UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.E. CONTROL AND INSTRUMENTATION

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.	CO9111	Transducers and Measurements	3	0	0	3
3.	CO9112	System theory	3	0	0	3
4.	CO9113	Control System Design	3	1	0	4
5.	ET9112	Micro controller based System Design	3	0	0	3
6.	E1	Elective I	3	0	0	3
		TOTAL	**18**	**2**	**0**	**20**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	CO9121	Computer Aided Design of Instrumentation Systems	2	0	2	4
2.	CO9122	Digital instrumentation	3	0	0	3
3.	CO9123	Process control and instrumentation	3	1	0	4
4.	CO9124	Nonlinear control	3	0	0	3
5.	E2	Elective II	3	0	0	3
6.	E3	Elective III	3	0	0	3
PRACTICAL						
7.	CO9125	Digital Control and instrumentation lab	0	0	3	2
		TOTAL	**17**	**1**	**5**	**22**

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.	CO9131	Project Work 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.	CO9141	Project Work Phase II	0	0	24	12
		TOTAL	**0**	**0**	**12**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD THE DEGREE = 69

ELECTIVES FOR M.E CONTROL AND INSTRUMENTATION

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1.	ET9111	Advanced Digital System Design	3	0	0	3
2.	CO9151	Soft Computing Techniques	3	0	0	3
3.	EB9111	Analysis of Power converters	3	0	0	3

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
4.	EB9123	Special Electrical Machines	3	0	0	3
5.	ET9159	Advanced Digital Signal Processing	3	0	0	3
6.	ET9122	Real Time Operating System	3	0	0	3
7.	CO9152	Multi Sensor Data Fusion	3	0	0	3
8.	ET9113	Design of Embedded Systems	3	0	0	3
9.	EB9124	Control of Electric Drives	3	0	0	3

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
10.	HV9111	Electromagnetic Field Computation & Modeling	3	1	0	4
11.	HV9153	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3
12.	CO9153	Micro Electro Mechanical Systems	3	0	0	3
13.	CO9154	Principles of Robotics	3	0	0	3
14.	CO9155	Optimal Control and Filtering	3	0	0	3
15.	CO9156	Advanced topics in Nonlinear Control	3	0	0	3
16.	CO9157	System Identification and Adaptive control	3	0	0	3
17.	ET9161	Programming with VHDL	3	0	0	3
18.	CO9158	Digital Image Processing	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 Serve r 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

REFERENCES:

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

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.

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.

CO 9113 CONTROL SYSTEM DESIGN **LT P C**
3 1 0 4

1. CONVENTIONAL DESIGN METHODS 9

Design specifications- PID controllers and compensators- Root locus based design-Bode based design-Design examples

2. DESIGN IN DISCRETE DOMAIN 9

Sample and Hold-Digital equivalents-Impulse and step invariant transformations-Methods of discretisation-Effect of sampling- Direct discrete design – discrete root locus Design examples

3. OPTIMAL CONTROL 9

Formation of optimal control problems-results of Calculus of variations- Hamiltonian formulation-solution of optimal control problems- Evaluation of Riccati's equation State and output Regulator problems-Design examples

4. DISCRETE STATE VARIABLE DESIGN 9

Discrete pole placement- state and output feedback-estimated state feedback-discrete optimal control- dynamic programming-Design examples

5. STATE ESTIMATION 9

State Estimation Problem -State estimation- Luenberger's observer-noise characteristics- Kalman-Bucy filter-Separation Theorem-Controller Design-Wiener filter-Design examples.

L=45, T=15, Total= 60

REFERENCES

1. M. Gopal "Modern control system Theory" New Age International, 2005.
2. Benjamin C. Kuo "Digital control systems", Oxford University Press, 2004.
3. G. F. Franklin, J. D. Powell and A. E. Naeini "Feedback Control of Dynamic Systems", PHI (Pearson), 2002.
4. Graham C. Goodwin, Stefan F. Graebe and Mario E. Salgado "Control system Design", PHI (Pearson), 2003.
5. G. F. Franklin, J. D. Powell and M Workman, "Digital Control of Dynamic Systems", PHI (Pearson), 2002.
6. B.D.O. Anderson and J.B. Moore., 'Optimal Filtering', Prentice hall Inc., N.J., 1979.
7. Loan D. Landau, Gianluca Zito," Digital Control Systems, Design, Identification and Implementation", Springer, 2006.

