KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638 052
(Autonomous Institution affiliated to Anna University of Technology, Coimbatore)

M.E. DEGREE IN POWER ELECTRONICS AND DRIVES (FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER – I

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11AE101	Applied Mathematics for Electrical Engineers	3	1	0	4	50	50	100
11CI102	System Theory	3	1	0	4	50	50	100
11PE101	Modeling and Analysis of Electrical Machines	3	1	0	4	50	50	100
11PE102	A.C. Converters	3	0	0	3	50	50	100
11PE103	Power Semiconductor Devices and D.C. Converters	3	0	0	3	50	50	100
11AE106	Computational Intelligent Techniques	3	1	0	4	50	50	100
	PRACTICAL							
11PE104	Advanced Power Electronics Laboratory	0	0	3	1	100	0	100
				Total	**23**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES (FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER – II

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
11PE201	Solid State DC Drives	3	1	0	4	50	50	100
11PE202	Solid State AC Drives	3	1	0	4	50	50	100
11PE203	Power Electronics for Renewable Energy Systems	3	0	0	3	50	50	100
	Elective-I	3	0	0	3	50	50	100
	Elective-II	3	0	0	3	50	50	100
	Elective-III	3	0	0	3	50	50	100
	PRACTICAL							
11PE204	Advanced Drives Laboratory	0	0	3	1	100	0	100
11PE205	Computer Aided Simulation and Design Laboratory	0	0	3	1	100	0	100
				Total	**21**			

CA – Continuous Assessment, ESE – End Semester Examination

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M.E. DEGREE IN POWER ELECTRONICS AND DRIVES (FULL TIME)

CURRICULUM

(For the candidates admitted from academic year 2011 – 12 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	THEORY							
	Elective-IV	3	0	0	3	50	50	100
	Elective-V	3	0	0	3	50	50	100
	Elective-VI	3	0	0	3	50	50	100
	PRACTICAL							
11PE301	Project Work - Phase I	0	0	12	6	50	50	100
				Total	**15**			

CA – Continuous Assessment, ESE – End Semester Examination

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks		
		L	T	P		CA	ESE	Total
	PRACTICAL							
11PE401	Project Work - Phase II	0	0	24	12	100	100	200
				Total	**12**			

CA – Continuous Assessment, ESE – End Semester Examination

LIST OF ELECTIVES					
Course Code	**Course Title**	**L**	**T**	**P**	**C**
11AE023	Project Management	3	0	0	3
11AE026	Virtual Instrumentation Systems	3	0	0	3
11AE102	Advanced Digital Signal Processing	3	1	0	4
11CI015	Optimal Control Theory	3	1	0	4
11PE011	Advanced Topics in Power System Protection	3	0	0	3
11PE012	Advances in Power Electronics	3	0	0	3
11PE013	Computer Aided Design of Electrical Machines	3	1	0	4
11PE014	Computer Aided Simulation and Design of power Electronic Systems	3	1	0	4
11PE015	Computer Communication and Networks	3	0	0	3
11PE016	DSP Based Electromechanical Motion Control	3	0	0	3
11PE017	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3
11PE018	Embedded System and Applications	3	0	0	3
11PE019	Energy Conservation, Management and Auditing	3	0	0	3
11PE020	Microprocessor and Microcontroller Applications in Power Electronics	3	0	0	3
11PE021	Nonconventional Energy Systems	3	0	0	3
11PE022	PLC & SCADA	3	1	0	4
11PE023	Power Electronic Applications in Power Systems	3	0	0	3
11PE024	Power Quality Engineering	3	0	0	3
11PE025	Programming with VHDL	3	1	0	4
11PE026	Special Electrical Machines and Control	3	0	0	3

11AE101 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS

(Common to Applied Electronics and Power Electronics Branches)

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the concept of variational problems and to find out the extremals of the given functional
- To develop the concept of Linear and Non-linear programming problems and finding solutions through various methods
- To know the types of functions and relations and their application
- To know the representation of graphs.

MODULE - I **15**

Calculus of Variation: Functional –definition-Variational problem: Euler Lagrange equation-Solutions of Euler Lagrange equation – Variational problems involving one unknown function, Several unknown functions – Functionals dependent on higher order derivatives – Variational problems involving Several independent variables .Isoperimetric problems-Ritz method.

Introduction to Optimization: Linear Programming Problem: Mathematical Formulation – Basic definitions – Solutions of LPP: Graphical method, Simplex method –Big–M method and Two phase method.

MODULE - II **15**

Optimization Techniques: Duality theory – Dual simplex method -Transportation Problem (Balanced) – Initial Basic Feasible Solution by Vogel's approximation method – Solution by MODI method – Assignment problems – Hungarian method.

Non - Linear Programming: Formulation of non–linear programming problem – Constrained optimization with equality constraints – Constrained optimization with inequality constraints – Graphical method of non–linear programming problem involving only two variables – Kuhn-tucker conditions with non-negative constraints.

MODULE - III **15**

Functions and Relations: Injective – Surjective – Bijective functions – Compositions – Identity – Inverse – Relations – Properties of relations.

Graph Theory: Introduction – Basic terminology – Representation of graphs – Connected graphs – Matrix representation of graphs (excluding graphs) – Applications – Critical path method – Shortest path problems – Trees – Definition – Binary tree.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Venkataraman. M.K, "Higher Mathematics for Engineering & Science", National Publishing Company, 2006.
2. Taha, H.A., "Operations Research- An Introduction", 6th Edition, PHI, 2000.
3. Trembly J.P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw–Hill, New Delhi, 2008.
4. Harary.F, "Graph Theory", Narosa Publisher, New Delhi, 1990.
5. West, Douglas.B, "Introduction to Graph Theory", Prentice Hall, 1996.
6. Kanti Swarup Gupta, P.K and Man Mohan "Operations Research", S.Chand & Co ., 1997.

11CI102 SYSTEM THEORY

(Common to M.E. Power Electronics, Control and Instrumentation)

3 1 0 4

Objective:

On completion of the course the students are expected

- To understand the concept of State space approach and Dynamic Programming.
- To enhance the knowledge about State feedback and Non-linear Systems.
- To know about Describing Function Techniques and Stability analysis**.**

MODULE - I **15**

State Variable Analysis: Review of state variable representation and state variable models in continuous systems. Solutions of state equations- State transition matrix and its properties — free and forced responses -State description of sampled continuous time plants and systems with dead time. Solutions of difference equations-Relation between transfer function and state variable representation. Controllability and observability-Effect of sampling on controllability and observability.

MODULE - II **15**

State feedback: - Effects of state feedback, pole placement and feedback gain matrix- State estimators: Full-dimensional state estimator – reduced dimensional state estimator - connection of state feedback and state estimator – PI feedback- Deadbeat Observers- Dead beat Control.

Non-linear Systems:- Behaviour of non-linear systems, jump resonance, sub-harmonic oscillation- Phase plane analysis: Singular points - construction of phase portraits using isoclines- limit cycle analysis

MODULE - III **15**

Describing Function Techniques: Describing Function of nonlinearities - gain function and its determination for analytically and graphically defined nonlinearities- conditions for stability - stability of oscillation - accuracy of Describing Function method - stability of systems with multiple nonlinearities - closed-loop frequency response

Stability analysis: Stability in the sense of Liapunov - second method of Liapunov - Liapunov stability analysis of linear time invariant systems and non linear system- Krasovski's theorem- variable gradient method of generating Liapunov functions.

Lecture: 45, Tutorial :15 TOTAL: 60

REFERENCE BOOKS

1. Gopal, M., "Digital Control and State Variable Methods", Tata McGraw-Hill, New Delhi, 2008.
2. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India Pvt. Ltd., 4th Edition 2002.
3. Houpis, C.H, Digital Control System- Theory, Hardware and Software, Second Edition, McGraw-Hill, New York 1999
4. Gibson, J.E, Nonlinear Automatic Control, McGraw Hill Book Co, 1963.
5. Cunningham, W.J., Introduction to Nonlinear Analysis McGraw Hill, 1958
6. Chen. C.T., Linear System Theory and Design, Holt Rinebart and Winston, 1984
7. Kuo, B.C., "Digital Control Systems", Oxford University Press, Oxford, 2003.

11PE101 MODELING AND ANALYSIS OF ELECTRICAL MACHINES

3 1 0 4

Objective:

To give coverage to the students in the area of modeling and analysis of various AC, DC and special machines.

MODULE – I **15**

Basics of Electrical Machine Modeling: Essential of Rotating Electrical Machines – Conventions – The Basic Two Pole Machine – Invariance of Power – Transformations from Three Phase to Two Phase – Electrical Torque – Restriction of the Generalized Theory of Electrical Machines.

