CURRICULUM AND SYLLABUS

REGULATION – 2011

M.Tech. POWER ELECTRONICS AND DRIVES

(4 Semesters)

KALASALINGAM UNIVERSITY

FACULTY OF ELECTRICAL ENGINEERING

KRISHNANKOIL – 626 190

KALASALINGAM UNIVERSITY

Anand Nagar, Krishnankoil - 626 190

Department of EEE

M.TECH - POWER ELECTRONICS AND DRIVES

CURRICULUM

Semester I

Code No.	Subject	L	T	P	C
MAT5101	Applied Mathematics	3	0	0	3
EEE5201	Modeling and Analysis of Electrical Machines	3	0	0	3
EEE5202	Power Switching Devices	3	0	0	3
EEE5203	Analysis of Power Converters	3	0	0	3
EEE5204	Analysis of Inverters	3	0	0	3
EEE****	Elective I	3	0	0	3
EEE5281	Power Electronics and Drives Lab - I	0	0	3	2
	Total	-	-	-	20

Semester II

Code No.	Subject	L	T	P	C
EEE5205	Digital Controllers in Power Electronics Applications	2	1	0	3
EEE 5206	Solid State DC Drives	3	0	0	3
EEE 5207	Solid State AC Drives	3	0	0	3
EEE 5208	Embedded Control based Electrical Drives	3	0	0	3
EEE****	Elective II	3	0	0	3
EEE****	Elective III	3	0	0	3
EEE 5282	Power Electronics and Drives Lab – II	0	0	3	2
	Total	-	-	-	20

Semester III

Code No.	Subject	L	T	P	C
EEE****	Elective IV	3	0	0	3
EEE****	Elective V	3	0	0	3
EEE****	Elective VI	3	0	0	3
EEE 6298	Project Work Phase-I	0	0	18	6
	Total	-	-	-	15

Semester IV

Code No.	Subject	L	T	P	C
EEE 6299	Project Work Phase-II	0	0	36	12
	Total	-	-	-	12

TOTAL CREDITS – 67

LIST OF ELECTIVES

Code No.	Subject	L	T	P	C
	I Year				
EEE 5001	Systems Theory	3	0	0	3
EEE5002	Power System Modelling	3	0	0	3
EEE 5007	Flexible AC Transmission Systems	3	0	0	3
EEE5010	High Voltage Direct Current Transmission	3	0	0	3
EEE5111	Data Communication and Networks	3	0	0	3
EEE 5117	Soft Computing	3	0	0	3
EEE5209	Special Electrical Machines	3	0	0	3
EEE5210	Digital Signal Processors	3	0	0	3
EEE5211	Switched Mode Power Conversion	3	0	0	3
	II Year				
EEE5013	Digital Signal Processing	3	0	0	3
EEE5015	Renewable Power Generation	3	0	0	3
EEE6001	Power Quality	3	0	0	3
EEE6016	Energy Efficiency In Electrical Utilities	3	0	0	3
EEE6201	Fuzzy Systems and Neural Networks	3	0	0	3
EEE6203	Digital Simulation of Power Electronics Systems	3	0	0	3
EEE6204	PWM Converters and Applications	3	0	0	3
EEE6205	Programmable Logic Controllers	3	0	1	4
EEE6206	Digital instrumentation	3	0	0	3
EEE6207	Non Linear Control	3	0	0	3
EEE6208	System Identification and Adaptive Control	3	0	0	3

KALASALINGAM UNIVERSITY

Anand Nagar, Krishnankoil - 626 190

Department of EEE

M.TECH - POWER ELECTRONICS & DRIVES ENGINEERING
SYLLABUS

Semester – I

MAT5101	APPLIED MATHEMATICS	L	T	P	C
		3	0	0	3

CLASSICAL OPTIMIZATION TECHNIQUES
Statement of optimization problem – classification – Optimization technique-unconstrained Optimization – equality constraints – inequality constraints – Lagrange Multiplier method – Kuhn-Tucker Condition - Indirect search methods – Gradient of a function – Steepest descent method – Conjugate gradient method – Newton's method.

LINEAR PROGRAMMING
Standard form of Linear programming problem – definitions and theorems – Solution of linear simultaneous equations – simplex algorithm – graphical method – dual simplex method – transportation problem - applications.

MATRIX THEORY
Matrix Norms- Jordan Canonical form Generalized Eigen vectors-Singular Value Decomposition- Pseudo Inverse-Least square Approximations –QR Algorithm.

PROBABILITY AND RANDOM PROCESS
Probability- random process variables - binomial, Poisson, geometric, uniform normal, exponential distributions - moment generating and their properties- functions of random variables.

QUEUING THEORY
Single and multiple server Markovian queuing models- customer impatience- Queuing applications.

TEXT BOOKS

1. Singiresu S.Rao ,Engineering Optimization , New Age International (P) Ltd , 2001
2. Gupta S.C. and Kapoor V.K. Fundamentals of Mathematical Statistics, sultan Chand and sons, Newdelhi, 2001
3. Lewis.D.W. Matrix Thoery, Allied Publishers, Chennai 1995

REFERENCES

1. S.D.Sharma, Operations Research, Kedar Nath Ram Nath & co,20
2. M.K. Ochi., Applied Probability and Stochastic processes, John Wiley & sons 1992.
3. Bronson.R. Matrix operations , Schaums outline series , Tata Mcgraw Hill,

		L	T	P	C
EEE5201	**MODELLING AND ANALYSIS OF ELECTRICAL MACHINES**	**3**	**0**	**0**	**3**

Newyork

PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION

Energy conversion from stored magnetic energy – co-energy and force/torque – single and doubly excited systems.

BASIC CONCEPTS OF ROTATING MACHINES

Calculation of air gap mmf and per phase machine inductance using physical machine data – Voltage and torque equation of dc machine – three phase induction machine and salient pole synchronous machines in phase variable form.

REFERENCE FRAME THEORY

Static and rotating reference frames – transformation relationships – static symmetrical three phase R, R-L, R-L-M and R-L-C circuits – application of reference frame theory to three phase induction and synchronous machines – dynamic direct and quadrature axis model in arbitrarily rotating reference frames – voltage and torque equations – derivation of steady state phasor relationship from dynamic model – generalized theory of rotating electrical machine and Kron's primitive machine.

DYNAMIC EQUIVALENT CIRCUIT PARAMETERS OF MACHINES

Standard and derived machine time constants – frequency response test – Analysis and dynamic modeling of two phase asymmetrical induction machine and single phase induction machine.