ET 9112 MICRO CONTROLLER BASED SYSTEM DESIGN **L T P C**

3 0 0 3

AIM

To expose the students to the fundamentals of microcontroller based system design.

OBJECTIVES

To impart knowledge on

i. 8051 Microcontroller based system design.
ii. Microchip PIC 8 bit microcontroller based system Design

1. 8051 ARCHITECTURE 9

Architecture – memory organization – addressing modes – instruction set – Timers - Interrupts - I/O ports, Interfacing I/O Devices – Serial Communication.

2. 8051 PROGRAMMING 9

Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOSLite – FullRTOS –Task creation and run – LCD digital clock/thermometer using FullRTOS

3. PIC MICROCONTROLLER 9

Architecture – memory organization – addressing modes – instruction set – PIC progrmming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, MP-LAB.

4. PERIPHERAL OF PIC MICROCONTROLLER 9

Timers – Interrupts, I/O ports- I^2C bus-A/D converter-UART- CCP modules -ADC, DAC and Sensor Interfacing –Flash and EEPROM memories.

5. SYSTEM DESIGN – CASE STUDY 9

Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling AC appliances –Measurement of frequency - Stand alone Data Acquisition System.

TOTAL : 45 PERIODS

REFERENCES:

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008
2. John Iovine, ‘PIC Microcontroller Project Book ’, McGraw Hill 2000
3. Myke Predko, “Programming and customizing the 8051 microcontroller”, Tata McGraw Hill 2001.

CO 9121 COMPUTER AIDED DESIGN OF INSTRUMENTATION SYSTEMS L T P C
2 0 2 4

1. DATA ACQUISITION AND INSTRUMENT INTERFACE 9

Programming and simulation of Building block of instrument Automation system – Signal analysis, I/O port configuration with instrument bus protocols - ADC, DAC, DIO, counters & timers, PC hardware structure, timing, interrupts, DMA, software and hardware installation, current loop, RS 232/RS485, GPIB, USB protocols,

2. VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES 9

Block diagram and architecture of a virtual instrument, Graphical programming in data flow, comparison with conventional programming, Vis and sub-Vis, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

3. DESIGN TEST & ANALYSIS 9

Spectral estimation using Fourier Transform, power spectrum, correlation methods, Stability analysis, Fault analysis –Sampling, Data Parity and error coding checks, Synchronization testing – Watch dog timer, DMA method – Real-time Clocking, Noise- Gaussian, White analysis

4. PC BASED INSTRUMENTATION 9

Introduction – Evolution of signal standard – HART Communication protocol – Communication modes – HART networks – control system interface – HART commands – HART field controller implementation – HART and the OSI model

5. SIMULATION OF PHYSICAL SYSTEMS 9

Simulation of linear & Non-linear models of systems, Hardware in loop simulation of physical systems using special softwares.

L=30, P=30,Total=60

REFERENCES:

1. K. Ogatta, "Modern control Engineering", Fourth edition, Perason education 2002.
2. Dorf and Bishop, "Modern Control Engineering", Addison Weseley, 1998.
3. Patrick H. Garrett," High performance Instrumentation and Automation", CRC Press, Taylor & Francis Group, 2005.
4. MAPLE V programming guide
5. MATLAB/SIMULINK user manual
6. MATHCAD/VIS SIM user manual.
7. LABVIEW simulation user manual

CO 9122 DIGITAL INSTRUMENTATION **L T P C**
3 0 0 3

1. DATA ACQUISITION SYSTEMS **9**

Overview of A/D converter, types and characteristics – Sampling , Errors. Objective – Building blocks of Automation systems –Counters – Modes of operation- Frequency, Period, Time interval measurements, Prescaler, Heterodyne converter for frequency measurement, Single and Multi channel Data Acquisition systems.

