UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.E. ELECTRICAL DRIVES AND EMBEDDED CONTROL

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA9122	Applied Mathematics for Electrical Engineers	3	1	0	4
2	EB9111	Analysis of Power Converters	3	0	0	3
3	EB9112	Dynamic Modelling, Analysis and Design of DC Drives	3	0	0	3
4	ET9113	Design of Embedded System	3	0	0	3
5	CO9112	System Theory	3	0	0	3
6	E1	Elective I	3	0	0	3
		TOTAL	**18**	**1**	**0**	**19**

SEMESTER II

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EB9121	Computer Aided Design of Power Electronic Circuits	3	1	0	4
2	EB9122	Dynamic Modelling, Analysis and Design of AC Drives	3	0	0	3
3	EB9123	Special Electrical Machines	3	0	0	3
4	EB9124	Control of Electric Drives	3	0	0	3
5	E2	Elective II	3	0	0	3
6	E3	Elective III	3	0	0	3
PRACTICAL						
7	EB9125	Electric Drives Laboratory	0	0	3	2
		TOTAL	**18**	**1**	**3**	**21**

SEMESTER III

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	E4	Elective IV	3	0	0	3
2	E5	Elective V	3	0	0	3
3	E6	Elective VI	3	0	0	3
PRACTICAL						
4	EB9131	Project Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER IV

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	EB9141	Project Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 67

ELECTIVES FOR ELECTRICAL DRIVES AND EMBEDDED CONTROL

SEMESTER I

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	HV9111	Electro Magnetic Field Computation and Modelling	3	1	0	4
2	PE9151	Advanced Power Semiconductor Devices	3	0	0	3
3	CO9111	Transducers and Measurements	3	0	0	3

SEMESTER II

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	EB9151	Micro System Design	3	0	0	3
2	PE9152	Power Quality	3	0	0	3
3	PE9124	Micro-Controller and DSP based System Design	3	0	0	3
4	PS9123	Flexible AC Transmission Systems	3	0	0	3
5	ET9153	Design of Embedded Control System	3	0	0	3
6	ET9122	Real Time Operating System	3	0	0	3

SEMESTER III

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	EB9152	Applications of MEMS Technology	3	0	0	3
2	PE9154	Power Electronics for Renewable Energy Systems	3	0	0	3
3	CO9154	Principles of Robotics	3	0	0	3
4	CO9157	System Identification and Adaptive Control	3	0	0	3
5	CO9151	Soft Computing Techniques	3	0	0	3
6	PS9155	Wind Energy Conversion Systems	3	0	0	3
7	HV9153	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3
8	ET9162	Computers in Networking and Digital Control	3	0	0	3
9	ET9161	Programming with VHDL	3	0	0	3

UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO VI SEMESTERS (PART TIME)

M.E. ELECTRICAL DRIVES AND EMBEDDED CONTROL

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	MA9122	Applied Mathematics for Electrical Engineers	3	1	0	4
2	EB9111	Analysis of Power Converters	3	0	0	3
3	EB9112	Dynamic Modelling, Analysis and Design of DC Drives	3	0	0	3
		TOTAL	**9**	**1**	**0**	**10**

SEMESTER II

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EB9121	Computer Aided Design of Power Electronic Circuits	3	1	0	4
2	EB9122	Dynamic Modelling, Analysis and Design of AC Drives	3	0	0	3
3	EB9123	Special Electrical Machines	3	0	0	3
		TOTAL	**9**	**1**	**0**	**10**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	ET9113	Design of Embedded System	3	0	0	3
2	CO9112	System Theory	3	0	0	3
3	E1	Elective I	3	0	0	3
		TOTAL	**9**	**0**	**0**	**9**

SEMESTER IV

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	EB9124	Control of Electrical Drives	3	0	0	3
2	E2	Elective II	3	0	0	3
3	E3	Elective III	3	0	0	3
PRACTICAL						

4	EB9125	Electric Drives Laboratory	0	0	3	2
		TOTAL	**9**	**0**	**3**	**11**

SEMESTER V

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	E4	Elective IV	3	0	0	3
2	E5	Elective V	3	0	0	3
3	E6	Elective VI	3	0	0	3
PRACTICAL						
4	EB9131	Project Phase I	0	0	12	6
		TOTAL	**9**	**0**	**12**	**15**

SEMESTER VI

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	EB9141	Project Phase II	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 67

ELECTIVES FOR ELECTRICAL DRIVES AND EMBEDDED CONTROL

SEMESTER III

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	HV9111	Electro Magnetic Field Computation and Modelling	3	1	0	4
2	PE9151	Advanced Power Semiconductor Devices	3	0	0	3
3	CO9111	Transducers and Measurements	3	0	0	3

SEMESTER IV

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	EB9151	Micro System Design	3	0	0	3
2	PE9152	Power Quality	3	0	0	3
3	PE9124	Micro-Controller and DSP based System Design	3	0	0	3
4	PS9123	Flexible AC Transmission Systems	3	0	0	3
5	ET9153	Design of Embedded Control System	3	0	0	3
6	ET9122	Real Time Operating System	3	0	0	3

SEMESTER V

SL NO.	COURSE CODE	COURSE TITLE	L	T	P	C
1	EB9152	Applications of MEMS Technology	3	0	0	3
2	PE9154	Power Electronics for Renewable Energy Systems	3	0	0	3
3	CO9154	Principles of Robotics	3	0	0	3
4	CO9157	System Identification and Adaptive Control	3	0	0	3
5	CO9151	Soft Computing Techniques	3	0	0	3
6	PS9155	Wind Energy Conversion Systems	3	0	0	3
7	HV9153	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3
8	ET9162	Computers in Networking and Digital Control	3	0	0	3
9	ET9161	Programming with VHDL	3	0	0	3

MA 9122 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS **L T P C**
3 1 0 4

1. ADVANCED MATRIX THEORY: **9**

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

2. LINEAR PROGRAMMING **9**

Formulation – Graphical Solution – Simplex Method – Two Phase Method – Transportation and Assignment Problems.