PMSM AND SRM

Permanent magnet synchronous machine: Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines - Construction and operating principle – dynamic modeling and self controlled operation – Analysis of Switched Reluctance Motors.

TEXT BOOKS

1. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans "Electric Machinery", Tata McGraw Hill, Sixth Edition, 2003.
2. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice Hall of India, 2003.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.

REFERENCES

1. C.V.Jones, "The Unified Theory of Electrical Machines", Butterworth, London, 1967.
2. Miller, T.J.E. "Brushless permanent magnet and reluctance motor drives" Clarendon Press, Oxford, 1989.

EEE5202	POWER SWITCHING DEVICES	L	T	P	C
		3	0	0	3

SWITCHING CHARACTERISTICS

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

CURRENT CONTROLLED DEVICES

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

VOLTAGE CONTROLLED DEVICES

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

FIRING AND PROTECTING CIRCUITS

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

THERMAL PROTECTION

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

TEXT BOOKS

1. B.W Williams "Power Electronics Circuit Devices and Applications".
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.

REFERENCES

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, Second Edition, 2009.
2. Mohan, Undcland and Robins, "Power Electronics – Converters, applications and Design, John Wiley and Sons, Third Edition, Singapore, 2003.

EEE5203	ANALYSIS OF POWER CONVERTERS	L	T	P	C
		3	0	0	3

SINGLE PHASE AC-DC CONVERTER

Uncontrolled, half controlled and fully controlled converters with R-L, R-L-E loads and free wheeling diode – continuous and discontinuous modes of operation - inverter operation – Dual converter - Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap.

THREE PHASE AC-DC CONVERTER

Uncontrolled, half controlled and fully controlled converter with R, R-L, R-L-E loads and free wheeling diodes – inverter operation and its limit – dual converter – performance parameters – effect of source impedance and overlap

DC-DC CONVERTERS

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – time ratio and current limit control – Four quadrant converter – Resonant and quasi – resonant converters.

AC VOLTAGE CONTROLLERS

Principle of phase control: single phase and three phase controllers – Y and Δ configurations – analysis with R and R-L loads.

CYCLOCONVERTERS

Principle of operation – Single phase and three phase cycloconverters – power circuits and gating signal generation.

TEXT BOOKS

1. Ned Mohan,Undeland and Robbin, "Power Electronics: converters, Application and design" John Wiley and sons.Inc,Newyork,2002.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, New Delhi, 2004.

REFERENCES

1. P.C Sen.," Modern Power Electronics ", Chand (s) & Co ltd, India, Second Edition, New Delhi- 2005.
2. P.S.Bimbra, " Power Electronics", Khanna Publishers, Eleventh Edition, 2003.
3. M.D Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, Second Edition, 2009.
4. G.K.Dubey, S.R.Doradia, A.Joshi, R.M.K.Sinha, "Thyristorized Power Controllers", John Wiely & Sons, 1986

EEE5204	ANALYSIS OF INVERTERS	L	T	P	C
		3	0	0	3

SINGLE PHASE VOLTAGE SOURCE INVERTERS

Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – McMurray-Bedford half bridge and full bridge inverters.

THREE PHASE VOLTAGE SOURCE INVERTERS

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters.

CURRENT SOURCE INVERTERS

Single phase CSI – Three phase CSI: Operation of six-step thyristor inverter – inverter operation modes – load commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters

MULTILEVEL INVERTERS

Multilevel concept – diode clamped, flying capacitor and cascade type multilevel inverters - comparison of multilevel inverters - application of multilevel inverters

RESONANT INVERTERS

Series and parallel resonant inverters – voltage control of resonant inverters – Class E resonant inverter – resonant DC-link inverters.

TEXT BOOKS

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Jai P.Agrawal, "Power Electronics Systems", Pearson Education, Second Edition,2002.

REFERENCES

1. P.C. Sen, "Modern Power Electronics", Chand (s) & Co ltd, India, Second Edition, New Delhi, 2005.

2. P.S.Bimbra, "Power Electronics", Khanna Publishers, Eleventh Edition, 2003.
3. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education, Second Edition, 2003.
4. M.D Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, Second Edition, 2009
5. G.K.Dubey, S.R.Doradia, A.Joshi, R.M.K.Sinha, "Thyristorized Power Controllers", John Wiely & Sons, 1986

EEE5281	Power Electronics and Drives Lab I	L	T	P	C
		0	0	3	2

1. Triggering circuits for single phase and three phase controlled converters.
2. PWM generation circuits for choppers.
3. Single phase half and fully Controlled converters with R and RL Load.
4. Three phase half and fully Controlled converters with R and RL Load.
5. Voltage control of fully Controlled converters.
6. DC-DC Choppers using self commutating Devices – Buck, Boost, Buck-Boost
7. Single phase inverters using IGBTs.
8. Three phase inverters using IGBTs.
9. Single phase and three phase AC-AC voltage regulators.
10. Single Phase and three phase Cycloconverter.
11. Simulation of power electronic converter using MATLAB/P-SIM/PSPICE.
12. Study and testing of UPS.

SEMESTER II

EEE5205	DIGITAL CONTROLLERS IN POWER ELECTRONICS APPLICATIONS	L	T	P	C
		3	0	0	3

TMS320LF240XA

Introduction to the C2xx DSP core and code generation - The components of the C2xx DSP core - Mapping external devices to the C2xx core - peripherals and Peripheral Interface - System configuration registers - Memory - Types of Physical Memory - memory Addressing Modes - Assembly Programming using C2xx DSP - Instruction Set - Software Tools.

I/O AND INTERRUPTS

Pin Multiplexing (MUX) and General Purpose I/O Overview - Multiplexing and General Purpose I/O Control Registers .Introduction to Interrupts - Interrupt Hierarchy - Interrupt Control Registers - Initializing and Servicing Interrupts in Software.

ADC AND EVENT MANAGERS

ADC Overview - Operation of the ADC in the DSP - Overview of the Event manager (EV) - Event Manager Interrupts - General Purpose (GP) Timers - Compare Units, Capture Units And Quadrature Enclosed Pulse (QEP) Circuitry - General Event Manager Information

FPGA

Introduction to Field Programmable Gate Arrays - CPLD Vs FPGA - Types of FPGA, Xilinx XC3000 series , Configurable logic Blocks (CLB), Input/Output Block (IOB) - Programmable Interconnect Point (PIP) - Xilinx 4000 series - HDL programming - overview of Spartan 3E and Virtex II pro FPGA boards - case study.

