage-Devices for voltage regulation-Utility voltage regulator application-Capacitors for voltage regulations-End user capacitor application-Regulating utility voltage with distributed resources-Flickers

Unit VIII. Power Quality Monitoring

Monitoring considerations-Historical perspective of power quality measuring instruments-Power quality measurement equipment-Assessment of power quality measurement data-Application of intelligent systems-Power quality monitoring standards

Reference books
1.Electrical power systems quality-Roger C.Dugan- McGraw- Hills
2.Power quality- C.Sankaran, CRC Press

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER ELECTRONICS)
M. Tech- II Semester

ENERGY AUDITING, CONSERVATION & MANAGEMENT
(Elective-IV)

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 .

TEXT BOOKS::

1. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-

REFERENCE BOOKS

1. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
2. Energy management hand book by W.C.Turner, John wiley and sons
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(POWER ELECTRONICS)

M. Tech- II Semester

POWER ELECTRONICS AND DRIVES LABORATORY

List of experiments

1. Operation of 3- phase Full-Converter on R & R-L load.
2. Performance & speed control of D.C. drive using 3-phase full Converter.
3. Performance & Operation of a four quadrant Chopper on D.C. Drive
4. Performance & Operation of a 3-phase A.C. Voltage controller on motor load.
5. Single Phase IGBT based PWM Inverter on R & R-L load
6. Operation of 3-phase IGBT based PWM Inverter on R & R-L load.
7. Performance & speed control of 3 phase slip ring Induction motor by Static Rotor Resistance controller.
8. Three phase PWM Pulse generation using PIC Micro controller
9. PIC Microcontroller based speed control of three phase Induction Motor
10. DSP based V/F Control of 3 phase Induction motor.