COMMON SYLLABUS
for
M Tech
On
Power Electronics and Drives

1st Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	EAM-101	Advanced Engg. Math	3	1	0	4	4
2	PEM101	Compulsory	3	1	0	4	4
3	PEM102	Compulsory	3	1	0	4	4
4	PEM103	Compulsory	3	1	0	4	4
5	PEM104	Elective I	4	0	0	4	4
		Total of Theory				20	20

Practical / Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	PEM191	Laboratory I	0	0	3	3	2
2	PEM192	Laboratory II	0	0	3	3	2
3	PEM193	Seminar I	0	0	3	3	2
		Total of Practical / Sessional				9	6
TOTAL OF SEMESTER:			18	02	09	29	26

2nd Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	PEM201	Compulsory	3	1	0	4	4
2	PEM202	Compulsory	3	1	0	4	4
3	PEM203	Compulsory	3	1	0	4	4
4	PEM204	Elective II	4	0	0	4	4
5	PEM205	Elective III	4	0	0	4	4
		Total of Theory				20	20

Practical / Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	PEM291	Laboratory III	0	0	3	3	2
2	PEM291	Laboratory IV	0	0	3	3	2
3	PEM293	Seminar II	0	0	3	3	2
		Total of Practical / Sessional				9	6
TOTAL OF SEMESTER:			18	02	09	29	26

3rd Semester

Theory:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	EMAN-301	Topic In Management	4	0	0	4	4
2	PEM301	Elective IV	4	0	0	4	4
		Total of Theory				8	8

Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total Contact Hrs	Credits
			L	T	P		
1	PEM391	Pre-submission Defense of Dissertation	0	0	0	0	4
2	PEM392	Dissertation (Part-I)	0	0	0	20	10
		Total of Sessional				20	14
TOTAL OF SEMESTER:						28	22

4th Sem

Sessional:

Sl. No.	CODE	Paper	Contacts periods Per weeks			Total	Credits
1	PEM491	Dissertation (Completion)	0	0	0	24	14
2	PEM492	Post-submission Defense of Dissertation	0	0	0	0	8
	PEM493	Comprehensive Viva-Voce	0	0	0	0	4
						24	26
TOTAL OF SEMESTER:						24	26

Total Credits: 26 + 30 + 22 + 22 = 100

FIRST SEMESTER:

A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	EMM101	Advanced Engineering Mathematics	1	100
2	PEM101	Power Electronics- I	1	100
3	PEM102	Electrical Machine Analysis	1	100
4	PEM103	Advanced Control Systems	1	100
5	PEM104	Elective II(Any one) (a) Solid State Power Controller (b) Digital Signal Processing (c) Microcontroller Based System Design (d) Energy Management & Audit	1	100
			TOTAL OF THEORY	500
B. PRACTICAL / SESSIONAL				
6	PEM191	Electrical Engineering Laboratory -I	1	100
7	PEM192	Electrical Engineering Laboratory -I I	1	100
8	PEM181	Seminar I	1	100
			TOTAL OF PRACTICAL / SESSIONAL	300
			TOTAL OF SEMESTER	800

SECOND SEMESTER:

A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	PEM201	Power Electronics- II	1	100
2	PEM202	Electric Drives	1	100
3	PEM203	Special Electrical machines	1	100
4	PEM204	Elective III (Any one) a) Generation of Non conventional Energy b) Advanced Mathematics-II c) Intelligent Control of Drives	1	100
5	PEM205	Elective IV (Any one) (a) Flexible AC Transmission Systems (b) Nonlinear Phenomena in switching systems	1	100
			TOTAL OF THEORY	500
B. PRACTICAL / SESSIONAL				
6	PEM291	Electrical Engineering Laboratory -I I I	1	100
7	PEM292	Electrical Engineering Laboratory -I V	1	100
8	PEM281	Seminar II	1	100
			TOTAL OF PRACTICAL / SESSIONAL	300
			TOTAL OF SEMESTER	800

THIRD SEMESTER:

A. THEORY				
SL. NO.	**CODE**	**SUBJECT**	**NO. OF PAPERS**	**MARKS**
1	EMAN301	Introduction to Management	1	100
2	PEM301	Elective V (Any one) (a) Power Quality Management (b) High Voltage DC Transmission	1	100
			TOTAL OF THEORY	200

B. SESSIONAL				
3	PEM382	Pre-submission Defense of Dissertation	1	100
4	PEM381	Dissertation (part I)	1	100
			TOTAL OF SESSIONAL	200
			TOTAL OF SEMESTER	400

FOURTH SEMESTER:

SESSIONAL				
1	PEM482	Post submission defense of dissertation	1	100
2	PEM481	Dissertation (Completion)	1	300
9	PEM483	Comprehensive Viva-Voce	1	100
			TOTAL OF SESSIONAL	500
			TOTAL OF SEMESTER	500

Advanced Engineering Mathematics

EAM 101
Contact: 3L+1T
Credits: 04

Complex Variables:
Review of complex variables, Conformal mapping & transformations, Function of complex variables, Pole and singularity, Integration with respect to complex argument, Residues and basic theorems on residues.