APPLICATIONS

Controlled Rectifier - Switched Mode Power Converters - PWM Inverters - DC motor control - Induction Motor Control

TEXT BOOKS:

1. Hamid.A.Toliyat and Steven G.Campbell " DSP Based Electro Mechanical Motion Control " CRC Press New York , 2004.
2. TMS320LF/LC240xA DSP Controllers Reference Guide – System and Peripherals Literature Number: SPRU357B, Revised December 2001. Texas Instruments.

REFERENCES:

1. XC 3000 series datasheets (version 3.1). Xilinx,Inc.,USA, 1998
2. XC 4000 series datasheets (version 1.6). Xilinx,Inc.,USA, 1999
3. Website: www.ti.com

EEE5206	SOLID STATE DC DRIVES	L	T	P	C
		3	0	0	3

DC MOTORS FUNDAMENTALS AND MECHANICAL SYSTEMS

DC motor- Types, induced emf, speed-torque relations; Speed control – Armature and field speed control; Ward Leonard control – Constant torque and constant horse power operations.

Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics – multi-quadrant operation; Drive elements, types of motor duty and selection of motor rating.

CONVERTER CONTROL

Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, performance characteristics.

Continuous and discontinuous armature current operations; Current ripple and its effect on performance; Operation with free wheeling diode; Implementation of braking schemes; Drive employing dual converter.

CHOPPER CONTROL

Class A, B, C, D and E chopper controlled DC motor – performance analysis, Chopper based implementation of braking schemes; Multi-phase chopper; related problems.

CLOSED LOOP CONTROL

Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison.

DIGITAL CONTROL OF D.C DRIVE

Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and gate firing.

TEXT BOOKS

1. Gopal K Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall Inc., New Yersy, 1989.
2. R.Krishnan, “ Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

REFERENCES

1. Gobal K.Dubey, “Fundamentals of Electrical Drives”, Narosal Publishing House, New Delhi, Second edition, 2009.
2. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
3. Vedam Subramanyam, “Electric Drives – Concepts and Applications”, Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.
4. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981.

EEE5207	SOLID STATE AC DRIVES	L	T	P	C
		3	0	0	3

CONVENTIONAL CONTROL OF INDUCTION MOTORS

Review of Induction Machine operation – Equivalent circuit – Performance of the machine with variable voltage, rotor resistance variation, pole changing and cascaded induction machines, slip power recovery – Static Kramer Drive, Static Scherbius Drive.

VSI AND CSI FED INDUCTION MOTOR CONTROL
VSI fed induction machine operation – Energy conservation issues – V/f operation theory – requirement for slip and stator voltage compensation. CSI fed induction machine – Operation and characteristics.

FIELD ORIENTED CONTROL
Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation.

DIRECT TORQUE CONTROL (DTC)
DTC control strategy, direct torque control of Induction Machines – Torque expression with stator and rotor fluxes.

SYNCHRONOUS MOTOR CONTROL
Synchronous motor control - Brush and Brushless excitation – Load commutated inverter fed drive.

TEXT BOOK
1. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2003.
2. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House,1992
3. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill, 2008.

REFERENCES
1. W.Leohard, " Control of Electrical Drives", Narosa publishing House,1992.
2. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press,
3. Oxford, 1988.

4. R. Krishnan, "Electric Motor & Drives: Modeling, Analysis and Control", Prentice
5. Hall of India, 2003 (New Edition).

EEE5208	EMBEDDED CONTROL BASED ELECTRICAL DRIVES	L	T	P	C
		3	0	0	3

PIC 16C7X and 16C8X MICROCONTROLLER ARCHITECTURE
Architecture – memory organization – addressing modes.

INSTRUCTION AND PROGRAMMING
instruction set – programming techniques – simple operation.

PERIPHERAL INTERFACE
Timers – interrupts – I/O ports – I^2C bus for peripheral chip access.

ADC AND DAC

A/D converter – D/A converter – UART.

SYSTEM DESIGN USING MICROCONTROLLERS

PWM Generation – Sensor Interfacing – LCD Interfacing– Keypad interfacing – AC load control – PID control of DC motor – System Simulation using Interface.

TEXT BOOK

1. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004

REFERENCE

1. John B.Peatman, 'Design with Microcontrollers', Tata MCGraw Hill
2. www.microchip.com
3. W.Leonhard , "Control of Electrical Drives", Narosa Publishing House, 1992
4. Software Tool for Simulation 'PROTEUS'- v 7professional.
5. Data Sheet for PIC 16C7X.

EEE5208	POWER ELECTRONICS AND DRIVES LABORATORY II	L	T	P	C
		0	0	3	2

1. Closed loop control of converter fed DC motor drive.
2. Closed loop control of chopper fed DC motor drive.
3. VSI fed three phase induction motor drive.
4. Three Phase Inverter voltage control
5. V/F Control of Three phase Induction Motor.
6. Speed control of three phase Synchronous Motor.
7. Speed Control of Switched Reluctance Motor
8. Digital (DSP/FPGA) control of Synchronous/Asynchronous Motor Drives.
9. Measurement of Performance Parameters of an AC/DC drive.
10. Field oriented / DTC control of AC drive
11. Simulation of Converter and Chopper fed DC drive
12. Simulation of Inverter fed AC drive

SEMESTER III

EEE 6298	PROJECT WORK (PHASE I)	L	T	P	C
		0	0	18	6

SEMESTER IV

EEE 6299	PROJECT WORK (PHASE II)	L	T	P	C
		0	0	36	12

LIST OF ELECTIVES - I YEAR

EEE 5001	SYSTEMS THEORY	L	T	P	C
		3	0	0	3

STATE SPACE ANALYSIS

Realization of State models – Non-uniqueness – Minimal realization – Balanced realization – Solution of state equations – State transition matrix and its properties – Free and forced responses – Properties – Controllability, Observability, Stabilisability and detectability – Kalman decomposition - Minimal and Balanced realization

MIMO SYSTEMS –FREQUENCY DOMAIN DESCRIPTIONS

Properties of transfer functions – Impulse response matrices – Poles and zeros of transfer function matrices – Critical frequencies – Resonance – Steady state and dynamic response – Bandwidth- Nyquist plots-Singular value analysis

ADAPTIVE CONTROL

Classification of adaptive control – Introduction to auto tuning – types of adaptive control- MRAC- MIT rule- Design and approaches –SIR – Introduction, Direct & Indirect method applications