3. ONE DIMENSIONAL RANDOM VARIABLES **9**

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

4. QUEUEING MODELS **9**

Poisson Process – Markovian queues – Single and Multi Server Models – Little's formula - Machine Interference Model – Steady State analysis – Self Service queue.

5. COMPUTATIONAL METHODS IN ENGINEERING **9**

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme – Solution of wave equation.

L +T: 45+15 = 60

BOOKS FOR REFERENCE:

1. Bronson, R., Matrix Operation, Schaum's outline series, McGraw Hill, New York, (1989).
2. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi (2002).
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, Probability and Statistics for Engineers & Scientists, Asia, 8th Edition, (2007).
4. Donald Gross and Carl M. Harris, Fundamentals of Queueing theory, 2nd edition, John Wiley and Sons, New York (1985).
5. Grewal, B.S., Numerical methods in Engineering and Science, 7th edition, Khanna Publishers, 200

EB 9111 ANALYSIS OF POWER CONVERTERS **L T P C**
3 0 0 3

1. SINGLE PHASE AC-DC CONVERTERS **9**

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

2. THREE PHASE AC-DC CONVERTERS **9**

Uncontrolled, half controlled and fully controlled with R-L, R-L-E loads and free wheeling diodes – Inverter operation and its limit – Dual converter – Performance parameter effect of source impedance and overlap.

3. DC – DC CONVERTERS **9**

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – Time ratio and current limit control – Full bridge converter – Resonant and Quasi-resonant converters.

4. DC – AC CONVERTERS **9**

Voltage source inverters - Principle of operation of half and full bridge inverters – 180 degree and 120 degree conduction mode inverters – Voltage control of three phase inverters using various PWM techniques – Harmonics and various harmonic elimination techniques – Analysis with R-L, R-L-E loads – Multi level inverters.

5. AC – AC CONVERTERS **9**

Principle of operation of AC Voltage Controllers, Cycloconverters – Analysis with R-L, R-L-E loads – Introduction to Matrix converters.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Ned Mohan , Undeland and Robbin, “Power Electronics: Converters, Application and Design” A John Wiley and Sons, Inc., Newyork, 1995
2. Rashid M.H . “Power Electronics Circuits, Devices and Applications”, Prentice Hall of India, New Delhi, 1995

REFERENCES

1. P.C Sen .”Modern Power Electronics” Wheeler publishing Co ,First Edition ,New Delhi- 1998.
2. P.S.Bimbra , “Power Electronics”, Khanna Publishers, Eleventh Edition , 2003.
3. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.

EB 9112 DYNAMIC MODELLING, ANALYSIS AND DESIGN OF DC DRIVES L T P C
3 0 0 3

1. SELECTION OF ELECTRIC DRIVES 9

Equations governing motor load dynamics – Steady state and dynamic state stability – Four quadrant operation – Duty and Rating – Heating and cooling curves – Selection of electric drives for applications: Agricultural pumps, steel mills, paper mills, rolling mills, spinning mills, cement industries, chemical industries, refineries, shipping, power stations and automobiles.

2. PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION 9

General expression of stored magnetic energy and co-energy, force and torque - Example using singly and doubly excited systems. Calculation of air-gap mmf and per phase machine inductance using physical machine data.

3. DYNAMIC MODELLING OF DC MACHINES 9

Voltage and torque equations – Dynamic characteristics of permanent magnet and shunt DC motors – State equations – Solution of dynamic characteristic by Laplace transformation - Computer simulation.

4. CONVERTER CONTROL OF DC MOTORS 9

Analysis of separately excited DC motors fed from single phase and three phase converters operating in different modes and configurations – Dynamic and regenerative braking of DC drives – Design of closed-loop operation of rectifier fed DC drive systems.

5. CHOPPER CONTROL OF DC MOTORS 9

Analysis of series and separately excited DC motors fed from different Choppers with CLC and TRC strategies – Dynamic and regenerative braking of DC drives – Design of closed-loop operation of DC drive systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Paul C.Krause, OlegWasyzczuk, Scott D.Sudhoff ‘Analysis of Electric Machinery and Drive Systems” IEEE Press, Second Edition, 2002.
2. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002.
3. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer-Verlag, Berlin,1990.
4. Dubey,G.K. “Power Semiconductor controlled devices”, Prentice Hall International, New Jersey, 1989.

REFERENCES:

1.Samuel Seely, “Electromechanical Energy Conversion”, Tata McGraw Hill Publishing Company, 2000.
2. A.E.Fitzgerald,Charles Kingsley,Jr. and Stephen D.Umans, “Electric Machinery”, Tata McGraw Hill, Fifth Edition, 1992.

3. Generalized theory of Electrical Machines, P.S.Bimra, Khanna Publishers, 1995.
4. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.

ET 9113 DESIGN OF EMBEDDED SYSTEMS **L T P C**
3 0 0 3

1. EMBEDDED DESIGN LIFE CYCLE **9**

Product specification – Hardware / Software partitioning – Detailed hardware and software design – Integration – Product testing – Selection Processes – Microprocessor Vs Micro Controller – Performance tools – Bench marking – RTOS Micro Controller – Performance tools – Bench marking – RTOS availability – Tool chain availability – Other issues in selection processes.

2. PARTITIONING DECISION **9**

Hardware / Software duality – coding Hardware – ASIC revolution – Managing the Risk – Co-verification – execution environment – memory organization – System startup – Hardware manipulation – memory mapped access – speed and code density.