Numerical Analysis:
Introduction, Interpolation formulae, Difference equation, Roots of equations,
Solution of simultaneous linear and non-linear equations, Solution techniques for ODE and PDE, Introduction to stabilty, Matrix eigen value and eigen vector problems.

Optimization Technique:
Calculus of several variables, Implicit function theorem, Nature of singular points, Necessary and sufficient conditions for optimization, Elements of calculus variation, Constrained Optimization, Lagrange multipliers, Gradient method, Dynamic programming.

Linear Algebra:
Vector space, Linear dependence of vectors, basis, linear transformations, inner product space, rank and inverse of a matrix, solution of algebraic equations, consistency conditions, Eigen values and eigen vectors, Hermitian and Skew Hermitian matrices.

Books:

1. John B. Conway, Functions of one complex variable, Springer International.
2. James Ward Brown & Ruel V. Churchill, Complex variable and application., Mc Graw Hill International edition .
3. John H. Mathews, Numerical Methods for Mathematics , science and Engineering, PHI
4. D.C. Sanyal and K. Das, A text Book of Numeriacl analysis, U.N. Dhar & Sons Pvt. Ltd.
5. S.S.Rao,, Optimisation theory and application, Wiely Eastern limited
6. Hoffman & Kunze. R, Linear Algebra, PHI

POWER ELECTRONICS – I

PEM 101
Contact: 3L+1T
Credits: 04

Switch Realization: Survey of power semiconductor devices, Power diode, SCR, GTO, LASCR, RCT, SITH, BJT, MOSFET, IGBT etc., Switching losses, driver circuits, protection, cooling, application .

Controlled Rectifiers (Converters): Single Phase / Three Phase, Half wave / full wave, half controlled /fully controlled converters with R, RL and RLE loads, Continuous and discontinuous current operations- Evaluation of performance parameters. Effects of source inductance- Power factor improvement techniques - twelve pulse converters - Dual converters.

DC- DC Converters: principle of operation of buck, boost, buck-boost, Cuk, fly back, forward, push-pull, half bridge, full bridge Converters with continuous and discontinuous operation, Input & output filter design, multi-output boost converters, diode rectifier based boost converters. State space analysis of regulators.

Design: Design considerations: snubber circuit, driver circuit, temperature control and heat sink, materials, windings. Design of converter and chopper circuits. Triggering circuits for converter and choppers. MMF equations, magnetic. Design of transformers and inductors.

Converter Dynamics / simulations: Feed back control for converters: regulation and control problem, control principles, model for feedback, P and PI control. Non linear dynamic modeling , Control and analysis of choppers, voltage mode and current mode control. Simulation: process, mechanics, techniques, PSPICE simulator.

EMI and Power Quality Problems. Power conditioning. PLL / Micro computer based converters and choppers

Texts:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
2. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.
3. Bimal K Bose, " Modern Power Electronics and AC Drives" PHI
4. R W Erickson and D Makgimovic,"Fundamental of Power Electronics" Springer, 2nd Edition.
5. P. T. Krein, "Elements of Power Electronics", OUP

Electrical Machines Analysis

PEM 102
Contact: 3L+1T
CREDITS: 04

Basic Principles for Analysis: Introduction, Magnetically coupled circuit, Electromechanical Energy Conversion, Machine windings and Air gap MMF, Winding inductances and voltage equations.

Reference Frame Theory: Introduction, Basic idea of Reference Frame, Synchronously rotating Reference Frame and Generalized Theory, Kron's primitive Machine and its mathematical Model, equation of voltage, power and torque, Other standard reference frames, Equation of transformation: change of variables, Transformation between reference frames, transformation of a balanced set, balanced steady state phasor relationship and voltage equations.

