APPROVED SYLLABUS OF

M. TECH. COURSE

CONTROL SYSTEMS

(From Academic Year 2004-2005)

IN

III BOARD OF STUDIES MEETING HELD

ON

31-07-2004

DEPARTMENT OF

ELECTRICAL & ELECTRONICS ENGINEERING

JNTU COLLEGE OF ENGINEERING

(AUTONOMOUS)

ANANTAPUR

INFORMATION ON THE COURSE TO BE INTRODUCED

1.0 Details about the Course

1.1 Name of the Course

Name of Degree / Diploma	Name of Specialization	Intake (Full / Part time) to be started	Year of Starting (Proposal Admission)	Duration (Total)	Name of Degree & for admi
M.Tech.	Control Systems	Full time 10 NS + 15 S	2002	2 Yrs 4 Semesters	4 Year Degree Course B.Tech./B.E. (EEE)

1.2 Course Structure and scheme of evaluation (Semester – wise)

Name of the Subject	Hrs. / Week L T P	Evaluation (Marks) Internal (Theory)	External (Practical)	Total
I-SEMESTER				
1. CS 11 Advanced Control Systems	4 - -	40	60	100
2. CS 12 Digital Control Systems	4 - -	40	60	100
3. CS 13 State & Parameter Estimation Theory	4 - -	40	60	100
4. EPS 14 Advanced Microprocessors	4 - -	40	60	100
5. CS 15 Programmable Logic Controllers - Principles and their Applications	4 - -	40	60	100
6. Elective-I				
i. CS 15 Advanced Instrumentation Systems	4 - -	40	60	100
ii. CS 16 Embedded Systems	4 - -	40	60	100
7. CS 17 Control Systems Lab	- - 3	40	60	100
II-SEMESTER				
1. CS 21 Optimal Control Theory	4 - -	40	60	100
2. CS 22 Adaptive Control Systems	4 - -	40	60	100
3. PID 23 Neural Networks & Fuzzy Systems	4 - -	40	60	100
4. PID 24 Advanced Digital Signal Processing	4 - -	40	60	100
5. CS 23 Control System Design	4 - -	40	60	100
6. Elective – II				
i. CS 24 Robotics and Control				
ii. CS 25 Distributed Control Systems	4 - -	40	60	100
7. CS 26 Simulation Lab	4 - -	40	60	100
	- - 3	40	60	100
III & IV SEMESTERS				
1. CS 31 Seminar			100	
2. CS 32 Project Work			Grading	
(Excellent / Good / Satisfactory / Unsatisfactory)				

CS 11 - ADVANCED CONTROL SYSTEMS

Unit I
Control System Design by the root locus method-lead, lag and lag-lead compensation, PI, PD, PID Controllers design procedures and examples.

Unit II
Control System Design by frequency response approach-lead, lag lag-lead compensation, PI, PD, PID Controllers – design procedures and examples.

Unit III: Eigen value and Eigen vector sensitivities in linear systems theory:
Continuous time systems: Introduction, first – order Eigen value sensitivities, first – order eigen vector sensitivities, second order eigen value sensitivities, second – order eigen vector sensitivities

Unit IV Mode – Controllability matrix:
Distinct eigen values, confluent eigen values associated with a single Jordan block, confluent eigen values associated with a number of distinct Jordan blocks, confluent eigen values associated with a number of non- distinct Jordan blocks

Unit V Mode – Controllability structure of multivariable linear systems:
Introduction, Distinct eigen values, confluent eigen values associated with single Jordan block, confluent eigen values associated with a number of distinct Jordan blocks

Unit VI Mode –Observability matrices:
Distinct eigen values, confluent eigen values, mode observability structure of multi variable linear system: Introduction, Distinct eigen values, confluent eigen values

Unit VII Non linear systems:
Common physical non-linearities; the phase-plane method-basic concepts, singular points, construction of phase trajectories-Isocline and Delta methods. Describing function-basic concept-derivation of describing functions-stability analysis by describing function method.

Unit VIII Lyapunov stability analysis:
Second method of Lyapunov, stability in the sense of Lyapunov, construction of Lyapunov function-Krasovskii's and variable gradient methods. Lyapunov stability analysis of linear time-invariant systems.