DC Machines Modeling and Analysis: Modeling: Theory of Operation – Field Excitation – Induced EMF – Equivalent Circuit – Electromagnetic Torque – Modeling of Field System and Armature System – Electromechanical Modeling – mathematical Modeling of DC Machine. Analysis: Steady state and Dynamic Analysis of DC Machine using Phase Controlled Converters and Choppers.

MODULE – II **15**

Induction Machines Modeling and Analysis : Modeling : Three Phase Induction Motor – Reference frame Theory – Axes Transformation – Equivalent Two Phase machine Voltage / Current from Three phase machine Voltage / Current – Kron Equation – Dynamic d axis and q axis Equivalent circuit – State Space Equation – Power invariant phase transformation – voltage transformation – Voltage and Torque equation of the equivalent two phase machine – Transformed equations – Generalized model in arbitrary reference frame, Stator reference frame, rotor reference frame and synchronously rotating reference frame model – Dynamic model of Induction Motor. Analysis: Control of induction motor by supply voltage, Supply frequency and Constant volts / Hz Control – Steady state performance – dynamic simulation.

MODULE – III **15**

Synchronous Machine Modeling and Analysis: Three Phase Salient pole Machine – Three phase to two phase Transformation –Voltage and Torque equation – Dynamic Machine model – Steady state and Dynamic analysis.

Special Machines: Permanent Magnet and Characteristics – Synchronous Machine with Permanent magnets: Machine Configuration – Variable Reluctance Machine: Basics – Analysis – Torque Production in Stepping motors – Linear Induction Motor.

Lecture: 45, Tutorial :15 TOTAL: 60

REFERENCE BOOKS

1. Bimal K Bose, “Modern Power Electronics and AC Drives”, PHI Learning, First Edition, 2009.
2. R Krishnan, “ Electric Motor Drives : Modeling, Analysis, and Control”, PHI Learning, First Edition, 2009.
3. P S Bimbhra, “Generalized Theory of Electrical Machines”, Khanna Publishers, 5th Edition, 1996.
4. Paul C Krause, “Analysis of Electric Machinery”, McGraw Hill Book Company, 2nd Edition, 1987.

11PE102 AC CONVERTERS

3 0 0 3

Objective:

- To study the basics of inverters and AC voltage controllers.
- To study the concepts of inverters and voltage controllers and its various controlling techniques.
- To expose the students about the need of analysis of multilevel and resonant inverters.
- To study the control strategies of voltage controllers.

MODULE – I **15**

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- Three phase inverters -180^0 and 120^0 conduction mode inverters with star and delta connected loads - Voltage control of three phase inverters- Current source inverters- Operation of six-step thyristor inverter – inverter operation modes – load commutated inverters – ASCI – current pulsations – comparison of CSI and VSI.

MODULE – II **15**

Multilevel and Resonant Inverters : Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters –Switching techniques for multilevel inverters- Comparison of multilevel inverters applications of multilevel inverters – Design and analysis of multilevel inverters for renewable energy applications- Resonant inverters -Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC-link inverters.

MODULE – III **15**

AC Voltage Controllers :Principle of On off control and phase control – single phase bidirectional controllers with resistive and inductive loads – Three phase bidirectional delta connected controllers - different Configurations- Analysis with pure R and L loads- Cycloconverters- Principle of operation - single phase and three phase cyclo converters- Control circuit strategies.

TOTAL: 45

REFERENCE BOOKS

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.
2. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education, Second Edition, 2003.
3. Ned Mohan,Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons Inc.,Newyork,1995.
4. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003
5. P.C. Sen, “Modern Power Electronics”, Wheeler Publishing Co, First Edition, New Delhi, 1998.

11PE103 POWER SEMICONDUCTOR DEVICES AND DC CONVERTERS

3 0 0 3

Objectives:

- To get an overview of different types of power semi-conductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters of controlled rectifiers.
- To study the operation, switching techniques and basic topologies of DC-DC switching regulators.

15

MODULE – I

Introduction to Power diodes - Steady state and transient characteristics - snubber circuits - Power transistors - Steady state, transient, thermal and gating characteristics of SCR, triggering circuits for SCR, introduction to GTO.Characteristics of MOSFET and IGBT, protection circuits of MOSFET and IGBT.Operation and characteristics of modern semi conductor devices, comparison between different power devices.

MODULE – II **15**

Single and three phase-half controlled and fully controlled converters with R-L, R-L-E loads and freewheeling diodes – continuous and discontinuous modes of operation – Dual converter - Sequence control of converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap-reactive power and power balance in converter circuits-12 pulse converter.

MODULE – III **15**

Analysis and design of DC to DC converters- Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters- Time ratio and current limit control .Step up & step down choppers - various choppers configurations - Output voltage equation - Harmonics, power factor. Software simulation of single phase, three phase controlled rectifiers and choppers.

TOTAL : 45

REFERENCE BOOKS

1. Mohan N, Undeland and Robins, “Power Electronics – Concepts, applications and design”, John Wiley and sons, Singapore, 2000.
2. Rashid M.H., “Power Electronics circuits, Devices and Applications”, Prentice Hall India, Third Edition, New Delhi, 2004.
3. M.D. Singh and K.B.Khanchandani, “Power Electronics”, Tata McGraw Hill, 2001.
4. P.C Sen.,’ Modern Power Electronics ‘, Wheeler publishing Co, First Edition, New Delhi.
5. P.S.Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.

11AE106 COMPUTATIONAL INTELLIGENT TECHNIQUES

(Common to, Applied Electronics, Power Electronics and Control and Instrumentation Engineering and Mechatronics Engineering)

3 1 0 4

Objective:

- To expose the students about the different types of architecture, learning and training methods of neural networks
- To study the concept of rule based system and its modeling
- To expose the students the various optimization techniques
- To learn and analyze the modeling of neuro fuzzy systems
- To study the various real time applications of neuro fuzzy system

MODULE – I **15**

Neural Networks: Introduction to Soft computing – Neural Networks – Supervised learning- Perceptrons – Adaline – Back propagation Multilayer perceptrons – Radial Basis Function Networks – Unsupervised Learning and Other Neural Networks – Competitive Learning Networks – Kohonen Self Organizing Networks – Learning Vector Quantization – Hebbian Learning.

Fuzzy Logic: Fuzzy Sets – Basic Definition and Terminology – Set theoretic operations – Member function formulation and parameterization – Fuzzy Rules and Fuzzy Reasoning

MODULE - II **15**

Fuzzy Logic: Extension principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modeling.

Optimization techniques: Derivative-based Optimization: Descent Methods – The Method of steepest Descent – Classical Newton's Method – Step Size Determination – Derivative free Optimization: Genetic Algorithms – Simulated Annealing – Random Search – Downhill Simplex Search.

MODULE -III **15**

Neuro Fuzzy Modelling: Adaptive Neuro Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling – Framework – Neuron Functions for Adaptive Networks – Neuro Fuzzy Spectrum.

Applications: Printed Character Recognition – Inverse Kinematics Problem – Automobile fuel efficiency prediction – Soft Computing for Color Recipe Prediction – Single MLP approaches – CANFIS modeling for color recipe prediction

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. J.S.R Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, Pearson Education, 2004.
2. R.C.Eberhart, P.K.Simpson and R.Dobbins, "Computational Intelligence PC Tools", AP Professional, Boston 1996.
3. David E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, New York, 1989.
4. S.Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India, New Delhi, 2004.

11PE104 ADVANCED POWER ELECTRONICS LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

1. Design of snubber circuits, di/dt protection, gate signal generation and driver circuits
2. Design of single phase AC to Dc converter using SCR
3. Design of three phase AC to Dc converter using SCR
4. Design of DC to DC converter using IGBT/MOSFET
5. Design of Current Source Inverter using SCR
6. Design of Voltage Source Inverter using IGBT
7. Design of AC to AC converter using SCR
8. Design of Cycloconverter
9. Four Quadrant operation of Dual converter
10. Harmonic filter design

11PE201 SOLID STATE DC DRIVES

3 1 0 4

Objective:

To give exposure in the conventional Solid State DC Drives and various control techniques employed for controlling DC drives

MODULE - I **15**

Review of Conventional DC Drives : Different techniques of speed control and methods of braking of series and Methods of braking of series and separately excited DC motor - Ward-Leonard Speed control - Inching and jogging -Models and transfer function of series and Separately excited DC motor.

Converter Control of DC Motors: Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations - Problems on DC machines fed by converter supplies CLC and TRC strategies.

MODULE - II **15**

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. Simulation of converter and chopper fed DC drive.

Digital Control of DC 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.

MODULE - III **15**

Chopper Control of DC Motors: Analysis of series and separately excited DC motors fed from different Choppers - effect of saturation in series motors CLC and TRC strategies.

Design of Converter fed DC Drives: Speed loop - current loop - armature current reversal - field current reversal – Inching - Digital controller and firing circuits - simulation.

