JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

(Established by an Act No.30 of 2008 of A.P. State Legislature)

Kukatpally, Hyderabad – 500 085, Andhra Pradesh (India)

M. Tech. (CONTROL ENGINEERING/ CONTROL SYSTEMS)
(R13) COURSE STRUCTURE AND SYLLABUS

I Year-I Semester

S.No.	Group	Subject	L	P	Credits
		Advanced Control Systems	3	0	3
		Digital Control Systems	3	0	3
		State and Parameter Estimation Theory	3	0	3
		DSP Processor Architecture and Applications	3	0	3
	Elective-I	Programmable Logic Controllers and their Applications	3	0	3
		Advanced Instrumentation Systems			
		Process Modeling and Simulation			
	Elective-II	Embedded Systems	3	0	3
		Robotics and Control			
		Advanced Microprocessors			
	Lab	Control Engineering and Simulation lab	0	3	2
		Seminar	-	-	2
		Total Credits	18	**3**	**22**

I Year - II Semester

S.No.	Group	Subject	L	P	Credits
		Optimal Control Theory	3	0	3
		Adaptive Control Theory	3	0	3
		Neural Networks & Fuzzy Systems	3	0	3
		Control System Design	3	0	3
	Elective-III	Non-linear Systems	3	0	3
		Distributed Control Systems			
		Process Dynamics and Control			
	Elective-IV	Advanced Digital Signal Processing	3	0	3
		Real Time Systems			
		Intelligent and Knowledge Based Systems			
	Lab	Signal Processing Lab	0	3	2
		Seminar	-	-	2
		Total Credits	18	**3**	**22**

II Year- I Semester

S.No.	Group	Subject	L	P	Credits
		Comprehensive Viva-Voce	-	-	2
		Project Seminar	-	3	2
		Project Work Part-I	-	-	18
		Total Credits	-	3	**22**

II Year- II Semester

S.No.	Group	Subject	L	P	Credits
		Project Work Part-II and Seminar	-	-	22
		Total Credits	-	-	**22**

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

ADVANCED CONTROL SYSTEMS

UNIT-I:

Control system design by root locus method-lead, lag and lead lag compensation. PI, PD and PID controllers design procedures and examples.

Control system design by frequency response approach- lead, lag and lead lag compensation. PI, PD and PID controllers design procedures and examples.

UNIT- II:

EIGEN VALUE AND EIGENVECTOR SENSITIVITIES IN LINEAR SYSTEM THEORY: Continuous time systems: Introduction, first-order Eigen value sensitivities, first order eigenvector sensitivities, second-order Eigen value sensitivities, first order eigenvector sensitivities, second-order Eigenvector sensitivities.

UNIT- III:

MODE-CONTROLLABILITY MATRIX: Distinct Eigen-values, confluent Eigen-values associated with single Jordan block, confluent Eigen-values associated with number of distinct Jordan blocks, confluent Eigen-values associated with a number of non-distinct Jordan block.

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 non-distinct Jordan blocs.

UNIT- IV:

OBSERVABILITY MATRICES: Distinct Eigen-values, confluent Eigen-values, mode observability structure of multivariable linear systems: Introduction, Distinct Eigen-values, confluent Eigen-values.

Nonlinear systems: Common physical nonlinearities: the phase plane method – basic concept, 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- V:

LYAPUNOV STABILITY ANALYSIS: Second method of Lyapunov, stability in the sense of Lyapunov, construction of Lyapunov functions – Krasovskii's and variable gradient methods, Lyapunov stability analysis of linear time varying systems.

TEXT BOOKS:

1. Advanced Control Systems B. N. Sarkar, PHI Learning Private Limited.
2. Advanced Control Theory, Somanath Majhi, Cengage Learning.
3. Control System Engineering – I J Nagarath, M. Gopal – New Age International – 3rd edition.
4. Control Systems – N K Sinha – New Age International – 3rd edition.

REFERENCE BOOKS:

1. Automatic Control Systems – B C Kuo – PHI – 7th edition.
2. Modern Control Systems – Hsu and Meyer.
3. Modal Control theory and applications – Brian Porter & Roger Corssley.
4. Modern Control Engineering - K. Ogata – PHI – 3rd edition.
5. Modern Control Engineering, D. Roy Choudhury, PHI Learning Private Limited.
6. Automatic Control Systems, Kunche Sridhar, Kuo & Golnaraghi, Wiley India.
7. Modern Control Engineering, Yaduvir Singh, S. Janardhanan, Cengage Learning.
8. Modern Control Systems an Introduction, S. M. Tirupathi, Firewal Media.