2. INTERFACING AND DATA TRANSMISSION **9**

Data transmission systems – 8086 Microprocessor based system design – Peripheral Interfaces – Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

3. INSTRUMENTATION BUS **9**

Introduction, Modem standards, Basic requirements of Instrument Bus standards, Bus communication, interrupt and data handshaking , Interoperability, interchangeability for RS-232, USB, RS-422, RS-485.

4. PARALLEL PORT BUSES **9**

Field bus, Mod bus, GPIB, IEEE-488, VME, VXI, Network buses – Ethernet – TCP/IP protocols; CAN bus- basics, Message transfer, Fault confinement.

5. CASE STUDIES **9**

PC based DAS, Data loggers, PC based industrial process measurements like flow, temperature, pressure and level development system, CRT interface and controller with monochrome and colour video display.

TOTAL : 45 PERIODS

REFERENCES:

1. A.J. Bouwens, “Digital Instrumentation” , TATA McGraw-Hill Edition, 1998.
2. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice-Hall India, 2005.
3. H S Kalsi, “Electronic Instrumentation” Second Edition, Tata McGraw-Hill,2006.
4. Joseph J. Carr, “Elements of Electronic Instrumentation and Measurement” Third Edition, Pearson Education, 2003.
5. Buchanan, “Computer busses”, Arnold, London,2000.
6. Jonathan W Valvano, “Embedded Microcomputer systems”, Asia Pvt. Ltd., Brooks/Cole, Thomson, 2001.

CO 9123 PROCESS CONTROL AND INSTRUMENTATION L T P C

3 1 0 4

1. PROCESS DYNAMICS 9

Introduction to process control-objective of modelling-models of industrial process-hydraulic tanks-fluid flow systems-mixing process-chemical reactions-thermal systems-heat exchangers and distillation column.

2. CONTROL ACTIONS AND CONTROLLER TUNING 9

Basic control actions-on/off, P, P+I, P+I+D, floating control-pneumatic and electronic controllers- controller tuning-time response and frequency response methods- non-linear controllers.

3. COMPLEX CONTROL TECHNIQUES 9

Feed forward-ratio-cascade-split range-inferential-predictive-adaptive and multivariable control.

4. PROGRAMMABLE LOGIC CONTROLLERS 9

Evolution of PLC – Sequential and Programmable controllers – Architecture – Programming of PLC – Relay logic and Ladder logic – Functional blocks – Communication Networks for PLC.

5. COMPUTER CONTROL OF PROCESSESS 9

PLC based control of processes – Computer control of liquid level system – heat exchanger – Smart sensors and Field bus.

L=45, T=15,Total=60

REFERENCES

1. George Stephanopolus, "Chemical Process Control", Prentice Hall India
2. Harriot P., “Process Control”, Tata McGraw-Hill, New Delhi, 1991.
3. Norman A Anderson,” Instrumentation for Process Measurement and Control” CRC Press LLC, Florida, 1998.
4. Dale E. Seborg, Thomas F Edgar, Duncan A Mellichamp, “Process dynamics and control”, Wiley John and Sons, 1989.
5. Marlin T.E., “Process Control”, Second Edition McGraw hill, New York, 2000.
6. Balchan J.G. and Mumme G., “Process Control Structures and Applications”, Van Nostrand Renhold Co., New York,1988.
7. Lucas M.P, “Distributed Control System”, Van Nostrand Reinhold Co. NY 1986
8. Pertrezeulla, “Programmable Controllers”, McGraw-Hill, 1989
9. Chidambarm. M, “ Computer control of processes”, Narosa Publications, 2002.