Reference Books:

1. Modern Control Engineering - K.Ogata – PHI - 3rd edition.
2. Control Systems Engineering – I.J.Nagrath, M.Gopal – New Age International -3rd edition.
3. Control Systems – N.K.Sinha - New Age International - 3rd edition,
4. Automatic Control Systems – B.C.Kuo – PHI – 7th edition.
5. Modern Control Systems – HSU & MEYER
6. Modal control theory and applications Brian porter& Roger crossley

CS 12 DIGITAL CONTROL SYSTEMS

UNIT-1: Introduction to Digital Control systems

Advantages of Digital control systems- -Practical aspects of the choice of sampling rate- Basic discrete time signals - Quantization – Sampling theorem -Data conversion and Quantization- Sampling process- Mathematical modeling- Data reconstruction and filtering of sampled signals – zero-order hold - z transform and inverse z transform Relationship between s- plane and z- plane- Difference equation-Solution by recursion and z-transform- pulse transfer functions of the zero-order Hold and relationship between G(s) and G(z)– Bilinear transformation .

UNIT-II: Analysis of Digital Control Systems

Digital control systems- Pulse transfer function- z transform analysis of open loop, closed loop systems- Modified z- transfer function- Stability of linear digital control systems- Stability tests- Steady-state error analysis- Root loci - Frequency domain analysis- Bode plots- Gain margin and phase margin

UNIT-III: Classical Design of Digital Control Systems

Cascade and feedback compensation by continuous data controllers- Digital controllers-Design using bilinear transformation- Root locus based design- Digital PID controllers- Dead beat control design- Case study examples using MATLAB

UNIT-IV: State Space Analysis of Digital Control Systems

State equations of discrete data systems with Sample and Hold devices, state equations of digital systems with all digital elements, State transition equation: Z transform method. Relation between state equations and transfer function's. Concepts on Controlability and Observability. Digital state observer : Design of the full order and reduced order state observer- Pole placement design by state feed back (single input and multi input). Design of discrete data systems with dead beat response.

UNIT-V: Optimal Digital Control: Formulation of the optimum control problem-Quadratic integral and matrix differential equations-The optimum gain matrix-Kalman filter is an observer-Kalman filter gain and variance equations.

Reference books:

1. B.C Kuo, Digital Control Systems (second Edition), Oxford University Press, Inc., New York, 1992.
2. G.F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.
3. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill Publishing Company, 1997.
4. John F. Walkerly, Microcomputer architecture and Programs, John Wiley and Sons Inc., New York, 1981.
5. K. Ogata, Discrete Time Control Systems, Addison-Wesley Longman Pte. Ltd., Indian Branch, Delhi, 1995.
6. C. H. Houpis and G.B. Lamont, Digital Control Systems, McGraw Hill Book Company, 1985.
7. Fundamentals of Linear State Space Systems – John S. Baey – Mc. Graw-Hill - 1st edition
8. Control System Design – Bernard Fried Land – Mc. Graw-Hill - 1st edition
9. Continuous and Discrete Control Systems-Dorsay- Mc-Graw-Hill

CS 13 STATE AND PARAMETER ESTIMATION THEORY

UNIT – I

Maximum likelihood method, Invariance of maximum likelihood estimator, Bayes cost methods: Mean square error (Minimum error variance) method, uniform cost method, Absolute cost method, relationships of these estimators.

UNIT – II

Linear minimum variance method, least square method, sequential estimation, Non linear estimation, unbiased estimators, efficient estimators, asymptotic properties, sensitivity and error analysis.

UNIT – III

Gauss- Markov discrete time model, initial state description, propagations of means and co variances, signal model, state statistics, output statistics, Estimation criteria, minimum variance estimate.

UNIT – IV

Discrete time kalman filter, best linear estimator property of kalman filter, identification as a Kalman filtering problem, Kalman filter applications.

UNIT – V

Fixed point smoothing, fixed log smoothing, fixed interval smoothing, extended kalman filter.