Induction Machines: Introduction, Voltage and torque equations in machine variables, Equations of Transformation for rotor circuit, Voltage and Torque Equations in Arbitrary reference Frame Variables, Analysis of steady state operation, Free acceleration characteristics viewed from other reference frame, Dynamic performance during sudden change in load torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

Synchronous Machines: Introduction, Voltage and torque equations in machine variables, Voltage and Torque Equations in Arbitrary reference Frame Variables, Voltage and Torque Equations in Rotor Reference Frame Variables, Torque Equations in Substitute variables, Analysis of steady state operation, Dynamic Performance during a sudden change in Input torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

DC Machines: Introduction, Voltage and torque equations in machine variables, Basic types of the machine, Dynamic characteristics of permanent magnet and DC Shunt Motors, Time domain Block Diagrams and state equations, Solution of Dynamic equation by Laplace Transformation.

Texts:

1. P.C. Krause, "Analysis of electric machinery and Drives", McGraw Hill, New York, 1986

References:

1. Ong Moon Lee "Dynamics Simulation of Electical Machines" Prentice Hall
2. Bimbhra P.S., "Generalized Circuit Theory of Electrical Machines", Khanna Publishers, Delhi, 5th Edition, 1995.
3. Adkins B., " The General Theory of Electrical Machines", John Wiley Sons, 1957.
4. Seely S., "Electro-Mechanical Energy Conversion", McGraw Hill, 1962.

Advanced Control Systems

PEM 103
Contact: 3L+1T
Credits: 04

Review of Modeling and Analysis of LTI Systems:
Modeling of physical Systems. Design specifications and performance indices, Motion control systems,
Transportation lags. Approximation of time-delay functions., Sensitivity of control systems to parameter variations. Effects of disturbance of signals. Disturbance rejection.

Analysis in state-space:
A perspective on state-space design. State variables. State models for physical systems. SISO and MIMO systems. Solution of state equations. Transfer function. Eigenvalues and eigenvectors. Jacobian linearization technique. State transformations and diagonalisation. Transformation to phase-variable canonical form. Controllability and observability. Duality property. Stability.

Introduction to Discrete-time Systems:
Basic elements of discrete-time control system. Z-transform and properties. Inverse Z-transform. Difference equation and its solution by Z-transform method. Z-transfer function. State diagram of digital systems. Time delay. Direct, cascade and parallel decomposition of Z-transfer functions.

Feedback control design:
Continuous control design. Proportional, derivative and integral control action. PID controller tuning rules. Ziegler-Nichols method. Two degree of freedom control systems.
Compensator design using Bode diagram in frequency response approach. Lag, Lead, Lag-lead compensator.
Control law design for full state feedback by pole placement. Full order observer system. Observer based state feedback. Separation principal.

Non linear system:
Classification and types of non-linearity. Phenomena peculiar to non-linear systems. Methods of analysis. Linearization based on Taylor's series expansion. Jacobian Linearization.
Phase trajectory and its construction. Phase-plane analysis of linear and non-linear sustems. Existence of limit cycles. Describing function of typical non-linearities. Stability analysis by DF method. Introduction to DIDF. Popov's circle criterion. Stability analysis by Lyapunov's indirect and direct methods, Lypunov's theorem.

Reference Books:

1. Ogata, K – Modern Control Engineering, PHI Learning
2. Kuo, B.C. – Automation Control Systems, Prentice Hall
3. Roy Choudhury, D – Modern Control Engineering, Prentice Hall
4. Nagrath, J. J. Gopal, M – Control System Engineering, New Age Pub.
5. Schulz, D.G. and Melsa, . L. – State Functions and Linear Control Systems, McGraw-Hill.
6. Stepheni, Shahian, Savant, Hostetler – Design of feedback control systems, Oxford University Press.
7. Vidyasagar- Nonlinear system analysis, Prentice-Hall.
8. Gibson, J.E.- Non linear system , Mc. Grawhill.
9. Gopal. M, Digital Control and State Variable Methods, TMH.

Solid State Power Controllers

P 104(a)
Contact: 4L
Credits: 04

FACTS CONCEPTS: Electrical Transmission Network – Necessity – Power Flow in AC System – Power Flow and Dynamic stability considerations of a transmission interconnection – relative importance of controllable parameter – opportunities for FACTS – possible benefits for FACTS Technology – FACTS Controllers – Types, brief description and definitions

STATIC VAR COMPENSATION: Need for compensation – introduction to shunt and series compensation – objectives of shunt and series compensation – configuration and operating characteristics – Thyristor Controlled Reactor (TCR) – Thyristor

Switched Capacitor (TSC) – Fixed Capacitor - Thyristor Controlled Reactor (FC – TCR) – Comparison of TCR, TSC and FC – TCR

SERIES COMPENSATORS: 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 of Permanent Magnet Brush less DC Motors – controllers PM DC Motor