CO 9124 NONLINEAR CONTROL **L T P C**

3 0 0 3

1. PHASE PLANE ANALYSIS 9

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

2. DESCRIBING FUNCTION 9

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

3. LYAPUNOV THEORY 9

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

4. FEEDBACK LINEARIZATION 9

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

5. SLIDING MODE CONTROL 9

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

TOTAL : 45 PERIODS

REFERENCES

1. J A E Slotine and W Li, Applied Nonlinear control, PHI, 1991.
2. Hasan Khalil, "Nonlinear systems and control", Prentice Hall.
3. S H Zak, "Systems and control", Oxford University Press, 2003.
4. Torkel Glad and Lennart Ljung, "Control Theory – Multivariable and Nonlinear Methods", Taylor & Francis, 2002.
5. G. J. Thaler, "Automatic control systems", Jaico publishers, 1993.
6. P.Albertos, A. Sala," Multivariable Control System", Springer, 2004

CO 9125 DIGITAL CONTROL AND INSTRUMENTATION LAB **L T P C**
0 0 3 2

1. Simulation of Converters
2. Simulation of Machines
3. Simulation of Power System
4. Simulation of Process Loop
5. Design of analog and digital interfaces
   (i) Digital input,
   (ii) Analog input,
   (iii) Digital output ,
   (iv) Analog output,
6. Design of analog and digital interfaces
   interrupts,
   timer handling.
7. Design of controllers for linear systems
8. Design of controllers for non linear systems
9. Hardware in loop simulation of system.(serial interface)
   (i) ELVIS
   (ii) Microcontroller
10. Hardware in loop simulation of closed loop control system.

P = 45 Total= 45

CO 9131 PROJECT WORK (PHASE I) **0 0 12 6**

CO 9141 PROJECT WORK (PHASE – II) **0 0 24 12**

ET 9111 ADVANCED DIGITAL SYSTEM DESIGN L T P C

3 0 0 3

AIM

To expose the students to the fundamentals of digital logic based system design.

OBJECTIVES

To impart knowledge on

i. Basics on Synchronous & Async digital switching design.
ii. Design & realisation of error free functional blocks for digital systems

1. SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Clocked Synchronous Sequential Networks (CSSN) Modelling of CSSN – State Stable Assignment and Reduction – Design of CSSN – Design of Iterative Circuits – ASM Chart – ASM Realization, Design of Arithmetic circuits for Fast adder- Array Multiplier.

2. ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Data Synchronizers – Designing Vending Machine Controller – Mixed Operating Mode Asynchronous Circuits.

3. FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA – Test Generation – Masking Cycle – DFT Schemes – Built-in Self Test.

4. SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9

Programming Techniques -Re-Programmable Devices Architecture- Function blocks, I/O blocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

5. NEW GENERATION PROGRAMMABLE LOGIC DEVICES 9

Foldback Architecture with GAL, EPLD, EPLA , PEEL, PML; PROM – Realization State machine using PLD – FPGA – Xilinx FPGA – Xilinx 2000 - Xilinx 3000

TOTAL : 45 PERIODS

REFERENCES:

1. Donald G. Givone, “Digital principles and Design”, Tata McGraw Hill 2002.
2. Stephen Brown and Zvonk Vranesic, “Fundamentals of Digital Logic with VHDL Deisgn”, Tata McGraw Hill, 2002
3. Mark Zwolinski, “Digital System Design with VHDL”, Pearson Education, 2004
4. Parag K Lala, “Digital System design using PLD”, BS Publications, 2003
5. John M Yarbrough, “Digital Logic applications and Design”, Thomson Learning, 2001
6. Nripendra N Biswas, “Logic Design Theory”, Prentice Hall of India, 2001
7. Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 2004.

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.

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 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.

ET 9159 ADVANCED DIGITAL SIGNAL PROCESSING

L T P C
3 0 0 3

1. INTRODUCTION 9

Mathematical description of change of sampling rate – Interpolation and Decimation, Filter implementation for sampling rate conversion – direct form FIR structures, DTFT, FFT, Wavelet transform and filter bank implementation of wavelet expansion of signals

2. ESTIMATION AND PREDICTION TECHNIQUES 9

Discrete Random Processes – Ensemble averages, Stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation – Power Spectral Density**.** AR, MA, ARMA model based spectral estimation. Parameter Estimation, Linear prediction – Forward and backward predictions, Least mean squared error criterion – Wiener filter for filtering and prediction, Discrete Kalman filter.

3. DIGITAL SIGNAL PROCESSOR 9

Basic Architecture – Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA.