3. INTERRUPT SERVICE ROUTINES **9**

Watch dog timers – Flash Memory basic toolset – Host based debugging – Remote debugging – ROM emulators – Logic analyser – Caches – Computer optimisation – Statistical profiling

4. IN CIRCUIT EMULATORS **9**

Buller proof run control – Real time trace – Hardware break points – Overlay memory – Timing constraints – Usage issues – Triggers.

5. TESTING **9**

Bug tracking – reduction of risks & costs – Performance – Unit testing – Regression testing – Choosing test cases – Functional tests – Coverage tests – Testing embedded software – Performance testing – Maintenance.

TOTAL : 45 PERIODS

REFERENCE

1. Arnold S. Berger – “Embedded System Design”, CMP books, USA 2002.
2. Sriram Iyer, “Embedded Real time System Programming”
3. ARKIN, R.C., Behaviour-based Robotics, The MIT Press, 1998.

CO 9112 SYSTEM THEORY **L T P C**
3 0 0 3

1. STATE VARIABLE REPRESENTATION 9

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-No uniqueness of state model-State Diagrams-Physical System and State Assignment.

2. SOLUTION OF STATE EQUATION 9

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential-System modes-Role of Eigenvalues and Eigenvectors.

3. CONTROLLABILITY AND OBSERVABILITY 9

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

4. STABILTY 9

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

5. MODAL CONTROL 9

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems-The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL: 45 PERIODS

REFERENCES:

1. M. Gopal, “Modern Control System Theory”, New Age International, 2005.
2. K. Ogatta, “Modern Control Engineering”, PHI, 2002.
3. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill, 1999.
4. D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005.
5. John J. D’Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003.
6. Z. Bubnicki, ”Modern Control Theory”, Springer, 2005.

EB 9121 COMPUTER AIDED DESIGN OF POWER ELECTRONIC CIRCUITS **L T P C**
3 1 0 4

1. INTRODUCTION **9**

Importance of simulation – General purpose circuit analysis – Methods of analysis of power electronic systems – Review of power electronic devices and circuits.

2. ADVANCED TECHNIQUES IN SIMULATION **9**

Analysis of power electronic systems in a sequential manner – coupled and decoupled systems – Various algorithms for computing steady state solution in power electronic systems – Future trends in computer simulation.

3. MODELING OF POWER ELCTRONIC DEVICES **9**

Introduction – AC sweep and DC sweep analysis – Transients and the time domain analysis – Fourier series and harmonic components – BJT, FET, MOSFET and its model- Amplifiers and Oscillator – Non-linear devices.

4. SIMULATION OF CIRCUITS **9**

Introduction – Schematic capture and libraries – Time domain analysis – System level integration and analysis – Monte Carlo analysis – Sensitivity/stress analysis – Fourier analysis.

5. CASE STUDIES **9**

Simulation of Converters, Choppers, Inverters, AC voltage controllers, and Cyclo-converters feeding R, R-L, and R-L-E loads – computation of performance parameters: harmonics, power factor, angle of overlap.

L:45+ P:15=60

REFERENCES

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. John Keown “Microsim, Pspice and circuit analysis”-Prentice Hall Inc., 1998.

EB 9122 DYNAMIC MODELLING, ANALYSIS AND DESIGN OF AC DRIVES **L T P C**
3 0 0 3

1. REFERENCE FRAME THEORY **9**

Theory of transformation – Phase transformation and commutator transformation – Invariance of Power - Static and rotating reference frames – balanced steady-state voltage and torque equations using transformation theory.

2. DYNAMIC MODELLING OF INDUCTION MACHINES **9**

Induction machines – Equivalent circuit – Complete speed-torque characteristics - Voltage and torque equations in static and rotating reference frames – Analysis of steady state and dynamic operations - Dynamic performance under unbalanced/fault conditions - Computer simulation.

3. DYNAMIC MODELLING OF SYNCHRONOUS MACHINES **9**

Synchronous machines – Equivalent circuit – Machine reactances and time constants - Voltage and torque equations in static and rotating reference frames – Analysis of steady state and dynamic operations - Dynamic performances under unbalanced/fault conditions - Computer simulation.

4. INDUCTION MOTOR DRIVES **9**

Variable voltage operation – Variable frequency operation – Constant flux operation – Torque-Slip characteristics – Constant Torque and Constant power operation – Dynamic and regenerative braking of VSI fed drives – Power factor considerations – Field oriented control – Design of closed loop operation of Induction motor drive systems.

5. SYNCHRONOUS MOTOR DRIVES **9**

Need for leading PF operation – Open loop VSI fed drive and its characteristics – Self control – Torque control – Torque angle control – Power factor control – Brush less excitation systems – Starting methods – Field oriented control – Design of closed loop operation of Synchronous motor drive systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Paul C.Krause, OlegWasyzczuk, Scott D.Sudhoff ‘Analysis of Electric Machinery and Drive Systems” IEEE Press, Second Edition, 2002.
2. R.Krishnan,” Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002.
3. Bose.B.K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006.
4. Murphy J.M.D.,Turnbull F.G., “Thyristor control of AC Motors”, Peragamon Press,Oxford,1988.

REFERENCES:

1. Samuel Seely, “Electromechanical Energy Conversion”, Tata McGraw Hill Publishing Company, 2000.
2. A.E.Fitzgerald,Charles Kingsley, Jr. and Stephen D.Umans, “Electric Machinery”, Tata McGraw Hill,5th Edition,1992.
3. Generalized theory of Electrical Machines, P.S.Bimra, Khanna Publishers, 1995.
4. Dubey,G.K. “Power Semiconductor controlled devices”, Prentice Hall International, NewJersey,1989.
5. Ned Mohan, Advanced Electric Drives, Analysis, Control and Modelling using Simulink MNPERE, 2001.
6. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.