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Gopal K Dubey, “Power Semiconductor controlled Drives”, Prentice Hall Inc., New Jersy, 1989.
2. Buxbaum, A.Schierau, K.and Staughen, "A Design of control System for d.c Drives ", Springer-Verlag, berlin, 1990.
3. R.Krishnan, “ Electric Motor Drives – Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
4. Bimal K.Bose “Modern Power Electronics and AC Drives”, Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003.
5. P.C Sen “Thyristor DC Drives”, John wiely and sons, New York, 1981.
6. B.K Bose, Expert System, fuzzy logic and logic and neural network applications in power electronics and motion control, proceedings of IEEE, special issue on Power Electronics and motion control, August 1994, PP.1303.

7. T. Thyagarajan, “Investigations on intelligent control strategies for air heating systems”, Ph.d Thesis, Anna University, Nov.1999.
8. V.Senthil Kumar, “Investigation on intelligent control strategies for permanent magnet, brushless dc Drive, M.E Thesis, Division of Power Electronic and drive”, Anna University, Dec'

11PE202 SOLID STATE AC DRIVES

3 1 0 4

Objective:

To give exposure in the conventional Solid State AC Drives and various control techniques employed for controlling AC drives

MODULE - I **15**

Introduction to Induction Motors: Steady state performance equations – Rotating magnetic field – torque production, Equivalent circuit– Variable voltage, constant frequency operation – Variable frequency operation, constant Volt/Hz operation. Drive operating regions, variable stator current operation, different braking methods.

Conventional Control of Induction Motors: Performance of the machine with variable voltage - rotor resistance variation - pole changing and cascaded induction machines -slip power recovery - static Kramer drive.

MODULE - II **15**

VSI and CSI fed Induction Motor Control: A.C. voltage controller 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 – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed IM variable frequency drives comparison- Regenerative braking of VSI fed drives-torque-slip characteristics of VSI fed drives

Rotor Controlled Induction Motor Drives: Static rotor resistance control - injection of voltage in the rotor circuit – static scherbius drives - power factor considerations – modified Kramer drives- Sub Synchronous operation

MODULE - III **15**

Field Oriented Control and Direct Torque Control: Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy. Torque expression with stator and rotor fluxes

Synchronous Motor Drives: Wound field cylindrical rotor motor – Equivalent circuits – performance equations of operation from a voltage source – Power factor control and V curves – starting and braking, self control – Load commutated Synchronous motor drives - Brush and Brushless excitation-load commutated inverter fed drive.

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989
2. R.Krishnan," Electric Motor Drives- Modelling,Analysis and control", Prentice-Hall of India Pvt.Ltd,New Delhi-2003.
3. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002.
4. W.Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992
5. Murphy J.M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.

11PE203 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

3 0 0 3

Objective:

- To study the basics of renewable energy sources and its applications
- To study the concepts of energy conversion in solar and wind using power electronic components
- To expose the students about the need and modeling of hybrid systems
- To study the power quality problems occurring in the renewable energy systems

MODULE - I **15**

Solar Energy Conversion : Trends in energy consumption - Energy sources and their availability - Photovoltaic Energy Conversion and applications: Solar radiation and measurement - Solar cells and their characteristics - Influence of insolation and temperature - PV arrays - Introduction to flexible solar cells - Electrical storage with batteries - Switching devices for solar energy conversion – Array sizing- Boost and buck boost converters - battery sizing - Selection of inverter – Stand alone inverters - Charge controllers - Water pumping and Street lighting - Analysis of PV Systems.

MODULE - II **15**

Wind Energy Conversion : Basic Principle of wind Energy conversion - Nature of Wind - Power in the wind - Components of Wind Energy Conversion System (WECS) - Performance of Induction Generators for WECS -Classification of WECS - Self Excited Induction Generator (SEIG) for isolated Power Generators - Theory of self excitation - Capacitance requirements - Controllable DC Power from SEIGs - Grid connectors concepts - Wind farm and its accessories- Grid related problems - Generator control - Performance improvements - Different schemes - AC voltage controllers - Harmonics and PF improvement.

MODULE - III **15**

Hybrid Systems and Power Converters : Need for Hybrid systems-Wind / Solar PV integrated systems - Selection of power conversion ratio - Optimization of system components - Storage - Reliability evolution - Power conditioning schemes: DC Power conditioning Converters - Maximum Power point tracking algorithms - AC Power conditioners - Line commutated inverters - Synchronized operation with grid supply-Grid interactive inverters-Multilevel inverters.

TOTAL: 45

REFERENCE BOOKS

1. Rai, G.D., "Non-conventional Energy Sources", Khanna Publishers, New Delhi, 2002.
2. Khan, B.H., “Non-Conventional Energy Resources”, Tata McGraw-hill Publishing Company, New Delhi, Second edition, 7th reprint, 2011.
3. Tiwari.G, “Fundamentals, Design, Modeling and applications of Solar Energy”, Narosa Publishers, 7th reprint 2010.
4. Thomas Markvart and Luis Castaser, “Practical Handbook of Photovoltaics”, Elsevier Publications, UK, 2003
5. Roger A. Messenger, Jerry Ventre, “Photovoltaic System Engineering”, CRC Press, 2004.
6. Daniel, Hunt, V., "Wind Power - A Handbook of WECS", Van Nostrend Co., New York, 1998.
7. Mukund R Patel, “Wind and Solar Power Systems”, CRC Press, 2004.

11PE204 ADVANCED DRIVES LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

1. Analysis of Dual converter fed DC motor drive
2. DSP controlled AC drive
3. Analysis of vector controlled Induction motor Drive
4. Harmonic analysis of Converter fed Drive
5. Microcontroller based speed control of VSI fed three phase Induction motor
6. DSP based speed control of BLDC motor
7. FPGA based speed control of SRM motor
8. Microcontroller based speed control of stepper motor
9. V/F controlled Induction motor Drive
10. Condition monitoring of three phase induction motor under fault condition (Simulation)

11PE205 COMPUTER AIDED SIMULATION AND DESIGN LABORATORY

0 0 3 1

LIST OF EXPERIMENTS

1. Simulation of Four quadrant operation of three-phase induction motor
2. Simulation of Automatic Voltage Regulation of three-phase Synchronous Generator
3. Simulation of Single Phase Fully controlled Converter for RLE Load
4. Simulation of Single Phase Dual Converter
5. Simulation of Three Phase Fully Controlled Converter
6. Simulation of Three Phase Full Bridge Inverter
7. Simulation of PWM Inverters
8. Simulation of Three Phase AC Voltage Controller
9. Simulation of Three Phase Cycloconverter
10. Simulation of Current Source Inverter

11AE023 PROJECT MANAGEMENT

(Common to M.E.Applied Electronics, Power Electronics)

3 0 0 3

PREREQUISITE:

Principles of Management/ Total Quality Management

Objective:

- To know the project phases and control
- Linear programming for solving problems
- To Estimate the Project cost
- To evaluate and manage the Project

MODULE - I **15**

Project Management Systems and Controls: Need – Goals- Evolution-different forms-project management in manufacturing, service and government sectors; Systems development cycle – project life cycle – conception phase: proposal, contracting – definition phase – execution phase: production / build, implementation – operation phase- case study. Tools for project planning – work break down structure, responsibility matrix, events and mile stones- Gantt charts.

Performance Analysis – cost, schedule, work package analysis, performance indices, updating time estimates, technical performance measurement; Performance Index monitoring – variance limits, controlling changes, contract administration, control problems, case study.

MODULE - II **15**

Network Scheduling and Project Cost Estimation: Network Diagram – critical path – late times – slack – float – calendar scheduling. Time estimates – probability of finishing by target completion date – meeting the target – simulating PERT network - - criticisms of PERT ; CPM – Time cost relationship – reducing project duration – shortest duration – total project cost – scheduling with resource constraints – resource loading and leveling – constrained resources: Introduction to GERT network, class studies in PERT/CPM.

Process – classification-expert opinion, analogy, parametric estimate, cost engineering- example: Contingency amount ; Elements of budgets and Estimates – direct labour, direct non- labour, overhead, general and administrative expenses, profit and total billing;

MODULE - III **15**

Project Management Information Systems (PMIS) and Project Evaluation: Functions – Computer based PMI Systems – Web-Based project management. Review meetings, reporting, terminating, termination responsibilities, closing the contract, project extensions, project summary evaluation. Cost accounting systems- project control process ; Project control emphasis – scope change control, quality control, schedule control, time buffers

Project cost accounting and management information system – cost summaries, cost schedules and forecasts – case study.

TOTAL : 45

REFERENCE BOOKS

1. Nicholas, John M., “Project Management for Business and Technology”, Prentice Hall India, New Delhi, 2002.
2. Pagnoni, Anastasia., “Project Engineering: Computer Oriented Planning and Operational Decision Making”, Springer-Verlag, Berlin, 1990.