NON-LINEAR SYSTEMS

Types of non-linearity – Typical examples – Equivalent linearization - Phase plane analysis – Limit cycles – Describing functions- Analysis using Describing functions- Jump resonance-Model reduction technique - Dominant pole concept, Pade approximation-Stability of trajectories-Phase pole circuits

STABILITY

Stability concepts – Equilibrium points – BIBO and asymptotic stability – Direct method of Liapunov – Application to non-linear problems – Frequency domain stability criteria – Popov's method and its extensions-stability loop-Kalman's stability

TEXT BOOKS

1. Gopal,M, Modern Control Engineering, Wiley, 1996
2. Ogatta,K., Modern Control Engineering, Pearson Education Asia, 1997

REFERENCE BOOKS

1. Eroni-Umez and Eroni, System dynamics & Control, Thomson Brooks/ Cole, 1998
2. Karl.J.Asborn & B.Jorn Wittermark, Adaptive Control, Pearson Education Singapore 2nd Edition 2003
3. Thaler,G,J.,Automatic control systems, Jaico publishers, 1993
4. John. S. Bay, Linear State Space Systems, McGrawHill International edition, 1999

EEE5002	POWER SYSTEM MODELLING	L	T	P	C
		3	0	0	3

SYNCHRONOUS MACHINE MODELLING

Physical description- dqo transformation-per unit representation-equivalent circuits for direct and quadrature axes- steady state analysis-electrical transient performance-magnetic saturation-equations of motion.

SYNCHRONOUS MACHINE REPRESENTATION IN STABILITY STUDIES

Simplifications for large scale studies- simplified model with amortissuers neglected-constant flux linkage model – reactive capability limits.

MODELLING OF EXCITERS AND PRIME MOVERS

Excitation system requirements –types of excitation systems –dynamic performance machines – control and protective functions – modelling of excitation systems - hydraulic turbines and governing systems-steam turbines and governing systems.

MODELLING OF TRANSMISSION LINES AND TRANSFORMERS

Transmission lines-electrical characteristics –equivalent circuit –voltage power characteristics- thermal limits- transformers –representation of two winding and three winding transformers – phase shifting transformers.

LOAD MODELLING

Basic load modelling – static load models – dynamic load models – acquisition of load model parameters –measurement based approach – component based approach-sample load characteristic- induction motor equivalent circuits and parameters – free acceleration characteristics – dynamic performance – changes in load torque – effect of three phase short circuit – effect of unbalanced faults.

TEXT BOOKS

1. Prabha Kundur ,Power System stability and control ,Tata MC Graw Hill Edition 1994

REFERENCES

1. Padiyar,K,R., Power System Dynamics, Stability and Control, B.S.Publications, 2nd edition, 2002.

EEE 5007	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

FACTS CONTROLLERS

Lack of control on active and reactive power flow – Conventional control mechanisms- Need for FACTS devices – Advances in power semiconductor devices – Types of FACTS controllers – Importance of FACTS controllers

SVC AND APPLICATIONS

Voltage control by Static Var Compensator (SVC) – Advantages of slope in dynamic characteristics – influence of SVC on system voltage – Design of SVC voltage regulator – Applications- Enhancement of transient stability – steady state power transfer – Enhancement of power system damping – prevention of voltage instability

TCSC AND APPLICATIONS

Operation of the Thyristor Controlled Series Capacitor(TCSC)- Different modes of operation – Modeling of TCSC – Variable reactance model – Modeling for stability studies- Applications – Improvement of the system stability limit – Enhancement of system damping – Voltage collapse prevention

EMERGING FACTS CONTROLLERS

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics – Unified Power Flow Controller (UPFC) – Principle of operation - Modes of Operation – Applications – Modeling of UPFC for Power Flow - Studies

CO-ORDINATION OF FACTS CONTROLLERS

Controller interactions – SVC _ SVC interaction- Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms

TEXT BOOK

1. Mohan Mathur.R., Rajiv . K.Varma, "Thyristor – Based Facts Controllers for ElectricalTransmission Systems", IEEE press and John Wiley & Sons, Inc.
John,A,T., "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers(IEEE), 1999

REFERENCE

1. Narain G.Hingorani, Laszio. Gyugy.L, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers –Delhi 2001.

EEE 5010	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
		3	0	0	3

DC POWER TRANSMISSION TECHNOLOGY

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

ANALYSIS OF HVDC CONVERTERS

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

CONVERTER AND HVDC SYSTEM CONTROL

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

HARMONICS&FILTERS

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

SIMULATION OF HVDC SYSTEMS

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

TEXT BOOKS

1. Padiyar, K.R., “HVDC Power Transmission System”, Wiley Eastern Limited, New Delhi 1990. First edition.
2. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering” New Age International (P) Ltd., New Delhi, 1990.

REFERENCES

1. Edward Wilson Kimbark, “Direct Current Transmission”, Vol. I, Wiley interscience, New York, London, Sydney, 1971.
2. Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983

EEE 5111	DATA COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

PROTOCOLS AND ARCHITECTURES

Protocols-layered approach-OSI model-DoD model-Hierarchical Approach-Local Network Technology- Bus/Tree topology-Ring topology-medium access protocols - Details of IEEE 802 standards.

NETWORK ACCESS PROTOCOL & INTERNETWORKING

Circuit Switched Network Access-Packet Switched Network Access-Broadcast Network Access-Principle of Internetworking-Bridges, Gateways-X, 75-internet protocols-ISO Internet protocol standard.

TRANSPORT PROTOCOL & ROUTING TECHNIQUES

Transport Service protocol Mechanisms-Network Service-Transport standards-Internet Transport protocols-Wireless UDP-Overview of routing techniques.

PRESENTATION/APPLICATION PROTOCOLS

File Transfer Protocols-World Wide Web-Electronic Mail-Overview of ISDN-ISDN Protocols.

NETWORK MANAGEMENT

Architecture of network management-Fault management-Congestion Control Algorithms -Security Management.

TEXT BOOK

1. Andrew Tannenbaum S., “Computer Networks ", 3rd Edition, Prentice Hall of India, 1997.

REFERENCES

1. Stallings, “Data and Computer Communication: Architectures, Protocols and Standards", IEEE Computer Society, 1987.
2. Kernel Texpian A.S., “Communication Network Management ", Prentice Hall, 1992.
3. " Network Management ", Standards, Uylers Black, McGraw Hill, 1995.
4. Comer and Stevens, " Internetworking with TCP/IP Vol.III: Client Server Programming and application ", 4th Edition, Prentice Hall, USA, 1996.