STATIC VOLTAGE AND PHASE ANGLE REGULATORS: Objectives of voltage and phase angle regulators – approaches to Thyristor – Controlled Voltage and Phase Angle Regulator

EMERGING FACTS CONTROLLERS: Construction and principle of operation of Linear Induction Motor - Universal Motor - Hybrid Motor – Linear Synchronous motor – Applications

POWER QUALITY: Power Quality problems in distribution systems, harmonics, harmonics creating loads, modeling, harmonic propagation, Series and parallel resonances, harmonic power flow, Mitigation of harmonics, filters, passive filters, Active filters, shunt, series hybrid filters, voltage sags & swells, voltage flicker. Mitigation of power quality problems using power electronic conditioners. IEEE standards.

Texts/References

1. Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers, New Delhi, 2001.
2. R. Mohan Mathur and Rajiv K. Varma, "Thyristor Based FACTS Controller for Electrical Transmission Systems", Wiley Interscience Publications, 2002
3. Narain G. Hingorani, "Flexible AC Transmission", IEEE Spectrum, April 1993, pp 40 – 45
4. Narain G. Hingorani, "High Power Electronics in Flexible AC Transmission", IEEE Power Engineering Review, 1998
5. Elinar V. Larsen, Juan J Sanchez – Gasca Joe H. Chow, "Concepts for design of FACTS controllers to damp power swings", IEEE Transactions on Power Systems, Vol. 10, No. 2, May 1995.
6. G.T. Heydt, Power Quality, Stars in a Circle Publications, Indiana, 1991.
7. T.J.E. Miller, Static Reactive Power Compensation, John Wiley & Sons, New York, 1982.

Digital Signal Processing

PEM 104(b)
Contact: 4L
Credit: 4

Introduction to Signal Processing: Review of Laplace transform, Z transform, Fourier transform. Discrete Fourier transform, Fast Fourier transform, Algorithms and complexity, Introduction to linear optimal filtering
Digital Filter: Definition and anatomy of a digital filter, Frequency domain description of signals and systems, Typical application of digital filters, Replacing analog filters with digital filters, Filter categories: recursive and non-recursive
Digital Filter Structures: The direct form I and II structures, Cascade combination of second order sections, Parallel combination of second order sections, Linear- phase FIR filter structures, Frequency sampling structure for the FIR filter
Effect of Word Length: Round off error, Truncation error, Quantization error, Limit cycle
Introduction to DSP Hardware: Application of DSP in control system and instrumentation

Suggested Readings:

1. S. K. Mitra, *Digital Signal Processing*,
2. J. C. Proakis, and D. G. Maniolakis, *Digital Signal Processing*: *Principles, Algorithms and Applications*, Prentice Hall.
3. Oppenheim, and R. W. Shaffer, *Discrete Time Signal Processing*, Prentice Hall, 1992.
4. J. Johnson, *Digital Signal Processing*, Prentice Hall.
5. B. Venkata Ramani, and M. Bhaskar, *Digital Signal Processors*, New Delhi: Tata McGraw Hill.

Micro controller based system design

PEM 104(c)
Contact: 4L
Credits: 04

Introduction – embedded systems and their characteristics, review of micro – processors, MPU design options, Instruction sets – CISC and RISC – instruction pipelining, the microcontroller – its applications and environment.

16 bit microcontroller – Intel 8096 CPU structure, register file – assembly language overview – addressing modes – Instruction set – simple programs

Introduction, PIC microcontrollers PIC 16 C6x/7x, architecture, register file structure and addressing modes, Instruction set, simple programs

Peripheral functions of PIC 16C6x/7x - Interrupts - Interrupts constraints – Interrupt servicing – Critical regions – External Interrupts – Use of Timers in interrupt Handling – Compare and capture mode – PWM outputs

I/O port expansion – Synchronous serial port module – State machines and key switches LCD display – I2C bus operations and subroutine – serial EEPROM

Analog to Digital converter: Characteristics and use

UART : Initialization – Data Handling circuitry and USE

Special Features of PIC – Reset Alternatives Low power operation – Serial programming – parallel slave port

REFERENCE BOOKS :
John B. Peatman, “Design with PIC Microcontrollers”, Pearson Education Asia, 2000.
John B. Peatman, “Design with Microcontrollers”, McGraw Hill, 1995.

Energy Management and Audit

PEM 104(d)
Contact: 4L
Credits: 04

Energy Scenario: Energy sources, security, conservation, strategy. **B**asics of Energy and its various form**s**.