11AE026 VIRTUAL INSTRUMENTATION SYSTEMS

(Common to M.E.Applied Electronics, Power Electronics)

3 0 0 3

PREREQUISITE

Microprocessor , Instrumentation

Objectives:

- To review background information required for studying virtual instrumentation.
- To study the basic building blocks of virtual instrumentation.
- To study the various techniques of interfacing of external instruments of PC.
- To study the various graphical programming environment in virtual instrumentation.
- To study a few applications in virtual instrumentation.

MODULE - I **15**

Introduction: General Functional description of a digital instrument - Block diagram of a Virtual Instrument - Physical quantities and Analog interfaces - Hardware and Software - User interfaces - Advantages of Virtual instruments over conventional instruments - Architecture of a Virtual instrument and its relation to the operating system.

Software Overview: Lab VIEW - Graphical user interfaces - Controls and Indicators - 'G' programming - Data types - Data flow programming - Editing - Debugging and Running a Virtual instrument - Graphical programming pallets - Front panel objects - Controls, Indicators, Object properties and their configuration – Typical examples.

MODULE - II **15**

Programming Structure: FOR loops, WHILE loop, CASE structure, formula node, Sequence structures - Arrays and Clusters - Array operations - Bundle - Bundle/Unbundle by name, graphs and charts - String and file I/O - High level and Low level file I/O's - Attribute modes Local and Global variables

Hardware Aspects: Installing hardware, installing drivers - Configuring the hardware - Addressing the hardware in Lab VIEW - Digital and Analog I/O function

MODULE - III **15**

Data Acquisition: Data Acquisition - Buffered I/O - Real time Data Acquisition

Lab VIEW Applications: Motion Control: General Applications - Feedback devices, Motor Drives – Machine vision – Lab VIEW IMAQ vision – Machine vision Techniques – Configuration of IMAQ DAQ Card - Instrument Connectivity - GPIB, Serial Communication - General, GPIB Hardware & Software specifications - PXI / PCI: Controller and Chassis Configuration and Installation.

TOTAL: 45

REFERENCE BOOKS

1. Johnson Garry W, "LabView Graphical Programming", Third Edition, Tata McGraw Hill, New Delhi, 2001.
2. Sanjay Gupta and Joseph John, “Virtual Instrumentation Using LabVIEW”, Tata McGraw-Hill, Ist Edition, 2008.
3. LabView: Basics I & II Manual, National Instruments, 2006.
4. Barry Paron, "Sensors, Transducers and LabVIEW", Prentice Hall , 2000.
5. Buchanan William and Buchanan Bill, “Computer Basics”, CRC Press, 2000.
6. Javitha Jerome, “ Virtual Instrumentation using Lab View”, PHI, 2008.

11AE102 ADVANCED DIGITAL SIGNAL PROCESSING

(Common to M.E. Applied Electronics, Communication Systems, Power Electronics, Control and Instrumentation, Computer and Communication)

3 1 0 4

Objective:

- To introduce the concept of discrete random signal processing.
- To understand the spectrum estimation and analysis using parametric and non-parametric approach.
- To estimate the signal by linear prediction.
- To study the concepts of adaptive filter and various error minimization algorithm.
- To understand the concepts of multirate digital signal processing.

MODULE – I **15**

Discrete Random Signal Processing: Discrete time random process – Random process: Ensemble averages- Gaussian process – stationary process – The autocovariance and autocorrelation metrices – ergodicity – white noise the power spectrum. Filtering random process – spectral factorization. Parseval's theorem – Wiener Khintchine relation.

Spectrum Estimation and Analysis: Non parmetric methods: Periodogram, performance of periodogram, modified periodogram, Bartlett's method, Welch's method.

MODULE - II **15**

Parametric methods: AR model – Yule-Walker method, MA model – ARMA model.

Linear Prediction: Forward and backward linear predictions, Solution of the normal equations – Levinson-Durbin algorithms. Least mean squared error criterion – The FIR Wiener filter – filtering – linear prediction and The IIR Wiener filters – Non causal IIR Wiener filter – the causal IIR Wiener filter.

Adaptive Filter: Concepts of adaptive filter – FIR adaptive filters – LMS algorithm – Applications: Noise cancellation

MODULE -III **15**

Adaptive Filter: Adaptive recursive filers– AR lattice structure and ARMA process, lattice – ladder filters.

Multirate Digital Signal Processing: Mathematical description of sampling rate – Interpolation and Decimation by integer factor – Sampling rate conversion by rational factor- Filter design for sampling rate conversion; direct form FIR structures, Polyphase structures, time-varient structures. Multistage implementation of sampling rate conversion. Applications – Subband coding of speech signals.

Lecture : 45, Tutorial : 15, TOTAL : 60

REFERENCE BOOKS

1. Hayes, Monson H. "Statistical Digital Signal processing and Modeling", John Wiley and Sons, Inc., 1996.
2. Proakis, John G. and Manolakis, Dimitris G. "Digital Signal Processing: Principles Algorithms and Applications", PHI, 2006.
3 Ifeachor, Emmanuel C. and Jervis, Barrie N. "Digital Signal Processing: A Practical Approach", Addison-Wesley Publishing Company, 2002.
4 George Box, Gwilym M. Jenkins, Gregory Reinsel, "Time Series Analysis: Forecasting & Control", 3rd Edition,

11CI015 OPTIMAL CONTROL THEORY

(Common to M.E.Control and Instrumentation Engineering, Power Electronics and Drives)

3 1 0 4

Objectives:

- To introduce the basics about linear optimal control and dynamic programming.
- To enhance the knowledge about Calculus of Variations and The Minimum (Maximum) Principle.

MODULE - I **15**

Introduction: Review: state space representation, matrix theory, static optimization with and without constraints. Calculus of variations-basic concepts-functionals of a single function and several functions-necessary conditions and boundary conditions

Optimal control formulation:The performance measures for optimal control problems-Hamiltonian approach-necessary conditions for optimal control-and Linear regulator problem-infinite time regulator problem-, Regulators with a prescribed degree of stability.

MODULE - II **15**

The Minimum (Maximum) Principle: Pontryagin's minimum principle and state inequality constraints, Minimum time problem, Minimum control energy problems. Singular intervals in optimal control.

Numerical Techniques: Numerical solution of two-point boundary value problem –Gradient method and Quasi Linearisation method - solution of Ricatti equation by iterative method.

MODULE- III **15**

Dynamic Programming: Principle of optimality - recurrence relation of dynamic programming for optimal control problem - computational procedure for solving optimal control problems - characteristics of dynamic programming solution - dynamic programming application to discrete and continuous systems - Hamilton Jacobi Bellman equation. Relationship between Dynamic Programming and Minimum Principle.

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS

1. Kirk Donald, "Optimal Control Theory", Prentice Hall, New Jersey, 1970.
2. Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Prentice Hall, New Jersey, 1979.
3 Desineni Subburam Naidu, "Optimal Control Systems", CRC Press,2003
4 Anderson B.D.O. and Moore J.B., "Optimal Control: Linear Quadratic Methods", Prentice Hall, New Jersey, 1979.

11PE011 ADVANCED TOPICS IN POWER SYSTEM PROTECTION

3 0 0 3

Objective:

To impart knowledge on the

- Basics of Power System Protection
- Static , Numerical and microprocessor based relays for power protection
- Recent trends in power system protection

MODULE - I **15**

Introduction : General philosophy of protection – Characteristic functions of protective relays – basic relay elements and relay terminology – Classification of Relays – Construction and operation of Electromagnetic relays – A review of conventional protection schemes for Transmission lines and station apparatus (Qualitative treatment only)

Static Relays : Static relays – Solid state devices used in static protection – Amplitude comparator and phase comparator – Static Over current relays: Non-directional, Directional - Synthesis of Mho relay, Reactance relay, Impedance relay and Quadrilateral Distance relay using Static comparators, Differential relay.(Qualitative treatment only)

MODULE - II **15**

Microprocessor Based Relays : Hardware and software for the measurement of voltage, current, frequency, phase angle – Microprocessor implementation of over current relays – Inverse time characteristics – Directional relay – Impedance relay– Mho relay, Differential relay – Numerical relay algorithms – SCADA Interfacing.(Qualitative treatment only)

Modern Protective Devices: Introduction to Digital Signal Processing - Logic devices and systems – Signal Processing Filters – DSP based relays – Traveling wave relays: Amplitude comparison relay, phase comparison relay, Directional comparison relay, Fault location. (Qualitative treatment only)

MODULE - III **15**

Modern Trends in Protective Relaying : Pilot relay protection: Wire pilot relaying, Carrier current pilot relaying, Microwave pilot relaying – Fibre-optic based relaying – Apparatus Protection: Digital protection of generators, Digital protection of Transformers – Protection of Long and short lines– Protection based on Artificial Intelligence – SCADA: Architecture, Use of SCADA in interconnected power systems.(Qualitative treatment only)

TOTAL: 45

REFERENCE BOOKS

1. Y.G.Paithankar , S.R.Bhide, " Fundamentals of Power System Protection", Prentice – Hall India, 2004
2. A.G.Phadke, J.S.Thorpe," Numerical relaying for Power Systems", John-Wiley and Sons, 1988
3. T.S.M.Rao, "Digital / Numerical Relays", Tata McGraw Hill,2005
4. Badri Ram and DN Vishwakarma, "Power system protection and Switchgear", Tata McGraw Hill, NewDelhi, 2003.
5. Ravindar P. Singh, "Digital Power System Protection", PHI, NewDelhi, 2007.
6. L.P.Singh, " Digital protection, Protective Relaying from Electromechanical to Microprocessor", John Wiley & Sons, 1995.
7. J.L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 1987.