EEE5117	SOFT COMPUTING	L	T	P	C
		3	0	0	3

ARTIFICIAL INTELLIGENCE (AI)

Intelligent search – Predicate Calculus – Learning Systems - Knowledge Representation and Reasoning – Semantic Networks – Frames - Knowledge Acquisition - Expert Systems - Intelligent Control.

ARTIFICIAL NEURAL NETWORKS (ANN)

Biological Neural Networks - Artificial Neural Networks - Topology of ANN – Learning rules – Supervised, Unsupervised, and Reinforcement Learning – Single Layer and Multilayer Perceptrons - Feed forward neural networks-The Back-propagation Training Algorithm - Binary and Continuous Hopfield Network - Associative Memory - Self-Organizing Maps.

FUZZY SYSTEMS

Classical Set – Fuzzy Set – Linguistic Variables - Membership Functions - Fuzzy relations – Fuzzy rules and Reasoning – Fuzzy Inference Systems – Defuzzification methods – Mamdani, Sugeno and Tsukamoto Fuzzy models – Fuzzy Decision Making – Fuzzy logic control

GENETIC ALGORITHMS (GA)

Survival of Fittest – GA Terminologies - Working Principle of Binary GA – Genetic Operators – Reproduction, Cross over and Mutation – Similarities and Differences with traditional methods – Schema and Schemata – GA theorem – Real Coded GA - Advantages and Limitations of GA – Applications.

CASE STUDIES/APPLICATIONS

Case studies in neural networks -Applications of fuzzy logic control - Hybrid system-Neuro fuzzy system-ANFIS applications.

TEXT BOOKS:

1. J.S.R. Jang., et al., "Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence", PHI, 2010.

2. Amit Konar, "Artificial Intelligence and Soft Computing: Behavioral and Cognitive modeling of the Human Brain", CRC Press, 2008.

REFERENCES:

1. Simon Haykin, "Neural Networks and Learning Machines", 3rd Edition, Pearson, 2009.

2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, Wiley, 2010.

3. Kalyanmoy Deb, "Multi-Objective Optimization Using Evolutionary Algorithms", 3rd Edition, Wiley, 2010.

4. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson, 2009.

5. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2008.

6. S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing", Wiley India, 2008.

7. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2008.

EEE 5210	DIGITAL SIGNAL PROCESSORS	L	T	P	C
		3	0	0	3

ARCHITECTURE AND ALGORITHMS OF DSP
Algorithms for signal processing – Basic architecture of DSPs.

TEXAS PROCESSORS
Architecture – Addressing modes – Instruction set – Programming

PERIPHERALS INTERFACES OF DSP
Peripherals – memory – Applications.

EXTERNAL INTERFACE

Digital and analog Interface – Host interface – Memory interface – DMA ports – Serial ports.

SPECIAL PROCESSORS FOR MOTOR CONTROL
Architecture – Special features – PWM generation – controller implementation

TEXT BOOKS

1. B. Venkataramani et al. "Digital Signal Processor – Architecture, Programming and Applications", TMH, New Delhi 2002.

REFERENCES

1. K.Padmanabhan et al. "A Practical approach to Digital Signal Processing", New
2. AgePublications, 2001.
3. Texas Instruments – Manuals
4. www.ti.com

EEE 5211	SWITCHED MODE POWER CONVERSION	L	T	P	C
		3	0	0	3

SWITCHED MODE DC-DC CONVERTER
Basic concepts of Switched Mode power converters, DC-DC converters Characteristics, constituent elements, operating principles.

STEADY STATE AND DYNAMIC ANALYSIS
Steady state analysis, stress and sizing of elements, control methods, duty ratio, current programmed, frequency programmed and sliding mode control, Dynamic analysis and frequency domain models.

RESONANT CONVERTERS
Classification of resonant converters, Basic resonant circuit concepts, Load resonant converters , Resonant switch converters, Zero voltage switching.

DESIGN OF RECTIFIERS

Design of feed back compensators, unity power factor rectifiers, resistor emulation principle and applications to rectifiers.

APPLICATIONS

Active filters-classifications and principle of operation, Power line disturbances, Power conditioners, Un-interrupted Power supplies.

REFERENCES

1. Switched Mode Power Conversion, Course Notes, CCE, IISc, 2004.
2. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004.
3. Philip T Krein,' Elements of Power Electronics ',Oxford Press,1998.

YEAR II

EEE 5013	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

DIGITAL SIGNAL PROCESSING

Digital signal processing - sampling of analog signals, selection of sample frequency, signal-processing systems, frequency response, transfer functions, signal flow graphs, filter structures, adaptive digital signal processing algorithms, discrete fourier transform - the discrete fourier transform, fast fourier transform - fast fourier transform algorithm, image coding, discrete cosine transforms.

DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS

Finite impulse response filters – finite impulse response filter structures, finite impulse response chips, infinite impulse response filters, specifications of infinite impulse response filters, mapping of analog transfer functions, mapping of analog filter structures.

MULTIRATE DSP

Decimation by a factor D, interpolation by a factor i, filter design and implementation for sampling rate conversion, multistage implementation of sampling rate conversion – sampling rate conversion by an arbitrary factor – applications of multirate signal processing – digital filter banks – quadrature mirror filter bank.

DSP PROCESSORS AND DSP APPLICATIONS

General purpose Digital Signal Processors: Texas Instruments TMS320 family – Motorola DSP 56333 family – analog devices ADSP 2100 family – Instruction set of TMS320C50 – simple programs. FFT Spectrum Analyser – musical sound processing. Power System Applications, Image Processing Applications.

ARITHMETIC UNITS AND INTEGRATED CIRCUIT DESIGN

Conventional number system, redundant number system, residue number system - bit-parallel and bit-serial arithmetic, basic shift accumulator, reducing the memory size,

complex multipliers, improved shift - accumulator - layout of very large scale integrated circuits, fast fourier transform processor, discrete cosine transform processor and interpolator as case studies.

TEXT BOOKS

1. Monson H. Hayes, Statistical Digital Signal Processing and modeling, John Wiley and sons, 2003.
2. Sajit K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill Publishing Company Ltd., New Delhi, 1998
3. John G. Proakis and Dimitris G. Manolakis, 'Digital Signal Processing, Algorithms and Applications'. PHI, New Delhi, 1995

REFERENCES

1. Lars Wanhammer, DSP Integrated Circuits, Academic press, New York, 2002.
2. Oppenheim. A. V, Discrete-time Signal Processing Pearson education, 2000.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, Digital signal processing – A practical approach, 2nd edition, Pearson edition, Asia.
4. Keshab K. Parhi, VLSI digital Signal Processing Systems design and Implementation, John Wiley and Sons, 2004.