4. APPLICATION OF DSP 9

Design of Decimation and Interpolation Filter, FFT Algorithm, PID Controller, Application for Serial Interfacing, DSP based Power Meter, Position control.

5. VLSI IMPLEMENTATION 9

Basics on DSP sytem architecture design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation of MAC & Filter structure.

TOTAL : 45 PERIODS

REFERENCES:

1. Bernard Widrow, Samuel D. Stearns, "Adaptive Signal Processing", Pearson Education, third edition, 2004.
2. Dionitris G. Manolakis, Vinay K. Ingle, Stepen M. Kogon,"Statistical & Adaptive signal processing, spectral estimation, signal modeling, Adaptive filtering & Array processing", McGraw-Hill International edition 2000.
3. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley and Sons, Inc.,
4. John G. Proaks, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education 2002.
5. S. Salivahanan, A. Vallavaraj and C. Gnanapriya "Digital Signal Processing", TMH,2000.
6. Avatar Sing, S. Srinivasan, "Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx", Thomson India, 2004.
7. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999,New York.
8. Ashok Ambardar,"Digital Signal Processing: A Modern Introduction",Thomson India edition, 2007.
9. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999,New York.

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.

CO 9152 MULTI SENSOR DATA FUSION **L T P C**
3 0 0 3

1. MULTISENSOR DATA FUSION INTRODUCTION: 9
sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used:Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

2. ALGORITHMS FOR DATA FUSION 9
Taxonomy of algorithms for multisensor data fusion. Data association. Identity declaration.

3. ESTIMATION: 9
Kalman filtering, practical aspects of Kalman filtering, extended Kalmal filters. Decision level identify fusion. Knowledge based approaches.

4. ADVANCED FILTERING 9
Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

5. HIGH PERFORMANCE DATA STRUCTURES: 9
Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems with in dependability bounds. Implementing data fusion system.

TOTAL : 45 PERIODS

REFERENCES:

1. David L. Hall, Mathematical techniques in Multisensor data fusion, Artech House, Boston, 1992.
2. R.R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, 1998.
3. Arthur Gelb, Applied Optimal Estimation, The M.I.T. Press, 1982.
4. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company, 1987.

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.

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.

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.

REFERENCES L=45: T=15, Total =60

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.

HV9153 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.

CO 9153 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

1. OVERVIEW OF MEMS 9

History of MEMS, MEMS and Microsystems, Scaling laws in Miniaturization. Materials for MEMS and Microsystems.

2. MICRO FABRICATIONS AND MICROMACHINING 9

Microsystem Design and Fabrication, Microsystem fabrication processes-Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical and Physical Vapor deposition, Deposition by Epitaxy, Etching. Bulk Micro manufacturing, Surface micromachining, LIGA process.

3. PHYSICAL MICROSENSORS 9

Design of Acoustic wave sensors, resonant sensor,Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Microsensors.

4. MICROACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys,
Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps.

5. CASE STUDIES 9

Ink jet pointer heads, Micro mirror TV Projector, DNA chip, Micro arrays, and RF electronic devices.

TOTAL : 45 PERIODS

REFERENCES

1. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997.
2. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001
3. B.H. Bao, "Analysis and design principles of MEMS Devices", Elsevier, 2005.
4. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002.
5. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006,

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 9155 OPTIMAL CONTROL AND FILTERING **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Statement of optimal control problem – Problem formulation and forms of optimal Control – Selection of performance measures. Necessary conditions for optimal control – Pontryagin's minimum principle – State inequality constraints – Minimum time problem.

2. LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING **9**

Linear optimal regulator problem – Matrix Riccatti equation and solution method – Choice of weighting matrices – Steady state properties of optimal regulator – Linear tracking problem – LQG 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.

3. NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL **9**

Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method solution of Ricatti equation by negative exponential and interactive Methods

4. FILTERING AND ESTIMATION **9**

Filtering – Linear system and estimation – System noise smoothing and prediction – Gauss Markov discrete time model – Estimation criteria – Minimum variance estimation – Least square estimation – Recursive estimation.