11PE012 ADVANCES IN POWER ELECTRONICS

3 0 0 3

Objective:

- To impart knowledge on the areas of Recent developments in the areas of power electronics such as
- Resonant converters for ZVS and ZCS
- Harmonic Reduction in power electronic converters
- Emerging power Electronic Devices

MODULE - I **15**

Resonant Converters and Utility Interface : Zero voltage and Zero current switching – Classification of resonant converters - Basic resonant circuit concepts - Load resonant converters - Resonant switch converters - Zero voltage switching, clamped voltage topologies -Resonant DC link Inverters and Zero voltage switching - High frequency link integral half cycle converters - Applications in SMPS and lighting.

Generation of current harmonics – Current harmonics and power factor - Harmonic standards and recommended practices - Need for improved utility interface - Improved single phase utility interface - Improved three phase utility interface - Interconnection of renewable energy source and energy storage system to the utility grid –Electromagnetic interference.

MODULE - II **15**

FACTS Devices and its Modeling : Introduction - Principles of reactive power control in load and transmission line compensation - Series and shunt reactive power compensation - Concepts of Flexible AC Transmission System (FACTS) - Static var compensators (SVC) - Thyristor controlled reactor - Thyristor switched capacitor - Solid state power control - Static condensers - Controllable series compensation - Thyristor controlled phase angle regulator and unified power flow control.

Modeling and methods of analysis of SVC and FACTS controllers - System control and protection– Harmonics and filters –Simulation and study of SVC and FACTS under dynamic conditions.

MODULE - III **15**

Emerging Devices : Power Junction Field Effect Transistors - Field Controlled Thyristors - JFET based devices Vs other power devices - MOS controlled thyristors -. Integrated Gate commutated Thyristor (IGCT) - Switching and steady state characteristics - - Intelligent power modules- Power integrated circuits - New semiconductor materials for power devices.

TOTAL: 45

REFERENCE BOOKS

1. Ned Mohan., Undeland and Robbins, " Power Electronics: Converters, Applications and Design ", John Wiley and Sons (Asia) Pte Ltd, Singapore, 2003.
2. Rashid, M.H., "Power Electronics – Circuits, Devices and Applications", Pearson education (Singapore) Pte. Ltd, New Delhi, 2004./ Prentice Hall of India, New Delhi.
3. Joseph Vithayathil., "Power Electronics", Mc-Graw Hill series in Electrical and Computer Engineering, USA, 1995.
4. Mohan Mathur P, Rajiv K Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", John Wiley and Sons Inc., IEEE Press,USA, 2002.
5. Roger C Dugan, Maric F Mcgranaghan, "Electrical Power System Quality", Mc-Graw Hill Inc, New York, 1996.
6. Bimal K Bose, "Modern Power Electronics – Evolution, Technology and application", Jaico Publishing House, Mumbai, 2006.

11PE013 COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES

3 1 0 4

Objective:

To give exposure in the conventional in computer aided design of electrical machines and control techniques employed for controlling the electrical machines.

MODULE - I **15**

Introduction : Conventional design procedures – Limitations – Need for field analysis based design.

Mathematical Formulation of Field Problems : Development of torque/force – Electromagnetic Field Equations – Magnetic Vector/Scalar potential – Electrical vector /Scalar potential – Stored energy in field problems – Inductance- Laplace and Poisson's Equations – Energy functional - Principle of energy conversion.

MODULE - II **15**

Philosophy of FEM : Mathematical models – Differential/Integral equations – Finite Difference method – Finite element method – Energy minimization – Variational method- 2D field problems – Discretisation – Shape functions – Stiffness matrix – Solution techniques.

CAD Packages: Elements of a CAD System –Pre-processing – Modelling – Meshing

MODULE - III **15**

CAD Packages and Design Applications : Material properties- Boundary Conditions – Setting up solution – Post processing.

Design of Solenoid Actuator – Induction Motor – Switched Reluctance Motor – Synchronous Machines.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Silvester and Ferrari,"Finite for Electrical Engineers" Cambridge University press, 1983.
2. S.R.H.Hoole, Computer – Aided, Analysis and Design of Electromagnetic Devices, Elsevier, New York, Amsterdam, London, 1989.
3. D.A.Lowther and P.P Silvester, Computer Aided Design in Magnetics, Springer verlag, New York, 1956.
4. S.J Salon,"Finite Element Analysis of Electrical Machines."Kluwer Academic Publishers, London, 1995.
5. C.W.Throwbridge,"An Introduction to computer Aided Electromagnetic Analysis", vector field ltd.
6. User Manuals of MAGNET, MAXWELL & ANSYS.Software.

11PE014 COMPUTER AIDED SIMULATION AND DESIGN OF POWER ELECTRONIC SYSTEMS

3 1 0 4

Objective:
To impart knowledge on simulation techniques of various power electronic switches, Converters and Drives using PSPICE, MATLAB

MODULE - I **15**

Introduction : Importance of simulation – Challenges in simulation -General purpose circuit analysis – Methods of analysis of power electronic systems – Review of power electronic devices and circuits.
Pspice : File formats - Description of circuit elements - Circuit description – Output variables - Dot commands - - SPICE models of Diode, Thyristor, Triac, BJT, Power MOSFET, IGBT and MCT.
MATLAB and Simulink : Toolboxes of MATLAB - Programming and file processing in MATLAB – Model definition and model analysis using SIMULINK - S-Functions - Converting S Functions to blocks.

MODULE - II **15**

Modeling of Power Electronic Devices : Review of numerical methods - Application of numerical methods to solve transients in DC switched R, L, R-L, R-C and R-L-C circuits - Extension to AC circuits - Modeling of diode in simulation - Diode with R, R-L, R-C and R-L-C load with ac supply - Modeling of SCR, TRIAC, IGBT and Power Transistors in simulation - Simulation of gate/base drive circuits, simulation of snubber circuits.
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.

MODULE - III **15**

Simulation of Converters and Drives : Diode rectifiers -Controlled rectifiers - AC voltage controllers - DC choppers – PWM inverters – waveform control - Voltage source and current source inverters - Space vector representation - Resonant pulse inverters - Zero current switching and zero voltage switching inverters -Simulation of power factor correction schemes
Simulation of speed control schemes for DC motors – Rectifier fed DC motors – Chopper fed DC motors – VSI and CSI fed AC motors – PWM Inverter – DC link inverter.

Lecture: 45, Tutorial: 15, TOTAL: 60

REFERENCE BOOKS

1. Rashid, M., Simulation of Power Electronic Circuits using pSPICE, PHI, 2006.
2. Rajagopalan, V. “Computer Aided Analysis of Power Electronic systems”-Marcell –Dekker Inc., 1987.
3. Ned Mohan, "Power Electronics: Computer Simulation Analysis and Education using PSPICE", Minnesota Power Electronics Research and Education, USA,1992.
4. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery : Using MATLAB/ Simulink", Prentice Hall PTR, New Jersey, 1998.
5. Bimal K Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, New Jersey, 1996.
6. Simulink Reference Manual , Math works, USA

11PE015 COMPUTER COMMUNICATION NETWORKS

3 0 0 3

Prerequisite

Computer Networks

Objective:

- To gain an understanding of the fundamentals of data communications networks
- To explain the concept of data communication
- To identify different components of computer network
- To identify different types of network
- To explain communication protocols and the concept of internetworking

MODULE – I **15**

Introduction: Definition of Networks – Classification of Networks – LAN, MAN, WAN, internet – Network Topology – Protocols and Standards – Network Models – OSI, TCP/IP Models of networking – Internet

Physical Layer: Review of Signals – Data Rate Limits – Performance Issues – Bandwidth, Throughput, Latency, Bandwidth-Delay Product, Jitter. Digital Transmission and Analog Transmission: Line coding techniques, PCM and Delta Modulation techniques – ASK, FSK, PSK, and QAM Techniques – Bandwidth Utilization: Multiplexing and Spreading