EEE 5015	RENEWABLE POWER GENERATION	L	T	P	C
		3	0	0	3

PHOTO-VOLTAICS

Basic characteristics of sunlight – solar energy resource – photovoltaic cell-characteristics – equivalent circuit – photo voltaic for battery charging – charge regulators – equipments and systems.

WIND TURBINES

Wind source – wind statistics - energy in the wind – aerodynamics - rotor types – forces developed by blades – aerodynamic models – braking systems – tower - control and monitoring system – power performance.

EMBEDDED GENERATION

Wind driven induction generators-power circle diagram-steady state performance – modeling-integration issues –impact on central generation- transmission and distribution systems – wind farm electrical design.

BIO MASS POWER

Municipal waste – Methods for obtaining energy from Bio mass –Anaerobic digestion-Ethanol fermentation –Gas holder – Fuel gas – manure – cogeneration of electrical power – Gas turbine topping systems-MHD generator topping – Gas turbine – Combustion chamber – Efficiency of materials for gas turbine.

OTHER RENEWABLE SOURCES

Micro-hydel electric systems – power potential – scheme layout – generation efficiency and turbine part flow-isolated and parallel operation of generators – geothermal-tidal and OTEC systems.

TEXT BOOKS

1. John F.Walker & Jenkins. N , 'Wind energy Technology ' , John Wiley and sons, chichester , U.K ,1997.
2. Agarwall ,M,P., ' Future sources of electrical power', S.Chand Co.Ltd., New Delhi, 1999.

REFERENCE

1. Van Overstraeton and Mertens R.P., 'Physics, Technology and use of Photovoltaic', Adam Hilger, Bristol,1996.

EEE6001	POWER QUALITY	L	T	P	C
		3	0	0	3

INTRODUCTION

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

HARMONICS

Harmonics- individual and total harmonic distortion- RMS value of a harmonic waveform-triplex harmonics- important harmonic introducing devices- SMPS-Three phase power converters-arcing devices- saturable devices- Harmonic Distortion of fluorescent lamps- effect of power system harmonics on power system equipment and loads-Modelling of network and components under non-sinusoidal conditions-transmission and distribution systems- shunt capacitors- transformers- electric machines-ground systems- loads that cause power quality problems- power quality problems created by drives and its impact on drives.

VOLTAGE RELATED PROBLEMS

Sources of sags and interruptions- estimating voltage sag performance-motor starting sags- estimating the sag severity-mitigation of voltage sags- active series compensators-static transfer switches and fast transfer switches- Sources of over voltages- Capacitor switching, lightning- Ferro resonance- mitigation of voltage swells- Surge arresters, low pass filters, power conditioners – Lightning protection, shielding, line arresters, protection of transformers and cables- computer analysis tools for transients, PSCAD and EMTP.

POWER QUALITY MONITORING

Monitoring considerations- Power line disturbance analyzer- per quality measurement equipment- harmonic / spectrum analyzer- flicker meters- disturbance analyzer- applications of expert system for power quality monitoring.

POWER QUALITY IMPROVEMENT

Static compensator - Distribution static compensator- Dynamic voltage restorer - Power factor corrector - Active filters - Shunt active filters - applications - PSCAD / EMTDC simulation of Active filters.

TEXT BOOKS

1. Arrillaga, J.," Power System Quality Assessment" , John Wiley, 2000.
2. Arrillaga J., Smith,B,C.,Vatsan,N,R and Wood,A,R., "Power System Harmonic Analysis," John Wiley, 1997.

REFERENCE BOOKS

1. Loi Lei Loi, "Power System Restructuring and Deregulation – Trading, performance & information technology", John Wiley Publications.
2. Ashok,S,A.," Selected Topics in Power quality and customer power " ,Course book for STTP 2004.
3. Surya Santoso, H.Wayne Beaty, Roger .C.Dugan, Mark .F.Mcgranaghan , Electric
4. Power System Quality'Mc Graw hill 2002.
5. Acha, E., Agelidis,V,G.,Anaya.,O., Laraand T.J.E.Miller, Power Electronic control in electrical systems.
6. Proceeding of VSAG 2005 – National Seminar Power Quality, EEE/A.K.College of Engineering.

EEE6016	ENERGY EFFICIENCY IN ELECTRICAL UTILITIES	L	T	P	C
		3	0	0	3

ELECTRICAL STATIC SYSTEMS AND MOTORS

Electrical System : Introduction to Electric Power Supply Systems - Electricity Billing - Electrical Load Management and Maximum Demand Control -Power Factor Improvement and Benefits – Transformers- Energy Efficient Transformers - System Distribution Losses - Harmonics - Analysis of Electrical Power Systems - Maximum Demand Controllers - Automatic Power Factor Controllers.

Electric Motors : Introduction - Motor Types - Motor Characteristics - Motor Efficiency - Motor Selection - Energy Efficient Motors - Factors Affecting Energy Efficiency and Minimising Motor - Losses in Operation - Rewinding Effects on Energy Efficiency - Speed Control of AC Induction Motors - Motor Load Survey: Methodology - Energy Efficient Motors - Soft Starter - Variable Speed Drives

ELECTRO MECHANICAL EQUIPMENTS – I

Compressed Air System: Introduction - Compressor Types - Compressor Performance - Compressed Air System Components - Efficient Operation of Compressed Air Systems - Compressor Capacity Assessment - Checklist for Energy Efficiency in Compressed Air System.

HVAC And Refrigeration System: Introduction - Types of Refrigeration System - Common Refrigerants and Properties - Compressor Types and Application - Selection of a Suitable Refrigeration System - Performance Assessment of Refrigeration Plants - Factors Affecting Performance and Energy Efficiency of - Refrigeration Plants - Energy Savings Opportunities

ELECTRO MECHANICAL EQUIPMENTS – II

Fans and Blowers: Introduction - Fan Types - Fan Performance Evaluation and Efficient System Operation - Fan Design and Selection Criteria - Flow Control Strategies - Fan Performance Assessment - Energy Saving Opportunities.

Pumps and Pumping System: Pump Types -System Characteristics - Pump Curves - Factors Affecting Pump Performance - Efficient Pumping System Operation - Flow Control Strategies - Energy Conservation Opportunities in Pumping Systems.