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DIGITAL CONTROL SYSTEMS

UNIT – I:

Block Diagram of typical control system- advantages of sampling in control systems – examples of discrete data and digital systems – data conversion and quantization – sample and hold devices – D/A and A/D conversion – sampling theorem – reconstruction of sampled signals –ZOH.

Z-transform: Definition and evaluation of Z-transforms – mapping between s-plane and z-plane – inverse z-plane transform – theorems of the Z-transforms –limitations of z-transforms –pulse transfer function –pulse transfer function of ZOH –relation between G(s) and G(z) – signal flow graph method applied to digital systems.

UNIT- II:

STATE SPACE ANALYSIS: State space modeling of digital systems with sample and hold – state transition equation of digital time in variant systems – solution of time in variant discrete state equations by the Z-Transformation – transfer function from the state model – Eigen values – Eigen vector and diagonalisation of the A-matrix – Jordan canonical form. Computation of state transition matrix-Transformation to phase to variable canonical form-The state diagram – decomposition of digital system – Response of sample data system between sampling instants using state approach.

Stability: Definition of stability – stability tests – The second method of Liapunov.

UNIT- III:

TIME DOMAIN ANALYSIS : Comparison of time response of continuous data and digital control systems-correlation between time response and root locus j the s-plane and z-plane – effect of pole-zero configuration in the z-plane upon the maximum overshoot and peak time of transient response – Root loci for digital control systems – steady state error analysis of digital control systems – Nyquits plot – Bode plot-G.M and P.M.

UNIT- IV:

DESIGN: The digital control design with digital controller with bilinear transformation – Digital PID controller-Design with deadbeat response-Pole placement through state feedback-Design of full order state observer-Discrete Euler Lagrance Equation – Discrete maximum principle.

UNIT-V:

DIGITAL STATE OBSERVER: Design of - Full order and reduced order observers.

Design by max.principle: Discrete Euler language equation-discrete maximum principle.

TEXT BOOKS:

1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition.
2. Digital Control Systems, V. I. George, C. P. Kurian, Cengage Learning.
3. Digital Control and State Variable Methods by M.Gopal, TMH.
4. Digital Control Engineering, M.Gopal

REFERENCE BOOKS:

1. Digital Control Systems, Kuo, Oxford University Press, 2nd Edition, 2003.

Digital Control Engineering Analysis and Design M. Sami Fadali Antonio Visioli, AP Academic Press.

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

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.

UNIT-II:

Uniform cost method, Absolute cost method, relationships of these estimators.
Linear minimum variance method, least square method, sequential
estimation,

UNIT-III:

Non linear estimation, unbiased estimators, efficient estimators, asymptotic properties, sensitivity and error analysis.
Gauss- Markov discrete time model, initial state description, propagations of means and co variances,

UNIT-IV:

Signal model, state statistics, output statistics, Estimation criteria, minimum variance estimate.
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

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

DSP PROCESSOR ARCHITECTURE AND APPLICATIONS

UNIT-I:

INTRODUCTION TO DIGITAL SIGNAL PROCESING: Introduction, A Digital signal-processing system, The sampling process, Discrete time sequences, Discrete Fourier Transform(DFT) and Fast Fourier Transform(FFT),Linear time-invariant systems, Digital filters, Decimation and interpolation, Analysis and Design tool for DSP Systems MATLAB,DSP using ATLAB.COMPUTATIONAL ACCURACY IN DSP IMPLEMENTATIONS: Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A/D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.

UNIT-II:

ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES: Basic Architectural features, DSP computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed issues Features for External interfacing.

EXECUTION CONTROL AND PIPELINING: Hardware looping, Interrupts, Stacks, Relative Branch Support, Pipelining and performance, Pipeline Depth, Interlocking, Branching effects, interrupt effects, pipeline Programming models.

UNIT-III:

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Commercial Digital signal-processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and Programming, On-Chip peripherals, Interrupts of TMS320C54XX processors, Pipeline Operation of TMS320C54XX Processors.

UNIT-IV:

IMPLEMENTATION OF BASIC DSP ALGORITHMS: The Q-notation, FIR Filters, IIR Filters, interpolation Filters, Decimation filters, PID Controller, Adaptive Filters,2-D Signal Processing. Implementation of FFT Algorithms: An FFT Algorithm for DFT Computation, A Butterfly Computation, Overflow and scaling, Bit reversed index generation, An 8-point FFT implementation on the TMS320C54XX,Computation of signal spectrum.