MODULE - II **15**

Communication Media: Parallel and Serial Transmission, MODEMS, Intelligent MODEMS

Data Link Layer: Error Detection and Correction techniques – Data Link Control: Framing, Flow and Error Control –, Stop and Wait, Sliding Window- HDLC and PPP protocols. Multiple Access Techniques – : FDM, TDM, ALOHA Techniques, Pure ALOHA, Slotted ALOHA, Carrier Sense Techniques **.**

Wired LANs: Wired LANs– IEEE 802 standards - Ethernet – IEEE 802.3 MAC Frame – Token Ring LAN – Token bus - Wireless LANs – IEEE 802.11 standard

MODULE -III **15**

Wired WANs: Wired WANs -Circuit-Switched Networks, Datagram Networks, Virtual Circuit-Switched Networks, Structure of Circuit and Packet Switches - Wireless WANs – Introduction to Cellular Telephone and Satellite networks

Internetworking: Internetworking – tunneling – IP Addressing Scheme – Structure of IP Datagram – IP Routing – TCP as Transport Layer Protocol – Structure of TCP Segment – TCP Connection: Establishment and Closing – SMTP Protocol for E-Mail Application

TOTAL : 45

REFERENCE BOOKS

1. Forouzan Behrouz A., " Data Communications and Networking", Fourth Edition, Tata McGraw-Hill, New Delhi, 2006.
2. William Stallings ., "Data and Computer Communications", Pease Publishers-2001.
3. Rowe Stanford H. and Schuh Marsha L., "Computer Networking", Pearson Education, New Delhi, 2005.
4. Kurose James and Ross Keith," Computer Networking: Top Down Approach featuring the Internet", Pearson Education, New Delhi, 2002.

11PE016 DSP BASED ELECTROMECHANICAL MOTION CONTROL

3 0 0 3

Objectives

On completion of this course, the student should be able to:

- Develop the programming and customizing the DSP controllers for the PE applications.
- Implement system based drives control using TMS320LF2407 processor.

MODULE - I **15**

Introduction to TMSLF2407 DSP controller and architecture :

Introduction to DSP controllers – Peripherals - types of physical memory - software tools - DSP Core –code generation - system configuration registers – memory - addressing modes - General purpose input/output functionality.

MODULE –II **15**

Interrupts:

Introduction to interrupts - interrupt hierarchy - interrupt control registers - initializing and servicing interrupt.

Event manager :

Overview of the event manager - event manager interrupts - general purpose timers - compare Units - capture units.

MODULE -III **15**

Case study:

Space vector pulse width modulation - stepper motor – PMSM - PMBLDC motor - vector control of induction motor - Switch reluctance motor

TOTAL: 45

REFERENCE BOOKS

1. Hamid A. Toliyat, Steven Campbell ,"DSP based electromechanical motion control", CRC press, New York, Washington Dc,2004.
2. Krishnan R, "Electric Motor Drives: Modelling, Analysis and Control, Prentice Hall of India Pvt Ltd, New Delhi, 2002
3. John G.Proakis, Dimitris G.Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", PHI.
4. B.Venkatramani & M.Bhaskar, "Digital Signal Processors architecture, Programming and Applications", TMH, 2002.
5. Peter Vas, "Vector Control of AC Machines", Oxford University Press, 1990.
6. Kenjo T and Nagamori S, "Permanent Magnet and Brushless DC Motor", Clarendon Press, London 1988.
7. Aearnely P. P., "Stepper Motors, A Guide to Motor Theory and Practice', Peter Perengrinus, London, 1982.

11PE017 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY

3 0 0 3

Objective:

To impart knowledge on the

- Basics of Electromagnetic interference
- Methods of elimination of EMI
- Various designs of EMC

MODULE - I **15**

Introduction to EMI and Coupling : EMI/EMC concepts and definitions - Sources of EMI - conducted and radiated EMI - Characteristics - Transient EMI, Time domain Vs Frequency domain EMI - Units of measurement parameters - EMC regulation- typical noise path- use of network theory- methods of eliminating interferences

Conducted, Radiated and Transient Coupling - Common Impedance Ground Coupling -Radiated Common Mode and Ground Loop Coupling - Radiated Differential Mode Coupling - Near Field Cable to Cable Coupling - Power Mains and Power Supply coupling.

MODULE - II **15**

Digital Circuit Noise, Measurements and EMI/EMC Standards : Frequency versus time domain- analog versus digital circuits- digital logic noise- internal noise sources- digital circuit ground noise – power distribution-noise voltage objectives-measuring noise voltages-unused inputs-logic families.

Civilian standards - FCC, CISPR, IEC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems - EMI Shielded Chamber - Open Area Test Site - TEM Cell, Sensors/ Injectors /Couplers - Test beds for ESD and EFT - Military Test Method and Procedures.

MODULE - III **15**

EMI Control Techniques and EMC Design : Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting.

PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Zoning, Motherboard Designs and Propagation Delay Performance Models.

TOTAL: 45

REFERENCE BOOKS

1. Henry W.Ott, "Noise Reduction Techniques in Electronic Systems", John Wiley and Sons, NewYork. 1988.
2. C.R.Paul, “Introduction to Electromagnetic Compatibility” , John Wiley and Sons,Inc, 1992.
3. Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc.(685 canton street, Norwood, MA 020062 USA) 1987.
4. V.P.Kodali, "Engineering EMC Principles, Measurements and Technologies", IEEE Press, 1996.
5. Bernhard Keiser, "Principles of Electromagnetic Compatibility", Artech house, 3rd Ed, 1986.

11PE018 EMBEDDED SYSTEM AND APPLICATIONS

3 0 0 3

Objective:

- Introduce the features and concepts of PIC Microcontroller that build an embedded system.
- To understand the concepts of PIC Microcontroller interface circuits
- To understand the architecture of the ARM processor and programming.
- To enable writing of efficient programs on any dedicated processor.

MODULE - I **15**

Introduction: Introduction to Embedded systems – Von Neumann and Harvard architecture – Need of Microcontrollers – selection criterion – Architecture – Features – Resets –Memory Organisations: Program Memory, Data Memory – Instruction Set – simple programs using Assembly language Instruction sets.

PIC 16F87X: Human and Physical Interface Support: Interrupts – Peripherals – I/O Parallel Ports –Timers – Capture/Compare/PWM (CCP) Modules Control registers –Serial ports – Master Synchronous serial Port (MSSP) in I2C mode and in SPI mode – USART

MODULE - II **15**

Interfacing: Analog-to-digital Converter (ADC) – Registers associated with the peripherals – Initializing the Peripheral modules using Assembly language.

ARM Processor Architecture and Programming: General concepts - ARM7 - Instruction Set Architecture, Levels in architecture, Functional description - processor and memory organization - Introduction to RISC architecture, pipelining, Instruction issue and execution - Instruction formats - Addressing modes - Data alignment and byte ordering – Simple Assembly Language programs.

MODULE - III **15**

Real-Time Operating System and Case Study - Applications: RTOS Introduction - RTOS Necessity - Architecture of the Kernel-task and task scheduler - Interrupt Service Routines- Semaphores - Mutex-Mailboxes - Message Queues – Event/Signals -Timers - Priority Inversion Problem – Preventing Interrupt priority - Scheduling approaches - Optimality of the Earliest deadline first (EDF) algorithm - Use of µC/OS-II- Case study of coding for an Automatic Chocolate Vending Machine using MUCOS RTOS- Case study of an Embedded system in Smart Card.

TOTAL: 45

REFERENCE BOOKS

1. Raj Kamal., "Embedded Systems Architecture, Programming and Design", Tata McGraw-Hill, New Delhi, 2003.
2. Wayne Wolf., "Computers as Components: Principles of Embedded Computing System Design", Morgan Kaufman Publishers, San Francisco, 2001.
3. Sriram V Iyer and Pankaj Gupta, Embedded Real time Systems Programming, Tata McGraw Hill, New Delhi, Eighth reprint 2007.
4. Vahid, Frank and Givargi, Tony., "Embedded System Design: A Unified Hardware/Software Introductions", John Wiley & Sons, New York, 2000.
5. Labrosse, Jean J., "MicroC/OS-II: The Real-Time Kernel", Second Edition, CMP Books Group west Publications, 2002.

11PE019 ENERGY CONSERVATION, MANAGEMENT AND AUDITING

3 0 0 3

Objective:

- To review the world and Indian energy scenario.
- To understand the importance of energy conservation and management.
- To Study the various opportunities for energy conservation in thermal and electrical utilities.
- Understand the process of Energy Auditing and opportunities for Energy auditors and managers.