Reference Books:

1. J.L.Melsa, Decision and Estimation theory, International student Edition, Mc Graw Hill-Kogakusha(Chapters 8,9,10 & 11).
2. B.D.O.Anderson and J.B.Moore, Optimal filtering, Prentice- Hall.(Chapters 2,3& 7)
3. J.S. Meditch, Stochastic Optimal linear estimation and control, Mc Graw Hill, 1969.
4. Van Trees H.L., Detection, Estimation and Modulation Theory, Part 1&2 John Wiley sons, 1968/1971/1972.
5. Deutsch .R., Estimation Theory, Prentice Hall, 1965
6. Jazwinski.A.H. Stochastic processes& Filtering Theory, Academic press, 1970.
7. S.M.Bozic, Digital & Kalman Filtering, Edward Arnold Publishers Ltd., London

EPS 13 - ADVANCED MICROPROCESSORS

Unit I Intel 8086/8088

Architecture, its register organization, Pin diagram, Minimum and Maximum Mode System and Timings, Machine language instruction formats, Addressing modes, Instruction set, Assembler directives and operators.

Unit II ALP and special Architecture Features

ALP, programming with an assembler, stack structure, Interrupts, Service subroutines and Interrupt programming and Macros.

Unit III Multiprocessor systems

Inter connection topologies, Numeric Processor 8087, I/O Processor 8089, Bus arbitration and control Design of PC Based Multiprocessor system, Virtual Memory, Paging, Segmentation

Unit IV Advanced Processors

Architectural features of 80386, 486 and Pentium Processors their memory management, Introduction to Pentium Pro Processors their features, RISC Vs CISC Processors, RISC properties, evaluation, Architectural features of DEC alpha AXP, Power PC family and Sun SPARC family systems.

Unit V Microcontroller

Microcontrollers – 8051 architecture, Hardware feature, Interrupts, Addressing modes, instruction set – Programming – Applications.

Reference books:

1. Intel Microprocessors, Architecture, Programming and interfacing 8086/8088, 80186, 80386 and 80486 – Barry B.Brey, PHI-5th Edition –2001
2. Advanced Microprocessors – TABAK – McGraw Hill Inc, 2nd Edition
3. 8051 Microcontroller – Architecture Programming & Applications – K.J.Ayala - Penram Intl.
4. Programming & Customizing the 8051 Microcontroller- Myke Pretko- TMH, 1st Edition, 1999.
5. The 8088 and 8086 Microprocessor- W.A. Triebel & Avtar Singh- PHI, 4th Edition, 2002

CS 14 PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS

Unit-I:
PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming Equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

Unit-II:
PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

Unit-III: LADDER DIAGRAMS:
Digital logic gates, programming in the Boolean algebra system, conversion examples
Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system.

Unit-IV:
PLC Resisters: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

Unit-V:
PLC Functions: Timer functions & Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions

Unit-VI:
Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications

Unit-VII:
Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

Unit-VIII:
Analog PLC operation: Analog modules& systems, Analog signal processing, Multi bit Data Processing, Analog output Application Examples, PID principles, positions indicator with PID control, PID Modules, PID tuning, PID functions.

Reference Books:

1. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI

2. Programmable Logic Controllers- Programming Method and Applications –JR.Hackworth &F.D Hackworth Jr. –Pearson, 2004

CS 15 ADVANCED INSTRUMENTATION SYSTEMS (Elective –I)

UNIT- I: Passive Electrical Transducers

Resistive Transducers- Resistance Thermometers- Hot wire resistance Transducers- Resistive displacement Transducers- Resistive strain Transducers- Resistive magnetic flux Transducers- Resistive optical radiation Transducers- Inductive Thickness Transducers- Inductive displacement Transducers- Capacitive Thickness Transducers- Capacitive displacement Transducers**.**

UNIT- II: Active Electrical Transducers -I

Thermoelectric Transducers- Piezo electric phenomenon- Piezo electric materials- Piezo electric torque Transducers- Piezo electric Acceleration transducers- Magnetostrictive phenomenon- Magnetostrictive Acceleration transducers- Hall effect Transducers- Tachometers- variable reluctance tachometers- Electromagnetic Flow meter.