DG SET SYSTEM AND COOLING TOWERS

DG set system: Introduction - Selection and Installation Factors - Operational Factors - Energy Performance Assessment of DG Sets- Energy Savings Measures for DG Sets.

Cooling Towers: Introduction - Cooling Tower Performance - Efficient System Operation - Flow Control Strategies - Energy Saving Opportunities in Cooling Towers

LIGHTING SYSTEM

Introduction - Basic Terms in Lighting System and Features - Lamp Types and their Features - Recommended Illuminance Levels for Various - Tasks/Activities/Locations - Methodology of Lighting System Energy Efficiency Study - Case Examples - Some Good Practices in Lighting - Electronic Ballasts - Energy Efficient Lighting Controls

TEXT BOOK

1. Book-3: Energy Efficiency in Electrical Utilities, Bureau of Energy Efficiency, New Delhi, India, II edition 2005

EEE 6201	FUZZY SYSTEMS and NEURAL NETWORKS	L	T	P	C
		3	0	0	3

FUZZY SYSTEM

Fuzzy sets and Crisp sets – Fuzzy Properties - Operation on fuzzy sets – Membership Functions – Fuzzyfication – Defuzzyfication – Fuzzy Inference System.

FUZZY APPLICATION

Non Linear Control – FKBC Computational Structure – FKBC types – PID, Sliding Mode, Sugeno Control – Temperature Control – Washing Machine Control- Decision Making.

NEURAL NETWORKS

Introduction – Biological Neural Networks – Activation Function - mathematical Model – Learning algorithm – Feed forward and Feedback network.

NEURAL NETWORK APPLICATIONS

Need for System Identification - System Identification using Neural Networks – Home Heating System – Control System Applications.

NEURO FUZZY SYSTEMS

Fuzzy-Neural Hybrids - Neuro-Fuzzy Hybrids - Tuning of Membership Functions – Applications.

REFERENCE BOOKS

1. Zimmermann, H.J., 'Fuzzy set theory and its applications', Allied publishers limited, Madras,1996.
2. Klir, G.J., and Folge., T., 'Fuzzy sets, uncertainty and information', PHI, New Delhi,1991.
3. EarlCox,'The Fuzzy Systems Handbook', AP professional Cambridge, MA 02139, 1994.
4. Introduction To Neural Networks using Matlab 6.0 by S.N.Sivanandam, S.Sumathi, S.N.Deepa, tata McGraw hill 2006.
5. Martin T. Hogan , Howard B.Demuth, M, 'Neural network design'
6. Zuroda, J.M.,'Introduction to Artificial Neural Systems', Jaico publishing house, Bombay, 1994.

EEE6203	**DIGITAL SIMULATION OF POWER ELECTRONIC SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

APPLICATION OF NUMERICAL METHODS IN ELECTRONIC CIRCUITS

Review of numerical methods - Application of numerical methods to solve transients in DC Switched R, L, RL, RC and RLC circuit - Extension to AC circuits.

SIMULATION MODEL OF ELECTRONIC DEVICES

Modeling of diode in simulation. Diode with R, R-L, R-C and R-L-C load with ac supply. Modelling of SCR, TRIAC, IGBT and Power Transistors in simulation. Application of numerical methods to R, L, C circuits with power electronic switches. Simulation of gate/base drive circuits, simulation of snubber circuits.

SIMULATION MODEL OF ELECTRICAL MACHINES

State space modeling and simulation of linear systems - Introduction to electrical machine modeling: induction, DC, and synchronous machines, simulation of basic electric drives, stability aspects.

SIMULATION MODEL OF POWER ELECTRONIC CIRCUITS

Simulation of single phase and three phase uncontrolled and controlled (SCR) rectifiers, converters with self commutated devices- simulation of power factor correction schemes, Simulation of converter fed dc motor drives Simulation of thyristor choppers with voltage, current and load commutation schemes, Simulation of chopper fed dc motor.

APPLICATION OF SIMULATION MODEL

Simulation of single and three phase inverters with thyristors and self-commutated devices, Space vector representation, pulse-width modulation methods for voltage control, waveform control. Simulation of inverter fed induction motor drives.

REFERENCES

1. 'Fundamentals of power Electronics using MATLAB' , Randall Shaffer, Cengage Learning 2008.
2. Robert Ericson, 'Fundamentals of Power Electronics', Chapman & Hall, 1997.
3. Issa Batarseh, 'Power Electronic Circuits', John Wiley, 2004
4. Simulink Reference Manua , Math works, USA.
5. 'Laboratory Experiments and PSPICE Simulation in Analog Electronics' L.K.Maheshwari, M.M.S.Anand PHI Learning (p) Ltd 2008.
6. Wayne Wolf," FPGA based system design ", Prentice hall, 2004

EEE6204	PWM CONVERTERS AND APPLICATIONS	L	T	P	C
		3	0	0	3

PRINCIPLE OF POWER CONVERTERS

AC/DC and DC/AC power conversion, overview of applications of voltage source converters, pulse modulation techniques for bridge converters.

PWM TECHNIQUES

Bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter; calculation of switching and conduction losses.

DYNAMIC MODEL

Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters; constant V/F induction motor drives.

RIPPLE CALCULATION

Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation.

COMPENSATION USING POWER CONVERTERS

Active power filtering-reactive power compensation; harmonic current compensation.

REFERENCES

1. Mohan, Undeland and Robbins,' Power Electronics; Converters, Applications and Design',John Wiley and Sons, 1989.
2. Erickson R W,' Fundamentals of Power Electronics', Chapman and Hall, 1997. Vithyathil J,'Power Electronics: Principles and Applications ', McGraw Hill, 1995.

EEE6205	PROGRAMMABLE LOGIC CONTROLLERS	L	T	P	C
		3	0	1	4

INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER

Study the history of development - examples of early applications - review of common computer mathematical functions - digital logic gates.

MAIN ELEMENTS OF THE PLC SYSTEM

CPU - memory maps - single bit I/O modules - Power Supplies.

PLC PROGRAMMING

Equipment – formats - ladder diagrams – scanning – Programming On/Off Inputs to produce On-Off Outputs - Basic PLC Programming.

PROGRAM USING REGISTER FUNCTIONS

Input - output registers - timer - counter functions - understand PLC arithmetic functions - square root - comparisons creation of ladder diagrams for process-control.

APPLICATIONS

Skip - Master Control Relay Functions - Interlocks Data Move Systems - Real time control using PLC - PID function in PLC – Soft PLC's, Lab Exercises.