EB 9123 SPECIAL ELECTRICAL MACHINES **L T P C**
3 0 0 3

1. STEPPING MOTOR **9**

Constructional features – Principle of operation – Modes of excitation – Torque production in variable reluctance stepping motor - Dynamic characteristics – Drive systems and circuit for open loop control – Closed loop control of stepping motor.

2. SWITCHED RELUCTANCE MOTORS **9**

Constructional features – principle of operation – Torque equation – Power controllers – Characteristics and control microprocessor based controller.

3. SYNCHRONOUS RELUCTANCE MOTORS **9**

Constructional features: axial and radial air gap Motors – Operating principle – Reluctance torque – phasor diagram –motor characteristics.

4.PERMANENT MAGNET SYNCHRONOUS MOTROS **9**

Principle of operation –EMF –Power input and torque expressions –Phasor diagram – power controller-Torque speed characteristics-Self control –Vector control –current control schemes.

5. PERMANENT MAGNET BRUSHLESS DC MOTORS **9**

Commutation in DC motors, Difference between mechanical and electronic commutators- Hall sensors, Optical sensors - Multiphase Brushless motor –Square wave permanent magnet brushless motor drives –Torque and emf equation-Torque speed characteristics-Controllers –Microprocessors based controller

TOTAL: 45 PERIODS

REFERENCES

1. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives”,Clarendon Press, Oxford,1989.
2. Kenjo, T, “Stepping motors and their microprocessor control ”,Clarendon Press,Oxford 1989.
3. R.Krishnan, “Switched Reluctance Motors Drives: Modelling, Simulation, Analysis Design and Applications”, CRC Press, New York, 2001.

EB 9124 CONTROL OF ELECTRIC DRIVES **L T P C**
3 0 0 3

CONVERTER FED DC DRIVES **9**

Microcontroller hardware circuit, flow charts waveforms, Performance characteristics of dc drives fed through single phase converters, 3-phase converters, dual converters, 1-phase fully controlled converter and 3-phase fully controlled converter fed dc drive.

CHOPPER FED DC DRIVES **9**

Microcontroller hardware circuits and waveforms of various modes of operation of chopper fed DC drives.

INVERTER FED INDUCTION MOTOR DRIVE **9**

Microcomputer controlled VSI fed induction motor drive - Detailed power circuit, generation of firing pulses and firing circuit, flow charts and waveforms for 1-phase, 3-phase Non-PWM and 3-phase PWM VSI fed induction motor drives. Sampling techniques for PWM inverter.

MATHEMATICAL MODELING OF FREQUENCY CONTROLLED DRIVE **9**

Development of mathematical model for various components of frequency controlled induction drive, mathematical model of the system for steady state and dynamic behaviour, Study of stability based on the dynamic model of the system.

CLOSED LOOP CONTROL OF MICROCOMPUTER BASED DRIVES **9**

Voltage, Current, Torque and Speed measurements using digital measurement techniques. Types of controllers, position and velocity measurement algorithm, closed loop control of microcomputer based drives.

TOTAL : 45 PERIODS

TEXT BOOKS :

1. Bose.B.K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006.
2. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer- Verlag, Berlin,1990.
3. Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill, 1988.

REFERENCES:

1. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002.
2. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.
3. Dubey G.K., Power semiconductor controlled drives, Prentice-HALL 1989

4. Control of Electric Drives, Leonard W, Springer Verlag, NY, 1985
5. Bose B.K., Microcomputer control of power electronics and drives, IEEE Press, 1987.
6. Bose B.K., Adjustable Speed A.C. drives, IEEE Press, 1993.

EB 9125 ELECTRIC DRIVES LABORATORY **L T P C**
0 0 3 2

1. Micro controller based speed control of Converter/Chopper fed DC motor.

2. Micro controller based speed control of VSI fed three-phase induction motor.

3. Micro controller based speed control of Stepper motor.

4. DSP based speed control of BLDC motor.

5. DSP based speed control of SRM motor.

6. Self control operation of Synchronous motors.

7. Condition monitoring of three-phase induction motor under fault conditions.

8. Re-programmable Logic Devices and Programming

   (a) VHDL programming – Examples

   (b) Verilog HDL programming – Examples

   (c) Realisation of control logic for electric motors using FPGA.

9. Simulation of Four quadrant operation of three-phase induction motor.

10. Simulation of Automatic Voltage Regulation of three-phase Synchronous Generator.

P = 45, TOTAL = 45

EB 9131 PROJECT WORK (PHASE I) 0 0 12 6

EB 9141 PROJECT WORK (PHASE – II) 0 0 24 12

HV 9111 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING L T P C
3 1 0 4

1. INTRODUCTION 9

Review of basic field theory – electric and magnetic fields – Maxwell's equations – Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

2. SOLUTION OF FIELD EQUATIONS I 9

Limitations of the conventional design procedure, need for the field analysis based design, problem definition , solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

3. SOLUTION OF FIELD EQUATIONS II 9

Finite element method (FEM) – Differential/ integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

4. FIELD COMPUTATION FOR BASIC CONFIGURATIONS 9

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Energy for basic configurations.

5. DESIGN APPLICATIONS 9

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

TOTAL : 45 PERIODS

REFERENCES

1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
2. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer-
   Verlage, 1992.

3. Nicola Biyanchi , “Electrical Machine analysis using Finite Elements”, Taylor and Francis Group, CRC Publishers, 2005.
4. S.J Salon, “Finite Element Analysis of Electrical Machines.” Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India
5. User manuals of MAGNET, MAXWELL & ANSYS software.
6. Silvester and Ferrari, “Finite Elements for Electrical Engineers” Cambridge University press, 1983.