Energy management & audit: Energy costs, Bench marking, efficiency, audit instruments.

Energy Action Planning: Role, motivation, training, information systems.

Energy monitor of Electrical system: Power supply, Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.
Electric motors: Types, characteristics, losses, efficiency, selection, energy efficient motors, Factors affecting motor performance, Rewinding and motor replacement issues. Energy saving opportunities with Pumps, cooling towers, fans and blower.
Lighting System: Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues.

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Books:
1. Albert : Plant Engineers & Managers Guide to Energy Conservation

2. Wayhe C.Tuner : Energy Management Handbook
3. Anthony J. Pansini. : Engineering Economic Analysis Guide Boo
4. D. Paul-Mehta : Handbook of Energy Engineering.
5. Paul O'Callaghan : Energy Management.
6. Books of Energy Management & Auditors, Bureau of Energy Efficiency, (A Statutory body under Ministry of Power, Government of India), www.bee-india.nic.in9 volume I,II,III & I

Electrical Engineering Laboratory-I

PEM 191
Contact: 2P
Credits: 02
Hardware experiments / Software experiments / hardware simulation / software simulation on Electrical Engineering.

Electrical Engineering Laboratory-II

PEM 192
Contact: 3P
Credits: 02

Hardware experiments / Software experiments / hardware simulation / software simulation on Electrical Engineering.

Seminar-I

EMP 193
Comtact: 3P
Credits: 02

Assigned Seminar on recent topics

Power Electronics - II

PEM 201
Contact: 3L+1T
Credits: 04

Inverters: Single and three phase bridge inverters with R, RL and RLE loads, Voltage control, Harmonic reduction, square wave inverters, PWM inverters, modulation techniques, SPWM, Selective Harmonic Elimination PWM and delta modulation. blanking time. harmonic spectrum
and comparison among different PWM techniques. Boost inverter. Current source inverters, Inverter Circuit Design .
Resonant Pulse Converters: Series and parallel resonant inverters - zero current and Zero voltage switching resonant converters, frequency response. Two quadrant zero voltage switching resonant converters, Resonant dc link inverters, design and analysis, soft switching, load dependent problem.

Multi level inverters: types, operations, features.

Cycloconverters: Single phase and three phase cycloconverters with R, RL and RLE loads – Voltage control , Harmonic analysis, operation waveforms designs.

AC voltage controllers: Single phase and three phase ac voltage controllers with R, RL and RLE loads, Voltage control, Harmonic analysis, operation waveforms PWM, Matrix converter, design.

Dynamics of above converters: Modeling and control of inverters, resonant pulse converters, cyclo-converters, ac voltage controllers. Application of microcomputer .

Design: Method for control design: averaging method, small signal analysis, linearization, challenge. Geometric control: hysteresis control, boundary control. Triggering circuit. Design of inverters, resonant pulse converters, cyclo-converters, ac voltage controllers circuits. PLL / Micro computer based inverters, cycloconverters, AC voltage controllers.

Texts:

1. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
2. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.
3. Bimal K Bose, " Modern Power Electronics and AC Drives" PHI
4. R W Erickson and D Makgimovic,"Fundamental of Power Electronics" Springer, 2nd Edition.
5. P. T. Krein, "Elements of Power Electronics", OUP

References

1. Joseph Vithayathil, "Power Electronics - Principles and Applications", McGraw Hill Inc., New York, 1995.
2. Vedam Subrahmanyam, "Power Electronics", New Age International (P) Limited, New Delhi, 1996.
R. Bausiere & G. Seguier, Power Electronic Converters, Springer- Verlag, 1987.
D.M.Mitchell, DC-DC Switching Regulator Analysis McGraw Hill, 1987

Electric Drives

PEM 202
Contact: 3L+1T
Credits: 04

Review of Conventional Drives: speed –torque relation, Steady state stability, methods of speed control, braking for DC motor – Multi quadrant operation , Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor . Criteria for selection of motor for drives.

Converter Control of DC Drives: Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Chopper Control of DC Drives: Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

Design of DC Drives: Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

Inverter fed AC Drives: : Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations., Problems and strategies.

Cyclo-converter fed AC Drives: Analysis of different AC motor with single phase and three phase cycloconverters Operations in different modes and configurations., Problems and strategies, vector Control and Rotor side Control

AC Voltage controller fed AC Drives: Speed Control and braking, Analysis of different AC motor with single phase and three phase ac voltage controllers. Operations in different modes and configurations. Problems and strategies.