5. KALMAN FILTER AND PROPERTIES **9**

Filter problem and properties – Linear estimator property of Kalman Filter – Time invariance and asymptotic stability of filters – Time filtered estimates and signal to noise ratio improvement – Extended Kalman filter.

TOTAL : 45 PERIODS

REFERENCES:

1. KiRk D.E., 'Optimal Control Theory – An introduction', Prentice hall, N.J., 1970.
2. Sage, A.P., 'Optimum System Control', Prentice Hall N.H., 1968.
3. Anderson, BD.O. and Moore J.B., 'Optimal Filtering', Prentice hall Inc., N.J., 1979.
4. S.M. Bozic, "Digital and Kalman Filtering", Edward Arnould, London, 1979.
5. Astrom, K.J., "Introduction to Stochastic Control Theory", Academic Press, Inc, N.Y., 1970.

CO 9156 ADVANCED TOPICS IN NONLINEAR CONTROL **L T P C**
3 0 0 3

1. PERTURBATION THEORY` 9

Vanishing and Non vanishing Perturbations – Continuity of solutions on the infinite interval – Interconnected systems – Slowly varying systems – Perturbation method – Averaging - Weakly nonlinear second-order oscillators – Exercises

2. SINGULAR PERTURBATIONS 9

Standard singular perturbation model – Time scale properties – Singular perturbation on the infinite interval – Slow and fast manifolds – stability analysis – exercises

3. GAIN SCHEDULING AND FEEDBACK LINEARIZATION 9

Control problem – stabilization via linearization – integral control via linearization – gain scheduling – Input output linearization – Full state linearization – state feedback control – tracking- exercises

4. INPUT-OUTPUT STABILITY 9

L stability – L stability of state models – L_2 gain – feedback system: small gain theorem – exercises – Passivity – State models - L_2 and Lyapunov stability

5. BAKSTEPPING CONTROL ALGORITHMS 9

Passivity based control – High gain observers – stabilization – Regulation via integral control - exercises

TOTAL : 45 PERIODS

REFERENCES

1. Hasan Khalil," Nonlinear systems and control", 3rd ed, PHI,
2. Slotine, J A E Slotine and W Li, "Applied Nonlinear control",1991, PHI
3. S.H. Zak," Systems and control", Oxford University Press

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.

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.

CO 9158 **DIGITAL IMAGE PROCESSING** **L T P C**
3 0 0 3

1. FUNDAMENTALS OF IMAGE PROCESSING 9

Introduction – Steps in image processing systems – Image acquisition – Sampling and Quantization – Pixel relationships – Color fundamentals and models, File formats, Image operations – Arithmetic, Geometric and Morphological.

2. IMAGE ENHANCEMENT 9

Spatial Domain: Gray level Transformations – Histogram processing – Spatial filtering smoothing and sharpening. Frequency Domain: Filtering in frequency domain – DFT, FFT, DCT – Smoothing and sharpening filters – Homomorphic Filtering.

3. IMAGE SEGMENTATION AND FEATURE ANALYSIS 9

Detection of Discontinuities – Edge operators – Edge linking and Boundary Detection – Thresholding – Region based segmentation – Morphological Watersheds – Motion Segmentation, Feature Analysis and Extraction.

4. MULTI RESOLUTION ANALYSIS AND COMPRESSIONS 9

Multi Resolution Analysis: Image Pyramids – Multi resolution expansion – Wavelet Transforms, Image compression: Fundamentals – Models – Elements of Information Theory – Error free compression – Lossy Compression – Compression Standards.

5. APPLICATION OF IMAGE PROCESSING 9

Image classification – Image recognition – Image understanding – Video motion analysis – Image fusion – Steganography – Digital compositing Mosaics – Colour Image Processing.

TOTAL : 45 PERIODS

REFERENCES :

1. Rafael C.Gonzalez and Richard E.Woods, “Digital Image Processing”, 2nd Edition, Pearson Education, 2003.
2. Milan Sonka, Valclav Halavac and Roger Boyle, “Image Processing, Analysis and Machine Vision”, 2nd Edition, Thomson Learning, 2001.
3. Anil K.Jain, “Fundamentals of Digital Image Processing”. Pearson Education, 2003.