PE 9151 ADVANCED POWER SEMICONDUCTOR DEVICES **L T P C**
3 0 0 3

1. INTRODUCTION **9**

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

2. CURRENT CONTROLLED DEVICES **9**

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

3. VOLTAGE CONTROLLED DEVICES **9**

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

4. FIRING AND PROTECTING CIRCUITS **9**

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

5. THERMAL PROTECTION **9**

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

TOTAL : 45 PERIODS

TEXT BOOKS

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

REFERENCES

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001.
2. Mohan, Undcland and Robins, "Power Electronics – Concepts, applications and Design, John Wiley and Sons, Singapore, 2000.

CO 9111 TRANSDUCERS AND MEASUREMENTS **L T P C**
3 0 0 3

1. RESISTIVE, INDUCTIVE AND CAPACITIVE ELEMENTS 9

Potentiometric, strain-gage and electrode elements – Inductive and Capacitive elements: structures, equivalent circuits and characteristics, single, differential and angle displacement elements, displacement to phase converters, and proximity elements, magnetostrictive elements, temperature instabilities and features.

2. TRANSFORMER, ELECTRODYNAMIC, SERVO AND RESONANT ELEMENTS 9

Transformer elements: Single core, differential, rotating coil and synchro transformers, weak-field sensors - Electrodynamic elements: Moving-coil, variable-reluctance- - Resonant elements: vibrating strings, vibrating beams, vibrating cylinders, piezoelectric resonators, acoustical resonators, microwave cavity resonators.

3. MECHANICAL, ACOUSTICAL AND FLOWMETERING ELEMENTS 9

Stresses state of diaphragm, dynamic characteristics of diaphragm, temperature drifts, sensitivity drifts, sensitivity to acceleration – Inertial mass elements: sensing and transduction elements of flowmeters, electromagnetic flowmeters, nanoelectrode electromagnetic flowmeters -ultrasonic elements – Acoustical elements: acoustical filters.

4. OPTICAL MICROSTRUCTURE SENSORS 9

Photo detectors: Thermal detectors, pneumatic detectors, pyroelectric detectors, photoemissive devices, photo conductive detectors, photo diodes, avalanche photo diodes, schottky photo diodes, photo transistors – Fiber optic sensors: Fibers as light guides, reflection sensors, Intrinsic multimode sensor, temperature sensor, phase modulated sensor, fiber optic gyroscopes and other fiber sensors

5.MISCELLANEOUS MINIATURE SENSORS 9

Magnetic sensors: Hall Effect sensors, magnetoresistors and other sensors – Solid state chemical sensors: Silicon based sensors, metal oxide sensors, solid electrolyte sensors, membranes – Electromechanical micro sensors and basic factors of design

TOTAL : 45 PERIODS

REFERENCES:

1. Alexander D Khazan, “Transducers and their elements – Design and application”, PTR Prentice Hall, 1994.
2. Pavel Ripka and Alois Tipek,“Modern sensors hand book”, Instrumentation and measurement series, ISTE Ltd., 2007
3. David Fraden. , PHI, 2004 “ Hand book of Modern Sensors, Physics,Design and Applications”, Third Edition, Springer India Pvt.Ltd, 2006.

EB 9151 MICRO SYSTEM DESIGN **L T P C**
3 0 0 3

1. LITHOGRAPHY AND PATTERN TRANSFER **9**

Photolithography – Alternative and emerging lithographic technologies – Pattern transfer with etching and additive techniques.

2.BULK MICROMACHNING **9**

Silicon crystallography – Silicon as a substance and structural material - Wet isotropic and anisotropic etching, Etching with bias – Etch stop techniques – problems in bulk micromachining - examples.

3.SURFACE MICROMACHINING **9**

Mechanical properties of thin films – surface micromachining processes – poly-silicon micromachining – Non-poly silicon micromachining – materials – examples.

4. LIGA **9**

LIGA Processes – Synchrotron orbital radiation – X-ray masks – LIGA Processes steps and materials – LIGA Applications.

5. PACKAGING TESTING AND CALIBRATION **9**

Packaging: Dicing – Wafer level packaging – wafer bonding – Connections between layers – self assembly – higher level of packaging – Testing and Calibration

TOTAL : 45 PERIODS

REFERENCES

1. Stephen D.Senturia, “ Micro System Design “,Kulwar Academic Publishers, 2001
2. Marc Madou , “Fundamentals of Microfabrication”,CRC Press, Gregory Kovacs, 1997.
3. Boston , “Micromachined Transducers Sourcebook”,WCB McGraw Hill, 1998.
4. M.H.Bao “Micromechanical transducers: Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.

PE 9152 POWER QUALITY **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Introduction – Characterisation of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

2. NON-LINEAR LOADS **9**

Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

3. MEASUREMENT AND ANALYSIS METHODS **9**

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

4. ANALYSIS AND CONVENTIONAL MITIGATION METHODS **9**

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

5. POWER QUALITY IMPROVEMENT **9**

Utility-Customer interface –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 – Custom power park – Status of application of custom power devices.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition)
3. Power Quality - R.C. Duggan
4. Power system harmonics –A.J. Arrillga
5. Power electronic converter harmonics –Derek A. Paice

PE 9124 MICRO-CONTROLLER AND DSP BASED SYSTEM DESIGN **L T P C**
3 0 0 3

1. PIC 16C7X MICROCONTROLLER **9**

Architecture memory organization – Addressing modes – Instruction set – Programming techniques – simple programs

2. PERIPHERALS OF PIC 16C7X **9**

Timers – interrupts – I/O ports – I^2C bus for peripheral chip access – A/D converter – UART

3. MOTOR CONTROL SIGNAL PROCESSORS **9**

Introduction- System configuration registers - Memory Addressing modes - Instruction set – Programming techniques – simple programs

4. PERIPHERALS OF SIGNAL PROCESSORS **9**

General purpose Input/Output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB)- PWM signal generation

5. APPLICATIONS OF PIC AND SIGNAL PROCESSORS **9**

Voltage regulation of DC-DC converters- Stepper motor and DC motor control- Clarke's and parks transformation-Space vector PWM- Control of Induction Motors and PMSM.