UNIT- III: Active Electrical Transducers –II

Photoelectric phenomenon- photoconductive Transducers- photovoltaic Transducers- Photo emissive Transducers- Ionization vacuum gauges- Ionization displacement Transducers- Digital displacement Transducers- Digital Tachometers- Electromechanical Transducers.

UNIT-IV: Feedback Transducer systems

Feedback fundamentals- Inverse Transducers- Temperature balance system- self-balancing potentiometers- self-balancing bridges- servo-operated manometer- Feedback pneumatic load cell- servo-operated electromagnetic flow meter- feedback accelerometer system- Non-contact position measurement.

UNIT-V: Signals and their representation

Laplace and Fourier Transforms- standard test signals- Periodic signals- aperiodic signals- bandwidth- modulated signals- sampled data pulse modulation.

UNIT-VI: Data Acquisition Systems

General configurations- single and multichannel DAS- A/D converters (successive approximation and dual slope integration)- sample and hold circuits- Anti alia filters- multiplexers and demultiplexers- Digital multiplexers.

UNIT-VII: Data Transmission and Telemetry

Characteristics of a Telemetry system- landline telemetry- radio telemetry- frequency division multiplexing- time division multiplexing.

UNIT-VIII: Data Display and recording systems

Data loggers- Analog indicators- Digital Readout systems- analog recorders- magnetic tape recorders- direct recording- frequency modulation recording- digital recording technique- floppy discs.

Reference Books:

1. D.V.S.murthy, “Transducers & Instrumentation” Prentice Hall of India pvt. Ltd., First edition-1995

2. C S Rangan- G R Sarma- V S V Mani, “Instrumentation Devices & Systems”, TMH- 2nd edition- 2003

CS 16 EMBEDDED SYSTEMS (Elective-I)

UNIT- I Overview of Embedded System:

Embedded System, types of Embedded System, Requirements of Embedded System, Issues in Embedded software development, Applications.

UNIT-II: Processor & Memory Organization:

Structural units in a processor, Processor selection, Memory devices, Memory selection, Memory Allocation & Map; Interfacing

UNIT-III: Devices, Device Drivers & Buses for Device Networks:

I/O devices, Timer & Counter devices, Serial Communication, Communication between devices using different buses.

Device drives, Parallel and serial port device drives in a system, Interrupt servicing mechanism, context and periods for context switching, Deadline and Interrupt Latency.

UNIT-IV: Programming & Program Modeling Concepts

Program elements, Modeling Processes for Software Analysis, Programming Models, Modeling of Multiprocessor Systems, Software algorithm Concepts, design, implementation, testing, validating, debugging, Management and maintenance, Necessicity of RTOS.

UNIT-V: Hardware and Software Co-Design

Embedded system design and co design issues in software development, design cycle in development phase for Embedded System, Use of ICE & Software tools for development of ES, Issues in embedded system design.

REFERENCE BOOKS:

1. Embedded Systems: Architecture, Programming and Design – Rajkamal, TMH 2003
2. Programming for Embedded System: DreamTech Software Team-John Wiley -2002

CS 21 OPTIMAL CONTROL THEORY

Unit-I: Dynamic Programming:
Optimal control law, the principle of optimality, application of the optimality principle to decision making, an optimal control system. Recurrence relation of dynamic programming, computational procedure for solving control problems, characteristics of dynamic programming solution.

Unit-II: Analytical results of Dynamic Programming:
Discrete linear regulator problem. Hamilton-Jacobi- Bellman equation, continuous linear regulator problems, necessary and sufficient conditions - Examples.

Unit-III The calculus of Variations& Pontryagin's minimum principle:

Fundamental concepts, functionals of a single function, functionals involving several independent functions, necessary conditions for optimal control, linear regulator problems.
Pontryagin's minimum principle and state inequality constraints, minimum time problems, minimum control effort problems.

Unit-IV: Iterative Numerical Techniques for finding optimal controls and Trajectories:
Two point boundary value problems, method of steepest descent algorithm, variation of extremals, variation of extremal algorithm, gradient projection algorithm.

UNIT-V:
The nature of the state estimation problem, non-statistical estimation design with full estimator dimension, non statistical estimation with reduced estimator design
Description of plants and noise statistics, statement of optimal estimation problem, reformation of the optimal estimation problem as an optimal regulator problem, solution to the regulator problem in feedback form, explicit solution of the optimal estimation problem.