TEXT BOOKS

1. John W.Webb and Ronald A Reis, Programmable Logic Controllers - Principles and Applications, Prentice Hall, New Jersey, 2nd edition, 1998
2. Frank D. Petruzella, Programmable Logic Controllers, McGraw Hill, Newyork, 2nd edition, 1997

REFERENCES

1. Curtis D. Johnson, Process Control Instrumentation Technology, Prentice Hall, New Delhi, 7th edition, 2002
2. Stenerson J., Fundamentals of Programmable Logic Controllers, Sensors and Communications, Prentice Hall, 1998
3. Michel G. and Duncan, F., Programmable Logic Controllers:Architecture and Application, John Wiley & Sons Pvt ltd., 1990

4. Carrow, R.A., Soft Logic: A Guide to Using a PC as a Programmable Logic Controller, Tata McGraw Hill, New Delhi, 1997

EEE6206	DIGITAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

INTRODUCTION

Digital codes – memory devices – basic building blocks – gates, ff - counters – discrete data handling – sampling – sampling theorem – aliasing errors – reconstruction – xtrapolation – synchronous - asynchronous sampling.

DIGITAL METHODS OF MEASUREMENTS

Review of A/D - D/A techniques – F/V - V/F conversion techniques – digital voltmeters and multimeters – automation - accuracy of digital voltmeters - multimeters – digital phase meters – digital tachometers – digital frequency, period - time measurements – low frequency measurements – automatic time - frequency scaling – sources of error – noise – inherent error in digital meters, hidden errors in conventional ac measurements – RMS detector in digital multimeters – mathematical aspects of RMS

DIGITAL DISPLAY AND RECORDING DEVICES

Digital storage oscilloscopes – Digital printers - plotters – CDROMS – Digital magnetic tapes - dot matrix - LCD display CROs – colour monitor - digital signal analyser - digital data acquisition

SIGNAL ANALYSIS

Amplifiers – filters – transmitter – receiver - wireless base – mobile station test sets - noise figures meters - RF network analyser – high frequency signal sources

CURRENT TRENDS IN DIGITAL INSTRUMENTATION

Special function add on cards – resistance card – input - output cards – counter, test - time of card - digital equipment construction with modular designing - interfacing to microprocessor - micro controllers - computers - computer aided software engineering tools (CASE) – use of case tools in design - development of automated measuring systems – interfacing IEEE cards – intelligent – programmable instruments using computers

TEXT BOOK

1. Bouwens, A.J., Digital Instrumentation, Tata Mcgraw hill, 2nd edition, 1997

REFERENCES

1. John Lenk, D., Handbook of Micro computer based Instrumentation and Control,1984

2. Doebelin, Measurement System, Application & Design, Tata McGraw-Hill, 4th Edition, 2002

		L	T	P	C
EEE6207	**NON LINEAR CONTROL**	**3**	**0**	**0**	**3**

PHASE PLANE ANALYSIS

Concepts of phase plane analysis- Phase portraits- singular points- Symmetry in phase plane portraits-Constructing Phase Portraits- Phase plane Analysis of Linear and Nonlinear Systems- Existence of Limit Cycles.

DESCRIBING FUNCTION

Describing Function Fundamentals-Definitions-Assumptions-Computing Describing Functions-Common Nonlinearities and its Describing Functions-Nyquist Criterion and its Extension-Existence of Limit Cycles-Stability of limit Cycles.

LYAPUNOV THEORY

Nonlinear Systems and Equilibrium Points-Concepts of Stability-Linearization and Local Stability-Lyapunov's Direct Method-Positive definite Functions and Lyapunov Functions- Equilibrium Point Theorems-Invariant Set Theorems-LTI System Analysis based on Lyapunov's Direct Method-Krasovski's Method-Variable Gradient Method-Physically – Control Design based on Lyapunov's Direct Method.

FEEDBACK LINEARIZATION

Feedback Linearization and the Canonical Form-Mathematical Tools-Input-State Linearization of SISO Systems- input-Output Linearization of SISO Systems-Generating a Linear Input-Output Relation-Normal Forms-The Zero-Dynamics-Stabilization and Tracking-Inverse Dynamics and Non-Minimum-Phase Systems-Feedback Linearization of MIMO Systems Zero-Dynamics and Control Design.

SLIDING MODE CONTROL

Sliding Surfaces- Continuous approximations of Switching Control laws-The Modeling/Performance Trade-Offs - MIMO Systems.

TEXT BOOK

1. J A E Slotine and W Li, Applied Nonlinear control, PHI, 1991.

REFERENCES

1. Hasan Khalil, "Nonlinear systems and control", Prentice Hall, 2002.
2. S H Zak, "Systems and control", Oxford University Press, 2003.
3. Torkel Glad and Lennart Ljung, "Control Theory – Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
4. G. J. Thaler, "Automatic control systems", Jaico publishers, 1993.

5. P.Albertos, A. Sala," Multivariable Control System", Springer, 2004

	SYSTEM IDENTIFICATION	**L**	**T**	**P**	**C**
EEE6208	**AND ADAPTIVE CONTROL**	**3**	**0**	**0**	**3**

MODELS FOR INDENTIFICATION

Models of LTI systems: Linear Models-State space Models-OE model- Model sets, Structures and Identifiability-Models for Time-varying and Non-linear systems: Models with Nonlinearities – Non-linear state-space models-Black box models, Fuzzy models'.

NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square –Forgetting factor- Maximum Likelihood – Instrumental Variable methods.

NON-LINEAR IDENTIFICATION AND MODEL VALIDATION

Open and closed loop identification: Approaches – Direct and indirect identification – Joint input-output identification – Non-linear system identification – Wiener models – Power series expansions - State estimation techniques – Non linear identification using Neural Network and Fuzzy Logic.

ADAPTIVE COTROL AND ADAPTATION TECHNIQUES

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR and MRAC – Different approaches to self-tuning regulators – Stochastic Adaptive control – Gain Scheduling.

CASE STUDIES

Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TEXT BOOK

1. Ljung Ed.," System Identification Theory for the User", PHI, 1987.

REFERENCES

1. Torsten Soderstrom, Petre Stoica, "System Identification", prentice Hall ` International (UK) Ltd,1989.
2. Astrom and Wittenmark," Adaptive Control ", PHI, 2001
3. William S. Levine, " Control Hand Book", 2000.
4. Narendra and Annasamy," Stable Adaptive Control Systems, Prentice Hall, 1989.