MODULE - I **15**

Energy Conservation: Energy Scenario – India and World – Energy Resources Availability in India – Energy consumption – Pattern, Energy Conservation Potential – Various Industries and Commercial Establishments, Energy Intensive Industry – An Overview. Energy Conservation and Energy Efficiency – Needs and Advantages. Characteristic Method Employed in Certain Energy Intensive Industries –Various Energy Conservation Measures in Steam Systems – Losses in Boiler – Methodology of upgrading Boiler program – Energy Conservation in Refrigeration and Air-conditioning Systems.

MODULE - II **15**

Energy Management: Importance of Energy Management, Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Life Cycle Cost, risk and Sensitivity Analysis, Financing Options, Energy Performance Contract and Role of ESCOS. Captive Power Generation Systems – Biomass, Wind and Diesel Power Generation – KVA Demand Estimation – Wheeling and Banking Concept – EB Bill detailing. Basics of Monitoring and Targeting – Elements of Monitoring and Targeting, Data and Information Analysis Techniques – Energy Consumption, Production, Cumulative sum of differences (CUSUM)

MODULE - III **15**

Energy Audit: Energy Auditing – Principle, Types, Methodologies, Barriers, Role of Energy Manager and Auditor – Energy Audit Questionnaire – Energy Conservation Act 2003. Purpose and Methodology with respect to Process Industries, Power Plants, Boilers etc. –Performance Evaluation of (i) Transformers (ii) Energy Distribution - Cable Selection and Cable losses (iii) Capacitors (iv) Electric Motors (v) Electrical Heating and Lighting Systems.

TOTAL: 45

REFERENCE BOOKS

1. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management & Case Study, Hemisphere, Washington, 1980.
2. CB Smith, Energy Management Principles, Pergamon Press, New York, 1981
3. Write, Larry C, Industrial Energy Management & Utilization, Hemisphere Publishers, Washington, 1998.
4. Trivedi, P.R., and Jolka, K.R., Energy Management, Common Wealth Publication, New Delhi, 1997.
5. Handbook on Energy Efficiency, TERI, New Delhi, 2001
6. Bureau of Energy Efficiency Exam Materials Volume I,II,III and IV

11PE020 MICROPROCESSOR AND MICROCONTROLLER APPLICATIONS IN POWER ELECTRONICS

3 0 0 3

Objective:

To impart knowledge on the areas of Recent developments in the areas such as

- Basics of microcontroller interfacing with power electronics devices
- Control of power electronic converters

MODULE - I **15**

Introduction to 8 & 16 bit processors

Architecture and programming of Intel 8085, Different modes of operation.

Interfacing of peripheral ICs

Interfacing of Timer(8253), PPI(8255), ADC(0808), DAC(0807), Programmable Interrupt controller (8259), Memory interfacing (RAM, EPROM and EEPROM)

MODULE - II **15**

Measurement and control implementation

Measurement and sensing of voltage, current, speed, power and power factor-using microprocessors. Implementation of P,PI, PID controllers using microprocessors

Introduction to Micro-controllers

Role of micro-controllers and its comparison with microprocessors.

Overview of micro-controller resources in standard micro-controllers INTEL 8096 .Program memory and data memory – Parallel ports – AD and DA converters – Reset circuitry – Watch dog timers – Power down considerations.

MODULE - III **15**

Programming Techniques

Overview of programming framework: CPU register structure- Addressing modes – Instruction set – Assembly Language programming – Handling complexity in Assembly language coding.

Software building blocks: Queues, Tables and Strings, State machines, Macros and assembler directives.

Interrupt structures: Latency – Interrupt Density constraints (IDC) and Interrupt Interval constraints (IIC) – Shared resources and Critical regions

Designing with peripheral resources and external HW

Designing with Timers, High Speed Input, High speed Output, PWM module, ADC for Power electronics control circuit using INTEL 8096 .Interfacing external hardware like Driver ICs, sensors and actuators. Interfacing external hardware like Driver ICs, sensors and actuators.

TOTAL: 45

REFERENCE BOOKS

1. John B. Peatman, "Design with Microcontrollers", Mc-Graw Hill International Addition, 1988.
2. Takashi Kenjo, " Power Electronics for the microprocessor Age", Oxford University Press, 1990.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems", Prentice Hall India Limited, 2000.

11PE021 NON CONVENTIONAL ENERGY SYSTEMS

3 0 0 3

Objective:

To impart knowledge on the

- Area of Renewable sources availability, methods of utilization
- Area of Power Electronics Converters for utility interface

MODULE - I **15**

Solar Energy : Introduction to solar energy: solar radiation, availability, measurement and estimation – Solar thermal conversion devices and storage – solar cells and photovoltaic conversion – PV systems – MPPT. Applications of PV Systems – solar energy collectors and storages.

Wind Energy : Introduction – Basic principles of wind energy conversion – wind data and energy estimation – site selection consideration – basic components of wind energy conversion system – Types of wind machines – basic components of wind electric conversion systems. Schemes for electric generations – generator control, load control, energy storage – applications of wind energy – Inter connected systems.

MODULE - II **15**

Chemical Energy Sources: Introduction – fuel cells – design and principles of operation of a fuel cell – classification of fuel cells. Types of fuel cells – conversion efficiency of fuel cells. Types of electrodes, work output and EMF of fuel cell, Applications of fuel cells. Hydrogen energy: Introduction – hydrogen production – electrolysis, thermochemical methods, Westing House Electro-chemical thermal sulphur cycle. Fossil fuel methods. Hydrogen storage, Utilization of hydrogen gas.

Energy from Oceans: Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, closed OTEC cycle. Energy from tides: Basic principles of tidal power, component of tidal power plants, operation methods of utilization of tidal energy, site requirements, storage, advantages and limitations of tidal power generation. Ocean waves, energy and power from the waves, wave energy conversion devices.

MODULE - III **15**

Geothermal Energy: Introduction, estimation of geothermal power, nature of geothermal fields, geothermal sources, inter connection of geothermal fossil systems, prime movers for geo thermal energy conversion. Application of geothermal energy. Energy from biomass: Introduction, Biomass conversion technologies, photosynthesis, classification of biogas plants. Biomass Energy conversion, Energy from waste.

Electrical Machines for Renewable Energy Conversion: Review of reference theory fundamentals - principle of operation and analysis: IG, PMSG, SCIG and DFIG.

Power Converters to Renewable Energy Sources (SOLAR): Line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing. (**WIND**) : Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters - matrix converters.

TOTAL: 45

REFERENCE BOOKS

1. SP Sukatme, "Solar Energy – Principles of thermal collection and storage, second edition, Tata McGraw Hill, 1991.
2. Rai. G.D, "Non Conventional Energy Sources", Khanna publishes, 1993.

3. J.A. Duffie and W.A. Beckman, “Solar Engineering of Thermal Processes”, Second Edition, John Wiley, New York, 1991.
4. D.Y. Goswami, F. Kreith and J.F. Kreider, “Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
5. D.D. Hall and R.P. Grover, “Bio-Mass Regenerable Energy, John Wiley, Newyork, 1987.
6. J. Twidell and T. Weir, “ Renewable Energy Resources”, E&FN Spon Ltd., London, 1986.

11PE022 PLC AND SCADA

3 1 **0** **4**

Objective:

- To get an overview of industrial automation.
- To know in detail above the various PLC configuration, Hardware and Software
- To know about the preliminary distributed control systems and its various architecture

MODULE- I **15**

PLC Programming: PLC: Evolution – Components of PLC – Advantages over relay logic - PLC programming languages – Ladder diagram – Programming timers and counters –PLC Specifications – Timer Functions: Types, programming - Counter Functions: Types, programming. Advanced functions – Arithmetic functions – Logic functions – Comparison functions - Program control instructions, math instructions, and sequencer instructions. Advanced Instructions in PLC – Program control instructions, math instructions, sequencer instructions.

MODULE - II **15**

DCS: DCS: Evolution – Different architectures – local control unit – Operator interface – Displays – Engineering interface.

HART: HART: Introduction – Evolution of signal standards – HART communication protocol – communication modes – HART networks – Control system interface – HART commands – HART field controller implementation – HART and ISO-OSI model.

Field Bus: Field bus: Introduction –Architecture – Basic requirements of field bus standard – Field bus topology – interoperability – interchangeability.

MODULE- III **15**

Applications of PLC: Bottle filling system – Material handling system – Spray Painting System – Pneumatic Stamping System.

Applications of DCS: Applications of DCS in Power plants, Iron and Steel plants, Chemical plants, Cement plants and Pulp and Paper plants.