Reference Books:

1) Optimal Control Theory an Introduction- Donald E.Kirk - Prentice-Hall Network series -First edition.
2) Optimal Control Theory", B.D.O. Anderson & Moore – PHI – 1991
3) Optimum System Control - A.P.Sage
4) Optimization Theory and Applications - Dr. S.S.Rao - Eastern Willy - . First edition
5) Control system theory with Engineering Applications-SE. Lyshevski- Jaico Publishers

CS 22 ADAPTIVE CONTROL SYSTEMS

UNIT I

Introduction-use of Adaptive control-definitions-essential aspects-classification. Model reference adaptive systems- different configurations- classification- mathematical description- Equivalent representation as a nonlinear time varying system- direct and indirect MRAC.

UNIT II

Continuous time MRAC systems- MIT rule- Lyapunov approach. Hyper stability approach- Narendra's error model approach- Discrete time MRAC systems- Hyper stability approach- Narendra's error model approach- Introduction- stability theorem- Relation to other algorithms- hybrid adaptive control.

UNIT III

Self tuning regulators- different approaches to self tuning- Recursive parameter estimation- implicit STR- Explicit STR- LQG self tuning- Hybrid self tuning control- Introduction- Derivation of an equivalent closed loop system- Hybrid predictor design- Hybrid self tuning algorithms.

UNIT IV

Variable structure schemes- reduced- order schemes- adaptive prediction control systems- Fuzzy logic adaptive control. Stochastic adaptive control- Multistep decision problems- the stochastic adaptive problem- dual control.

UNIT V

Introduction- A general purpose adaptive regulator- power systems- Electric generator control- Electric drives- Airborne vehicles- industrial Robots- Satellite altitude control.

Reference books

1.Adaptive control-K.J.Astrom and Bjorn Wittenmark-Peerson Education.

2.Adaptive Control System- Techniques & Applications-V.V.Chalam-Marcel Dekker Inc.

3. Adaptive control systems- Miskhin and Braun-MC Graw Hill

PID 23 NEURAL NETWORKS AND FUZZY SYSTEMS

Unit – I

Biological neuron Vs Artificial neuron, structure and activation functions – Neural network architectures-learning methods, stability and convergence.

Unit- II

Single layer networks -Mc Culloh- Pitts neuron model, Perceptron training and algorithm, Delta learning, Widrow- Hoff learning rules, limitations, Adaline and modification.
Multilayer Networks-Architectures and Modelling, BP algorithm, radial basis functions.

Unit-III

Unsupervised learning-Winner take all learning, outstar learning, Counter propagation networks, Self organizing networks-Kohonen, Grossberg, Hamming NET, MAXNET, Hopfield networks, recurrent and associative memory, BAM and ART architectures

Unit-IV

Fuzzy sets and system – geometry of fuzzy sets – theorems – fuzzy and neural function estimators – FAM system architectures – Uncertainty and estimation – Types of uncertainty – Measures of Fuzziness – Classical measures of uncertainty – Measures of dissonance – confession specificity – knowledge base defuzzification

Unit-V

Application to load forecasting, Load flow, Fault detection- unit commitments, LF control – Economic dispatch, Neuro Fuzzy controllers

Reference Books:

1. Artificial Neural Networks – B.Yegna Narayana – PHI - 1st edition, 1999.
2. Neural Networks – Simon Haykin - Prentice Hall International Inc., 1999.
3. Neural Networks and Fuzzy System – Bart Kosko - 2nd edition, 2001.
4. Neural Network Fundamentals with Graphs, Algorithms & Applications – N. K. Bose and Liang – Mc Graw Hill, 1996.
5. Fuzzy logic with Fuzzy Applications – T.J.Ross – Mc Graw Hill Inc, 1997.

PID 24 ADVANCED DIGITAL SIGNAL PROCESSING

UNIT-I: Digital Filter Structure

Block diagram representation-Equivalent Structures-FIR and IIR digital filter Structures All pass Filters-tunable IIR Digital Filters-IIR tapped cascaded Lattice Structures-FIR cascaded Lattice structures-Parallel-Digital Sine-cosine generator-Computational complexity of digital filter structures.