TOTAL : 45 PERIODS

TEXT BOOKS:

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

2. Hamid A.Toliyat, Steven Campbell, 'DSP based electromechanical motion control',

CRC Press

PS 9123 FLEXIBLE AC TRANSMISSION SYSTEMS L T P C
3 0 0 3

1. INTRODUCTION 9

Reactive power control in electrical power transmission lines -Uncompensated transmission line - series compensation – Basic concepts of static Var Compensator (SVC) – Thyristor Switched Series capacitor (TCSC) – Unified power flow controller (UPFC).

2. STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of svc for power flow and transient stability – Applications: Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability.

3. THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping-SSR Mitigation.

4. VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability. SSSC-operation of SSSC and the control of power flow –Modelling of SSSC in load flow and transient stability studies. Applications: SSR Mitigation-UPFC and IPFC

5. CO-ORDINATION OF FACTS CONTROLLERS 9

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

TOTAL : 45 PERIODS

REFERENCES

1. R.Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi-
3. K.R.Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International(P) Limited, Publishers, New Delhi, 2008
4. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

ET 9153 DESIGN OF EMBEDDED CONTROL SYSTEM **L T P C**
3 0 0 3

1.EMBEDDED SYSTEM ORGANIZATION **9**

Embedded computing – characteristics of embedded computing applications – embedded system design challenges; Build process of Realtime Embedded system – Selection of processor; Memory; I/O devices-Rs-485, MODEM, Bus Communication system using I^2C, CAN, USB buses, 8 bit –ISA, EISA bus;

2.REAL-TIME OPERATING SYSTEM **9**

Introduction to RTOS; RTOS- Inter Process communication, Interrupt driven Input and Output -Nonmaskable interrupt, Software interrupt; Thread – Single, Multithread concept; Multitasking Semaphores.

3.INTERFACE WITH COMMUNICATION PROTOCOL **9**

Design methodologies and tools – design flows – designing hardware and software Interface . – system integration; SPI, High speed data acquisition and interface-SPI read/write protocol, RTC interfacing and programming;

4.DESIGN OF SOFTWARE FOR EMBEDDED CONTROL **9**

Software abstraction using Mealy-Moore FSM controller, Layered software development, Basic concepts of developing device driver – SCI – Software - interfacing & porting using standard C & C++ ; Functional and performance Debugging with benchmarking Real-time system software – Survey on basics of contemporary RTOS – VXWorks, UC/OS-II

5. CASE STUDIES WITH EMBEDDED CONTROLLER **9**

Programmable interface with A/D & D/A interface; Digital voltmeter, control- Robot system; - PWM motor speed controller, serial communication interface.

TOTAL : 45 PERIODS

REFERENCES:

1. Steven F. Barrett, Daniel J. Pack, "Embedded Systems – Design and Applications with the 68HC 12 and HCS12", Pearson Education, 2008.

2. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill, 2006.
3. Micheal Khevi, “The M68HC11 Microcontroller application in control,Instrumentation & Communication”, PH NewJersy, 1997.
4. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, “PIC Microcontroller and Embedded Systems- Using Assembly and C for PIC18”, Pearson Education,2008.
5. Steven F.Barrett,Daniel J.Pack,”Embedded Systems-Design & Application with the 68HC12 & HCS12”, Pearson Education,2008.
6. Daniel W. Lewis, “Fundamentals of Embedded Software”, Prentice Hall India, 2004.
7. Jack R Smith “Programming the PIC microcontroller with MBasic” Elsevier, 2007.
8. Keneth J.Ayala, “The 8086 Microprocessor: Programming & Interfacing the PC”, Thomson India edition, 2007.

ET 9122 REAL TIME OPERATING SYSTEMS **L T P C**
3 0 0 3

1. REVIEW OF OPERATING SYSTEMS **9**

Basic Principles - Operating System structures – System Calls – Files – Processes – Design and Implementation of processes – Communication between processes – Introduction to Distributed operating system – Distributed scheduling.

2. OVERVIEW OF RTOS **9**

RTOS Task and Task state - Process Synchronisation- Message queues – Mail boxes - pipes – Critical section – Semaphores – Classical synchronisation problem – Deadlocks -

3. REAL TIME MODELS AND LANGUAGES **9**

Event Based – Process Based and Graph based Models – Real Time Languages – RTOS Tasks – RT scheduling - Interrupt processing – Synchronization – Control Blocks – Memory Requirements.

4. REAL TIME KERNEL **9**

Principles – Design issues – Polled Loop Systems – RTOS Porting to a Target – Comparison and study of various RTOS like QNX – VX works – PSOS – C Executive – Case studies.

5. RTOS APPLICATION DOMAINS **9**

RTOS for Image Processing – Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems.

TOTAL : 45 PERIODS

REFERENCES:

1. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill, 2006.

2. Herma K., “Real Time Systems – Design for distributed Embedded Applications”,

Kluwer Academic, 1997.