SCADA: Supervisory Control and Data Acquisition (SCADA) – overview – Developer and runtime packages – architecture – Tools – Tag – Internal & External graphics, Alarm logging – Tag logging – structured tags – Trends – history – Report generation

Lecture:45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS

1 Webb John W. and Reis Ronald A., "Programmable Logic Controllers", Prentice Hall Publications, New Delhi, 2005.
2. Lukas, Michael P., "Distributed Control Systems", Van Nostrand Reinfold Company, 2002.
3. Petrezeulla, "Programmable Controllers", McGraw Hill, New York, 1989.
4. Popovic D. and Bhatkar V.P., "Distributed Computer Control for Industrial Automation, Marcel Dekkar Inc., New York, 1990.
5. Cimplicity Scada Packages Manual Fanuc India Ltd, 2004.

11PE023 POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS

3 0 0 3

Objective:

To give exposure in the area of application of power electronics converters in the field of power systems.

MODULE – I **15**

HVDC Transmission : Introduction – Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system – Configurations of HVDC links Modern trends in DC transmission – detailed analysis of twelve pulse converters – General principles of DC link control – Converter control characteristics – System Control hierarchy – Firing angle control – CEA control – MTDC systems – Potential applications of MTDC systems – Types of MTDC systems – Control and protection of MTDC systems – DC smoothening reactor – DC breakers – Generation of Harmonics and filtering – Power control – Higher level controllers.

MODULE - II **15**

FACTS and its Controllers: Flexible AC transmission systems (FACTS). Principles of series and shunt compensation. Description of static VAR compensators (SVC), Thyristor controlled series compensators (TCSC), Static phase shifters (SPS), Static condenser (STATCON), Static synchronous series compensator (SSSC) and Unified power flow controller flow controller (UPFC). Modeling and Analysis of FACTS controllers. Control strategies to improve system stability.

MODULE -III **15**

Utility Interface of Renewable Energy Sources : Stand alone operation of fixed and variable speed wind energy conversion systems and solar system – Grid connectors concepts – Grid connection issues – Grid integrated PMSG and IG Based WECS – Generator control – Performance improvements – Different schemes – AC voltage controllers Grid Integrated solar system – Maximum Power point tracking algorithms – DC Power conditioning converters – AC power conditioners – Line commutated inverters – Synchronized operation with grid supply – Harmonic problem – Harmonic filters and PF improvement – Need for Hybrid Systems – Range and type of Hybrid systems – Introduction to micro-grid.

TOTAL : 45

REFERENCE BOOKS

1. K.R.Padiyar, “HVDC Power Transmission Systems”, New Academic Science Ltd., February 2011.
2. J.Arrillaga, “High Voltage Direct Current Transmission”, IEE, 2nd Revised Edition, 1998.
3. P. Mohan Mathur, Rajiv K Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, John Wiley and Sons Inc., IEEE Press, USA, 2002.
4. Ned Mohan, Undeland and Robbins, “Power Electronics : Converters, Applications and Design”, Wiley India (P) Ltd., January 2007.
5. J.K.Kaldellis, “Stand-alone and Hybrid wind Energy Systems: Technology, Energy Storage and Applications”, Woodhead Publishing Ltd., Newdelhi, 2010.

11PE024 POWER QUALITY ENGINEERING

3 0 0 3

Objective:

To give exposure in the area of

- Basics of various power quality issues in the power systems.
- Various techniques of analysis (Wavelet)
- Methods of improvement of power quality

MODULE - I **15**

Power Quality Definitions and Fundamentals of Harmonics: Introduction – Power quality definitions: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation: common power frequency disturbances, Cures for low-frequency disturbances, Power acceptability curves (CBEMA and ITI).
Waveform distortions: Harmonic indices, inter-harmonics, voltage unbalance, flicker, Harmonic sources from commercial and industrial, Standards on harmonics, System response characteristics: System impedance, capacitor impedance, parallel resonance, series resonance loads, effects of resistance and resistive load, Effects of harmonic distortion: Impact on capacitors, transformers, motors, telecommunication.

MODULE - II **15**

Waveform Processing Techniques and Monitoring: Fundamental frequency characterisation: Curve-fitting algorithm, implementation, frequency estimation, R.M.S Error assessment, Fourier analysis: Convolution of harmonic phasors, sampled time functions, DFT, Efficiency of FFT algorithms, Wavelet transform, automation of disturbance reorganisation.
Monitoring considerations, Power quality measurement equipment: Types of instruments, wiring and grounding testers, disturbance analysers, spectrum and harmonic analyser, flicker meter, smart power quality monitor, transducer requirements, assessment of power quality measurement data: Off-line, On-line data assessment, Application of Intelligent systems.

MODULE - III **15**

Wiring, Grounding and Power Quality Improvement : Definitions, Reasons for grounding, Typical Wiring and grounding problems: Problems with conductors and connectors, missing safety ground, multiple neutral-to-ground connections, ground loops, Solutions to wiring and grounding problems: proper grounding practices, Rod, separately derived systems, grounding techniques for signal reference.
Harmonic filters: passive, Active and hybrid filters –Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method.

TOTAL: 45

REFERENCE BOOKS

1. Roger C.Dugan, “Electrical Power Systems Quality”, Tata McGraw-Hill, 2008.
2. J.Arrillaga,”Power system quality assessment”, John Wiley & Sons, 2001.
3. C.Sankaran, “Power Quality”, CRC Press, 2001.
4. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Academic Publishers, 2002.
5. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1994(2nd edition).
6. Power electronic converter harmonics –Derek A. Paice

11PE025 PROGRAMMING WITH VHDL

3 1 0 4

Objective:

- To understand and learn the Hardware Description Language
- To enable the students to implement, practical digital functional blocks using VHDL.
- To understand VHDL modeling of circuit and logic design, Subsystem design

MODULE - I **15**

VHDL modeling Concepts- Basic Modeling Constructs- Scalar Data Types and Operation- Concurrent Statements- Sequential Statements- Composite data types and operations.

MODULE - II **15**

Sub Programs: Procedures – Functions – Packages and Use Clauses – Generic Constants- Components- Generate Statement-Attributes- Guards and Blocks

MODULE - III **15**

Files and Input/Output- Test Benches- Design of ALU- Memory-MAC Unit. Case Study: Pipelined Accumulator Multiplier

Lecture: 45, Tutorial:15, TOTAL: 60

REFERENCE BOOKS

1. Peter J. Ashenden, " The Designer's Guide to VHDL (Systems on Silcon) , Volume: 3, Third Edition, Morgan Kaufmann Publishers ,2008
2. Roth C.H., "Digital System Design using VHDL", Thomson Learning, Singapore, 2001
3. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design", Second Edition, McGraw-Hill, New York, 2005
4. Perry Douglas L., "VHDL: Programming by Example", Fourth Edition, Tata McGraw-Hill, New Delhi, 2002.

11PE026 SPECIAL ELECTRICAL MACHINES AND CONTROL

3 0 0 3

Objective: To impart knowledge on

- Construction, Principle of operation, performance and control of switched reluctance motor.
- Construction, Principle of operation and performance of permanent Magnet synchronous Motor.
- Construction, Principle of operation and performance of synchronous reluctance motor and operation of vernier motor.
- Construction, Principle of operation, performance and controllers of permanent Magnet Brushless DC motors.
- Construction, Principle of operation and characteristics of stepper motor.

MODULE - I **15**

Switched Reluctance Motors: Constructional features – Principle of operation – Torque prediction – Inductance profile – Simple Application problem – Analysis – Types of Power controllers and converter topologies used – Current control schemes – Torque Speed Characteristics – Hysteresis and PWM – Phase current analysis for low, Medium and High speed operation – Microprocessor based control.

MODULE - II **15**

Permanent Magnet Synchronous Motors and Sychrel Motors: Permanent Magnet Motors – Classifications – PMSM - Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers - Converter - Volt-ampere requirements – Locus diagram and torque speed characteristics - Microprocessor based control – Constructional features – Synchrel – Types – Axial and Radial motors – Operating principle – Reluctance torque – Phasor diagram - Characteristics – Introduction to Vernier motor.

MODULE - III **15**

Permanent Magnet Brushless D.C. Motors and Stepper Motors: Principle of operation – Types – Comparison between conventional DC and PMBLDC – Electronic commutation – EMF and torque equations – Sensors for Rotor position – Power controllers – Motor characteristics and Computer control – Constructional features – Stepper motor – Types – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi stack configurations – Theory of torque predictions – Characteristics – Microprocessor based control.

TOTAL: 45

REFERENCE BOOKS

1. Miller T.J.E., “Brushless Permanent Magnet and Reluctance Motor Drives”, Clarendon Press, Oxford, 1989.
2. Kenjo T. and Nagamori S., “Permanent Magnet and Brushless DC Motors”, Clarendon Press, London, 1988.
3. Aearnley P. P., “Stepping Motors” A Guide to Motor Theory and Practice”, Peter Perengrinus, London, 1982.
4. Kenjo T., “Stepping Motors and Their Microprocessor Controls”, Clarendon Press, London, 1984.