Control and estimation o AC drives: Induction motor: Small signal models, scalar control, FOC control, sensor less control, DTC, adaptive control. Synchronous motor: sin SPM, synchronous reluctance machines, sin IPM machines, trapezoidal SPM, wound fitted SM, sensor-less operation, switched reluctance machines, Dynamics and Modeling of AC Drives.

Text:

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard Publishers Distributors, New Delhi, 2000

2. Murphy J.M.D, Turnbull, F.G, “Thyristor control of AC motor, Pergamon press, Oxford, 1988.
3. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
4. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.
5. Bimal K Bose, “ Modern Power Electronics and AC Drives” PHI
6. R. Krishnan, “Electric motor drives: modeling, analysis and control, Pearson.

Reference:

1. Dubey G.K. “Power Semiconductor controlled drives”, Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.
2. Sheperal, Wand Hully, L.N. “Power Electronic and Motor control” Cambridge University Press Cambridge 1987
3. Dewan,S. Slemon B., Straughen,A. G.R., “Power Semiconductor drives”, John Wiley and Sons, NewYork 1984.
4. Dubey G.K. “Power Semiconductor controlled drives”, Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989
5. Dewan,S. Slemon B., Straughen,A. G.R., “Power Semiconductor drives”, John Wiley and Sons, NewYork 1984
6. Sen. P.C. “Thyristor DC Drives”, John Wiley and sons, NewYork, 1981.
7. Subramanyam, V. “Electric Drives – Concepts and applications”, Tata McGraw Hill Publishing Co., Ltd., New Delhi 2003.

Special Electrical machine

PEM 203
Contact: 3L+1T
Credits: 04

Stepper Motor: Introduction, Types, Hybrid stepper motor- construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR Stepper motor- single stack and multi stack, Drive systems and circuit for open loop and Closed loop control of stepping motor. Dynamic characteristics. Single phase stepper Motor, Expression of voltage , current and torque for stepper motor and criteria for synchronization.

Switched Reluctance Motor: Constructional features, principle of operation, Design Aspects and profile of the SRM, Torque equation, Power converters and rotor sensing mechanism, expression of torque and torque-speed characteristics,

Permanent Magnet Materials: Permanent magnet materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets,

Brushless DC Motor : Construction, operation, sensing and switching logic scheme, Drive and power circuit, Theoritical analysis and performance prediction, transient Analysis.

Linear Induction Motor: Construction and principle of operation of Linear Induction Motor, Approximate calculation of the force on rotor.

Text:

1. Vekatratnam, “Special Electrical Machines”, Universities Press

2. Reference:

3. 1 Fitzerald and Kingsley,” Electrical Machines” McGraw Hill. Miller. T. J. E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
4. 2. Kenjo. T and Nagamori. S, “Permanent Magnet and Brushless DC Motors”, Clarendon Press, Oxford, 1989.
5. 3. Kenjo. T, “Stepping Motors and their Microprocessor Control”, Clarendon Press, Oxford, 1989
6. 4. Krishnan R, “Switched Reluctance Motor Drives”, Modelling, Simulation, Analysis, Design and applications, CRC press

Generation of Non conventional Energy

PEM 204(a)
Contact: 3L+1T
Credits: 04

INTRODUCTION TO SOLAR AND WIND ENERGY: Recent trends in energy consumption – World energy scenario – Energy sources and their availability – Conventional and renewable sources – Need to develop new energy technologies – Solar radiation and measurement – Solar cells and their characteristics – Influence of insulation and temperature – PV arrays – Electrical storage with batteries – Solar availability in Indi8a – Switching devices for solar energy conversion – Stand alone inverters – Charge controllers – Water pumping – Audio visual equipments, Street lighting, Analysis of PV systems

POWER CONDITIONING CONVERTERS:DC Power conditioning converters – Maximum Power point tracking algorithms – AC power conditioners – Line commutated inverters – synchronized operation with grid supply – Harmonic problem

WIND ENERGY CONVERSION SYSTEM: Basic principle of wind energy conversion – nature of wind – Wind survey in India – Power in the wind – components of a wind energy conversion system – Performance of Induction Generators for WECS – Classification of WECS

INDUCTION GENERATOR: Self excited Induction Generator for isolated Power Generators – Theory of self e excitation – Capacitance requirements – Power conditioning schemes – Controllable DC Power from SEIGs

OPTIMISATION TECHNIQUE: Wind / Solar PV integrated systems – selection of power conversion ratio – Optimization of system components – Storage

Text/References:
Rai G.D., "Non – Conventional Energy Sources", Khanna Publishers, 1993.
Rai G.D., "Solar Energy Utilisation", Khanna Publishers, 1993.
Daniel, Hunt V, "Wind Power – A Handbook of WECS", Van Nostrend Co., New York, 1981.
Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985.
Freris L. L., "Wind Energy Conversion", Prentice Hall (UK) Ltd., 1990

Advanced Mathematics -II

PEM 204(b)
Contact: 4L
Credits: 04

Advanced Matrix Theory: Computation of the greatest and the least eigen values of a matrix by power method, Modal matrix, Spectral matrix, Real Quadratic form.