3 Charles Crowley, “Operating Systems-A Design Oriented approach” McGraw Hill 1997.

4 C.M. Krishna, Kang, G.Shin, “Real Time Systems”, McGraw Hill, 1997.

5. Raymond J.A.Bhur, Donald L.Bailey, “An Introduction to Real Time Systems”, PHI 1999.

6. Mukesh Sighal and N G Shi “Advanced Concepts in Operating System”, McGraw Hill 2000.

EB 9152 APPLICATIONS OF MEMS TECHNOLOGY L T P C
3 0 0 3

1. MEMS: Micro-fabrication, Materials and Electro-mechanical concepts 9

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

2. Electrostatic Sensors and Actuation 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

3. Thermal Sensing and Actuation 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

4. Piezoelectric sensing and actuation 9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

5. CASE STUDIES 9

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.

TOTAL : 45 PERIODS

REFERENCES

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.

2. Marc Madou , “Fundamentals of microfabrication”,CRC Press, 1997.

3.Boston , “Micromachined Transducers Sourcebook”,WCB McGraw Hill, 1998.

4.M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.

PE 9154 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

2. ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION **9**

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

3. POWER CONVERTERS **9**

Solar: Block diagram of solar photo voltaic system -Principle of operation: 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.

4. ANALYSIS OF WIND AND PV SYSTEMS **9**

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system

5. HYBRID RENEWABLE ENERGY SYSTEMS **9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS

REFERENCES:

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

CO 9154 PRINCIPLES OF ROBOTICS **L T P C**
3 0 0 3

1. INTRODUCTION AND TERMINOLOGIES: **9**
Definition-Classification-History- Robots components-Degrees of freedom-Robot joints-coordinates- Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors-proximity and range sensors-social issues

2. KINEMATICS **9**
Mechanism-matrix representation-homogenous transformation-DH representation-Inverse kinematics-solution and programming-degeneracy and dexterity

3. DIFFERENTIAL MOTION & VELOCITIES **9**
Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Design-Lagrangian mechanics-dynamic equations-static force analysis

4. ROBOT CONTROL SYSTEM **9**
Sensor characteristics- Hydraulic, Pneumatic and electric actuators-trajectory planning-decentalised PID control- non-linear decoupling control

5. IMAGE PROCESSING & VISION SYSTEMS **9**
Two and three dimensional images-spatial and frequency domain representation-noise and edges- convolution masks-Processing techniques-thersholding-noise reduction-edge detection-segmentation-Image analysis and object recognition

TOTAL : 45 PERIODS

REFERENCES

1. Saeed B. Niku ,''Introduction to Robotics '', Pearson Education, 2002
2. Fu, Gonzalez and Lee Mcgrahill ,''Robotics '', international
3. R.D. Klafter, TA Chmielewski and Michael Negin, "Robotic Engineering, An Integrated approach", Prentice Hall of India, 2003.

CO 9157 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL **L T P C**

3 0 0 3

1. MODELS FOR INDENTIFICATION **9**

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

2. NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON **9**

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

3. NON-LINEAR IDENTIFICATION AND MODEL VALIDATION **9**

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

4. ADAPTIVE COTROL AND ADAPTATION TECHNIQUES **9**

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

5. CASE STUDIES **9**

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

TOTAL : 45 PERIODS

REFERENCES

1. Ljung," System Identification Theory for the User", PHI, 1987.
2. Torsten Soderstrom, Petre Stoica, "System Identification", prentice Hall ` International (UK) Ltd,1989.

3. Astrom and Wittenmark," Adaptive Control ", PHI
4. William S. Levine, " Control Hand Book".
5. Narendra and Annasamy," Stable Adaptive Control Systems, Prentice Hall, 1989.

CO 9151 SOFT COMPUTING TECHNIQUES **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

2.ARTIFICIAL NEURAL NETWORKS **9**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

3. FUZZY LOGIC SYSTEM **9**

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control for nonlinear time-delay system.

4. GENETIC ALGORITHM **9**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and anD-colony search techniques for solving optimization problems.

5. APPLICATIONS **9**

GA application to power system optimisation problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox.
Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

TOTAL : 45 PERIODS

REFERENCES

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. KOSKO,B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

PS 9155 WIND ENERGY CONVERSION SYSTEMS L T P C
3 0 0 3

1. INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

2. WIND TURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

3. FIXED SPEED SYSTEMS 9

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model-Generator model for Steady state and Transient stability analysis.

4. VARIABLE SPEED SYSTEMS 9

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

5. GRID CONNECTED SYSTEMS 9

Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

TOTAL : 45 PERIODS

REFERENCES

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990

2. Ion Boldea, “Variable speed generators”, Taylor & Francis group, 2006.
3. E.W.Golding “The generation of Electricity by wind power”, Redwood burn Ltd., Trowbridge,1976.
4. S.Heir “Grid Integration of WECS”, Wiley 1998.

HV 9153 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Sources of EMI, Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC)- EMC regulation- typical noise path- use of network theory- methods of eliminating interferences.

2. METHOD OF HARDENING **9**

Cabling –capacitive coupling- inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds- single point and multipoint ground systems- hybrid grounds- functional ground layout – grounding of cable shields- ground loops-guard shields.

3. BALANCING, FILTERING AND SHIELDING **9**

Power supply decoupling- decoupling filters-amplifier filtering –high frequency filtering- shielding – near and far fields- shielding effectiveness- absorption and reflection loss, Shielding with magnetic material- conductive gaskets, windows and coatings- grounding of shields.

4. DIGITAL CIRCUIT NOISE AND LAYOUT **9**

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.

5.ELECTROSTATIC DISCHARGE,STANDARDS AND LABORATORY TECHNIQUES9

Static Generation- human body model- static discharges-ED protection in equipment design- ESD versus EMC, Industrial and Government standards – FCC requirements – CISPR recommendations-Laboratory techniques- Measurement methods for field strength-EMI.