UNIT-II: Digital filter design

Preliminary considerations-Bilinear transformation method of IIR filter design-design of Lowpass highpass-Bandpass, and Bandstop- IIR digital filters-Spectral transformations of IIR filters- FIR filter design-based on Windowed Fourier series- design of FIR digital filters with least –mean-Square-error-constrained Least-square design of FIR digital filters

UNIT-III: DSP algorithm implementation

Computation of the discrete Fourier transform- Number representation-Arithmetic operations-handling of overflow-Tunable digital filters-function approximation

UNIT-IV Analysis of finite Word length effects

The Quantization process and errors- Quantization of fixed -point and floating -point Numbers-Analysis of coefficient Quantization effects - Analysis of Arithmetic Round-off errors-Dynamic range scaling-signal- to- noise ratio in Low -order IIR filters-Low-Sensitivity Digital filters-Reduction of Product round-off errors using error feedback-Limit cycles in IIR digital filters-Round-off errors in FFT Algorithms.

UNIT V: Power Spectrum Estimation

Estimation of spectra from Finite Duration Observations signals – Non-parametric methods for power spectrum Estimation – parametric method for power spectrum Estimation-Estimation of spectral form-Finite duration observation of signals-Non-parametric methods for power spectrum estimation-Walsh methods-Blackman & torchy method.

Reference Books:

1. Digital signal processing-sanjit K. Mitra-TMH second edition
2. Discrete Time Signal Processing – Alan V.Oppenheim, Ronald W.Shafer - PHI-1996 1st edition-9th reprint
3. Digital Signal Processing principles, algorithms and Applications – John G.Proakis - PHI –3rd edition-2002
4. Digital Signal Processing – S.Salivahanan, A.Vallavaraj, C. Gnanapriya – TMH - 2nd reprint-2001
5. Theory and Applications of Digital Signal Processing-LourensR. Rebinar&Bernold
6. Digital Filter Analysis and Design-Auntonian-TMH

CS 23 CONTROL SYSTEM DESIGN

UNIT-I: Synthesis of SISO Controllers and Architectural issues in SISO Control

- Polynomial approach
- PI and PID synthesis Revisited by using pole Assignment
- Smith predictor
- Models for deterministic disturbances and references
- Internal model principle for Disturbances and for reference Tracking
- Feed forward control – cascade control

UNIT-II: Dealing with Constraints and SISO Controllers parameterizations:

- Windup
- Anti windup scheme
- State saturation
- Introduction to model predictive control
- Preview – open loop inversion revisited
- Affine parameterization – The stable case
- PID synthesis by using the Affine parameterization
- Affine parameterization for systems having time delays
- Undesirable closed loop poles
- Affine parameterization: the unstable open loop case

UNIT-III: Analysis of MIMO Control loops

- Preview- motivational examples.
- Models for multi variable systems
- The Basic MIMO control loop
- Closed loop stability
- Steady state response for step inputs
- Frequency domain analysis
- Robustness issues – Problems

UNIT-IV: Exploring SISO Techniques in MIMO control

- Preview – completely Decentralized control
- Pairing of inputs and outputs
- Robustness issues in decentralized control
- Feed forward action in decentralized control
- Converting MIMO Problems to SISO Problems
- Industrial case study (strip flatness control)

UNIT-V: Model Predictive Control

Preview- Antiwindup- Revisited – What is Model Predictive Control – Stability- Linear Models with Quadratic cost function – State estimation and Disturbance prediction

Reference books:

1. MATLAB control system tool box
2. Control system design –Graham C Good win- Stefan F.Graebe Mario E.Salgado-Pearson Publications-2003
3. Computer aided design of control systems- by Resenbrock (Academic Press)

CS 24 - ROBOTICS AND CONTROL (Elective-II)

Unit I: Introduction-robot anatomy—coordinate frames-mapping- mapping Between rotated frames-mapping between translated frames-mapping between rotated and translated frames-description of objects in space-transformation of vectors—inverting homogeneous transform-fundamental rotation matrices

Unit-II Symbolic modeling of robots –direct kinematic model

Mathematical structure and notations-description of links and joints-kinematic modeling of the manipulator- Denavit-Hatenberg notation-kinematic relationship between adjacent links-manipulator transformation matrix

Unit III The Inverse kinematics

Manipulator work space – Solvability of kinematic model- -Solution techniques- closed form solution-guidelines to obtain closed form solution.