Linear Programming: Graphical method, Simplex method, Charnes Big M Technique, Two phase Technique, Revised Simplex method.

Nonlinear Programming: Nonlinear Programming with special reference to quadratic programming, Kun-Tucker conditions, Wolfe's modified simplex method.

Integral Equations: Integral Equations, Fredholm Integral Equations, Volterra Integral Equations, Deduction of Differential Equations to Integral Equations and vice-versa. Solution of Fredholm Integral Equations of 2^{nd} kind with Seperable Kernel. Iterative Methods for solving Integral Equations of the 2^{nd} kind.

Text/ Refference:
Taha H A :Operations research-An introduction , Macmillan publishing Co.
Simmons DM : Nonlinear Programming for Operations Research, PHI
Bazara, Shetty and Sherali : Nonlinear Programming
S S Rao : Optimization Techniques, Wiley Eastern
Francis B Hildebrand : Methods of Applied Mathematics,1992

Intelligent Control of Drives

PEM 204(c)
Contact:4L
Credits: 04

INTRODUCTION TO NEURAL NETWORKS : Introduction – biological neurons – Artificial neurons – activation function – learning rules – feed forward networks – supervised learning – perception networks – adaline – madaline – back propagation networks – learning factors – linear separability – Hopfield network – discrete Hopfield networks

ARCHITECTURE – TYPES: Recurrent auto association memory – bi-directional associative memory – temporal associative memory – Boltzmann machine Hamming networks – self – organizing feature maps – adaptive resonance theory network – Instar – Outsar model – counter propagation network – radial basis function networks

INTRODUCTION TO FUZZY SETS AND SYSTEMS: Crisp set – vaguness – uncertainty and imprecision – fuzzy set – fuzzy operation- properties – crisp versus fuzzy relations – fuzzy relation – cardinality operations, properties – fuzzy Cartesian product and composition – non – interactive fuzzy sets – tolerance and equivalence relations – fuzzy ordering relations – fuzzy morphism – composition of fuzzy relations

FUZZY LOGIC CONTROLLER: Fuzzy to crisp conversion – Lambda cuts for fuzzy sets and relations – definition methods – structure of fuzzy logic controller – database – rule base – Inference engine

APPLICATION AND DESIGN: Applications of Neural network and Fuzzy system for single phase fully controlled converter, single phase ac voltage controller, DC Drive and AC Drive
Designing of controllers using Simulation Software Fuzzy Logic Toolbox – Modeling of DC Machines using Simulation Software and Simulink Toolbox

Text Books:

1. Lawrence Fausatt, “Fundamentals of neural networks”, Prentice Hall of India, New Delhi, 1994.
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill International Edition, USA, 1997.
3. Bart kosko, “ Neural Networks and Fuzzy Systems”, Prentice Hall of India, New Delhi, 1994

Non linear Phenomena in Switching Systems.

PEM 205(a)
Contact: 4L
Credits: 04

Basics of Nonlinear Dynamics: System, state and state space model, Vector field- Modeling of Linear, nonlinear and Linearized systems, Attractors , chaos, Poincare map, Dynamics of Discrete time system, Lyapunov Exponent, Bifurcations, Bifurcations of smooth map, Bifurcations in piece wise smooth maps, border crossing and border collision bifurcation

Techniques for investigation of nonlinear Phenomena: Techniques for experimental investigation, Techniques for numerical investigation, Computation of averages under chaos, Computations of spectral peaks, computation of the bifurcation and analyzing stability.

Nonlinear Phenomena in DC-DC Converters: Border collision in the Current Mode controlled Boost Converter, Bifurcation and chaos in the Voltage controlled Buck Converter with latch, Bifurcation and chaos in the Voltage controlled Buck Converter without latch, Bifurcation and chaos in Cuk Converter. Nonlinear phenomenon in the inverter under tolerance band control

Nonlinear Phenomena in Drives: Nonlinear Phenomenon in Current controlled and voltage controlled DC Drives, Nonlinear Phenomenon in PMSM Drives.