TOTAL : 45 PERIODS

REFERENCES

1. Henry W.Ott, “ Noise reduction techniques in electronic systems”, John Wiley & Sons, 1989.

2. Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc. (685 canton street, Norwood, MA 020062 USA) 1987.
3. Bridges, J.E Milleta J. and Ricketts.L.W., “EMP Radiation and Protective techniques”, John Wiley and sons, USA 1976.
4. IEEE National Symposium on “Electromagnetic Compatibility”, IEEE, 445, hoes Lane, Piscataiway, NJ 08855.

ET 9162 COMPUTERS IN NETWORKING AND DIGITAL CONTROL **L T P C**
3 0 0 3

1. NETWORK FUNDAMENTALS: **9**

Data communication networking – Data transmission concepts – Communication networking - Overview of OSI- TCP/IP layers – IP addressing - DNS – Packet Switching – Routing –Fundamental concepts in SMTP, POP, FTP, Telnet, HTML, HTTP, URL, SNMP,ICMP.

2. DATA COMMUNICATION: **9**

Sensor data acquisition, Sampling, Quantization, Filtering ,Data Storage, Analysis using compression techniques, Data encoding – Data link control – Framing, Flow and Error control, Point to point protocol, Routers, Switches , Bridges – MODEMs, Network layer –Congestion control , Transport layer- Congestion control, Connection establishment.

3. VIRTUAL INSTRUMENTATION: **9**

Block diagram and Architecture – Data flow techniques – Graphical programming using GUI – Real time system – Embedded controller – Instrument drivers – Software and hardware simulation of I/O communication blocks – ADC/DAC – Digital I/O – Counter , Timer, Data communication ports.

4. MEASUREMENT AND CONTROL THROUGH INTERNET: **9**

Web enabled measurement and control-data acquisition for Monitoring of plant parameters through Internet – Calibration of measuring instruments through Internet, Web based control – Tuning of controllers through Internet

5. VI BASED MEASUREMENT AND CONTROL: **9**

Simulation of signal analysis & controller logic modules for Virtual Instrument control – Case study of systems using VI for data acquisition, Signal analysis, controller design, Drives control.

TOTAL : 45 PERIODS

REFERENCES:

1. Wayne Tomasi, “Introduction to Data communications and Networking” Pearson Education, 2007.
2. Al Williams, “Embedded Internet Design”, Second Edition, TMH, 2007.
3. Douglas E.Comer, “Internetworking with TCP/IP, Vol. 1”, Third Edition, Prentice Hall, 1999.
4. Cory L. Clark, “LabVIEW Digital Signal Processing and Digital Communication”, TMH edition 2005.

5. Behrouza A Forouzan,"Data Communications and Networking" Fourth edition, TMH, 2007.
6. Krishna Kant,"Computer based Industrial control",PHI,2002.
7. Gary Johnson, "LabVIEW Graphical Programming", Second edition, McGraw Hill, Newyork, 1997.
8. Kevin James, "PC Interfacing and Data Acquisition: Techniques for measurement, Instrumentation and control, Newnes, 2000.
9. Cory L. Clark,"LabVIEW Digital Signal processing and Digital Communications" Tata McGRAW-HILL edition, 2005.

ET 9161 PROGRAMMING WITH VHDL **L T P C**
3 0 0 3

1. VHDL FUNDAMENTALS **9**

Fundamental concepts- Modeling digital system-Domain and levels of modeling-modeling languages-VHDL modeling concepts-Scalar Data types and operations- constants and Variable-Scalar Types- Type Classification-Attributes and scalar types-expression and operators-Sequential statements.

2. DATA TYPES AND BASIC MODELING CONSTRUCTS **9**

Arrays- unconstrained array types-array operations and referencing- records - Access Types- Abstract Date types- -basic modeling constructs-entity declarations-Architecture bodies-behavioral description-structural descriptions-design Processing, case study: A pipelined Multiplier accumulator.

3. SUBPROGRAMS , PACKAGES AND FILES **9**

Procedures-Procedure parameters- Concurrent procedure call statements – Functions –Overloading –visibility of Declarations-packages and use clauses-Package declarations-package bodies-use clauses-Predefined aliases-Aliases for Data objects-Aliases for Non-Data items-Files- I/O-Files. Case study: A bit vector arithmetic Package.

4. SIGNALS, COMPONENTS, CONFIGURATIONS. **9**

Basic Resolved Signals-IEEE std_Logic_1164 resolved subtypes- resolved Signal Parameters - Generic Constants- Parameterizing behavior-Parameterizing structure-components and configurations-Generate Statements-Generating Iterative structure-Conditionally generating structure-Configuration of generate statements-case study: DLX computer Systems.

5. DESIGN WITH PROGRAMMABLE LOGIC DEVICES **9**

Realization of -Micro controller CPU.- Memories-I/O devices-MAC-Design,synthesis,simulation and testing.

TOTAL : 45 PERIODS

REFERENCES

1. Peter J.Ashenden, "The Designer's guide to VHDL", Morgan Kaufmann publishers,San Francisco,Second Edition, May 2001.
2. Zainalabedin navabi, "VHDL Analysis ans modeling of Digital Systems", McGraw Hill international Editions, Second Editions, 1998.

3. Charles H Roth, Jr. “Digital system Design using VHDL”, Thomson ,2006.
4. Douglas Perry, “VHDL Programming by Example”, Tata McGraw Hill,4th Edition 2002.
5. Navabi.Z., “VHDL Analysis and Modeling of Digital Systems”, McGraw International, 1998.
6. Peter J Ashendem, “The Designers Guide to VHDL”, Harcourt India Pvt Ltd, 2002
7. Skahill. K, “VHDL for Programmable Logic”, Pearson education, 1996.