Unit IV Manipulator differential motion and Statics

Linear and angular velocity of a rigid body - Relationship between transformation Matrix and angular velocity - Mapping velocity vector-Velocity propagation along links-Manipulator Jacobian - Jacobian Inverse- Jacobian Singularities- Static Analysis

Unit V Dynamic Modelling

Lagrangian Mechanics – Two degree of freedom Manipulator-Dynamic Model – Lagrange–Euler formulation - Newton –Euler Formulation – comparison of
Lagrange–Euler & Newton –Euler Formulations – Inverse Dynamics

Unit VI Trajectory Planning

Definitions and planning tasks- terminology-steps in trajectory planning- Joint space techniques-Cartesian space techniques- Joint space Vs Cartesian space Trajectory planning

Unit VII Control of manipulators

Open and close loop control – The manipulator control problem – Linear control schemes-Characteristics of second order linear systems- Linear Second order-SISO model of a manipulator joint- Joint Actuators- partitioned PD control scheme –PID control scheme – computed torque control- force control of robotic manipulators – description of force control tasks –Force-control strategies-Hybrid position/ force control- Impedance Force/Torque control

Unit –VIII Robotic sensors and applications

Sensing- Sensors in robotics – Kinds of sensors used in robotics- -Robotic vision- Robotic vision-Industrial applications of vision controlled robotic systems- process of Imaging-Architecture of robotic vision systems- Image Acquisition- Image representation-Image processing – Industrial applications –material handling – Process applications – Assembly applications – Inspection application – Principles of Robot applications and application planning, Justification of robots-Robot safety

Reference books:

1. Robotics and control –RKMittal And I J Nagrath TMH Publishers-1st edition-2003
2. Mikell P,Weiss G.M.,Nagel R.N., Odrey N.G., Industrial Robotics, McGraw Hill,1986.
3. Deb.S.R- Robotics Technology and flexible automation, Tata McGraw Hill, 1994.
4. Asfahi C.R. - Robotics and manufacturing automation, John wiley ,1992.
5. Klafter R.D.- Chimielewski T.A & Neign M., Robotics engineering: An integrated approach, Prentice Hall of India Pvt.Ltd., 1994.

CS 25 - DISTRIBUTED CONTROL SYSTEMS (Elective –II)

UNIT I

Architecture of computer control systems- controlled architecture-Distributed control architecture Data Highway system.

Distributed Computing System: Distributed processing, Digital control system- computer control, self tuning and adaptive algorithms

UNIT II

Supervising Control systems, multi layer hierarchical structure, system decomposition, open loop co-ordination strategies, model reality differences, closed loop co-ordinate strategies, integrated system, Optimization of parameter (ISOPE), double interactive systems.

UNIT III

Real time control systems: Design techniques and tools-MASCOT, Structured development of real time system, fault tolerance in mixed hardware-software systems- fault detection, measures-fault detection mechanism-Damage confident and assessment.

UNIT IV

Expert system in real time control-Knowledge based process management, Representation of knowledge, reasoning in real time, application of knowledge based systems for process management.

UNIT V

Real time task management, Task scheduling, dispatch, task co-operations and communications, distributed data, distributed control.

Reference book(s):

1. Distributed Computer control systems by SS Lamba, Y D Singh. TMH publications, New Delhi.

CS 17 – CONTROL SYSTEMS LAB

It should consist of various practicals / simulation assignments related to all core subjects and Electives.

CS 26 – SIMULATION LAB

It should consist of various practicals / simulation assignments related to all core subjects and Electives.

CS 31- SEMINAR

The topic should be related to the dissertation work based on recent international practices.

CS 32 – PROJECT WORK

The M.Tech project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering. The project may be analytical, computational, experimental or a combination of the three in a few cases. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical, computational, experimental aptitude of the student.