Control of Chaos: Hysteresis control, Sliding mode and switching surface control, OGY Method, Pyragas method, Time Delay control. Application of the techniques to the Power electronics circuit and drives.

Reference:

1. S Banerjee, Dynamics for Engineers, Jhon Wiley
2. S Banerjee, Nonlinear Phenomena in Power Electronics, IEEE Press
3. Steven H Strogatz, Nonlinear Dynamics and Chaos, Westview Press

Electrical Engineering Laboratory-III

PEM 291
Contact: 3P
Credits: 02

Hardware experiments / Software experiments / hardware simulation / software simulation on Electrical Engineering.

Electrical Engineering Laboratory-IV

PEMP 292
Contact: 4P
Credits: 02

Hardware experiments / Software experiments / hardware simulation / software simulation on Electrical Engineering.

Seminar-II

PEM 293
Contact: 3P
Credits: 02
Assigned Seminar on recent topics

Introduction to Management

MMAN 301
Contact: 4L
Credit: 4
To be prepared centrally

Power quality management

PEM 302(a)
Contact: 4L
Credits: 04

INTRODUCTION: Power Quality phenomena – Basic terminologies – various events in Power Quality – Causes for reduction in Power Quality — Power Quality Standards

VOLTAGE SAG: Causes of voltage sags – magnitude and duration of voltage sags – effect on adjustable AC Drives, DC drives, computers and consumer electronics – monitoring and mitigation of voltage sags.

INTERRUPTION: Origin of Long and Short interruptions – influence on various equipments – reliability of power supply – basic reliability evaluation techniques – monitoring and mitigation of interruptions

HARMONICS: Origin of harmonics – effect of harmonics on adjustable speed ac drives – harmonic reduction using PWM and harmonic injection.

POWER QUALITY MEASUREMENTS: Interpretation and analysis of Power Quality Measurements, Active Filters as Power Quality Conditioners – Basic concept of Unified Power Quality Conditioners.

Text:

1. Math. H. J. Bollen, "Understanding Power Quality Problems – Voltage Sags and Interruptions", IEEE Press, 2000
2. David D. Shipp and William S. Vilcheck, "Power Quality and Line Considerations for Variable Speed AC Drives", IEEE Transactions on Industry Applications, Vol. 32, March / April – 1996

Reference:

1. Po – Tai Cheng, Subhashish Bhattacharya and Deepak. D. Divan, "Line Harmonics Reduction in High – Power Systems Using Square – Wave Inverters – Based Dominant Harmonic Active Filter", IEEE Transactions on Power Electronics, Vol. 14, No. 2, March 1999
2. Hideaki Fujita and Hifofumi Akagi, "The Unified Power Quality Conditioner: The Integration of Series and Shunt Active Filters", IEEE Transactions on Power Electronics, Vol. 13, No. 2, March 1998.
3. Christopher J. Melhorn and Mark. F. McGranaghan, "Interpretation and Analysis of Power Quality Measurements", Electrotek Concepts, Inc.1998
4. Harmonic Distortion in the electric supply system", – Technical Note No. 3 from Integral Energy Power Quality Centre, University of Wollongong, March 2000

High Voltage DC Transmission

PEM 302(b)
Credit: 4L
Credits: 04

INTRODUCTION: Introduction to AC and DC Transmission – application of DC Transmission – description of DC transmission – DC system components and their functions – modern trends in DC Transmission
CONVERTER: Pulse Number – Converter configuration – analysis of Graetz circuit – converter bridge characteristics – characteristics of 12 Pulse converter
HVDC CONTROLLERS: General principle of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – Dc link power control – high level controllers
FILTERS: Introduction to harmonics – generation of harmonics – design of AC filters – DC filters – carrier frequency and RI noise
PROTECTION: Basics of protection – DC reactors – voltage and current oscillations – circuit breakers – over voltage protection – switching surges – lightning surges – lightning arresters for DC systems

Text/Reference:

1. Kimbark, "Direct Current Transmission – Vol. I", John Wiley and Sons Inc., New York, 1971
2. Padiyar. K. R., "HVDC Power Transmission Systems", Wiley Eastern Limited, New Delhi, 2000.
3. Arrillaga. J, "High Voltage Direct Current Transmission", Peter Peregrines, London, 1983

PEM 391
Pre submission Defense of Dissertation (Project Work)
Credits: 04

PEM 392
Dissertation (Project Work) -Part-I
Credits: 10

FOURTH SEMESTER:

PEM 491
Dissertation (Project Work) -completion
Credits: 14

PEM 492
Submission Defense of Dissertation (Project Work)
Credits: 8