UNIT-V:

INTERFACING MEMORY AND I/O PERIPHERALS TO PROGRAMMABLE DSP DEVICES: Memory space organization, External bus interfacing signals, Memory interface, parallel I/O interface, Programmed I/O, Direct Memory access(DMA).A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC-DSP interface example.

TEXT BOOKS:

1. Digital signal processing-S.Salivahanan, A.Vallavaraj .C.Gnanpriya-TMH-2nd reprint 2001.
2. Theory and applications of digital signal processing – Lourens R Rebinarand Bernold.
3. Digital filter analysis and design auntoniam-TMH.

REFERENCE BOOKS:

1. Digital signal processing-Sanjit K.Mitra-TMH second edition
2. Discrete time signal processing – LAN V.OPPHENHEIM,RONALD W.Shafer-PHI 1996 1st edition reprint
3. Digital signal processing principles – algorithms and applications-John G.Proakis-PHI-3rd edition2002.

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS
(Elective-I)

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. Digital logical gates programming in the Boolean algebra SYSTEM, CONVERSION EXAMPLES- Ladder diagrams for process control – Ladder diagrams for sequence listings – ladder diagram construction and flow chart for spray process system.

UNIT-III:
PLC Registers: Characteristics of registers – module addressing – holding registers – output registers – PLC functions – Timer functions and industrial application counters – counter function industrial application – Architecture functions – number function comparison functions.- number conversion functions.

UNIT–IV:
Data handling functions: SKIP, Master control relay – Jump Move FIFO, FAL, ONS, CLR and sweep functions and their applications.
Bit pattern and changing a bit shift register, sequence functions and applications – controlling of two axes and three axis Robots with PLC, Matrix functions.

UNIT-V:
Analog PLC operation: Analog modules and systems – Analog signal processing, multi-bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

TEXT BOOKS:
1. Programmable Logic Controllers, W. Bolton, Elsevier.
2. Programmable Logic Controllers – Programming methods and Applications by J R Hackworth and F D Hackworth Jr - Pearson Publications – 200

REFERENCE BOOKS:
1. Programmable Logic Controllers – Principles and Applications by John W Webb and Ronald A Reiss – Fifth edition – PHI

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

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

UNIT-III:
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-IV:
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 de-multiplexers - Digital multiplexers.

UNIT-V:
DATA TRANSMISSION, TELEMETRY AND DISPLAY: Characteristics of a Telemetry system - landline telemetry - radio telemetry - frequency division multiplexing - time division multiplexing.
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.

TEXT BOOK:

1. D.V.S.Murthy, Transducers & Instrumentation; Prentice Hall of India Pvt. Ltd., First edition – 1995.
2. Electrical and Electronic Measurements and Instrumentation, R. K. Rajput, S. Chand & Company Ltd.

REFERENCE BOOK:

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

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

PROCESS MODELING AND SIMULATION
(Elective-I)

UNIT- I:

INTRODUCTION TO MODELLING: Introduction to modeling, a systematic approach to model building, classification of models. Conservation principles, thermodynamic principles of process systems.

UNIT-II:

STEADY STATE AND DYNAMIC MODELS OF PROCESS SYSTEMS-I: Development of steady state and dynamic lumped and distributed parameter models based on first principles. Analysis of ill-conditioned systems.

UNIT–III:

STEADY STATE AND DYNAMIC MODELS OF PROCESS SYSTEMS-II: Development of grey box models. Empirical model building. Statistical model calibration and validation. Population balance models. Examples.

UNIT-IV:

SOLUTION STRATEGIES FOR LUMED PARAMETER MODELS: Solution strategies for lumped parameter models. Stiff differential equations. Solution methods for initial value and boundary value problems. Euler's method. R-K method, shooting method, finite difference methods. Solving the problems using *MATLAB/SCILAB.*

UNIT-V:

SOLUTION STRATEGIES FOR DISTRIBUTED PARAMETER MODELS: Solution strategies for distributed parameter models. Solving parabolic, elliptic and hyperbolic partial differential equations. Finite element and finite volume methods.

TEXT BOOK:

1. K. M. Hangos and I. T. Cameron, "Process Modeling and Model Analysis", Academic Press, 2001.

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

EMBEDDED SYSTEMS
(Elective-II)

UNIT-I:

OVERVIEW OF EMBEDDED SYSTEM: Embedded system, types of embedded systems, 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 drivers parallel and serial port device drives in a system, interrupt servicing mechanism and context & 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 multiprocessors 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 code sign issues in software development, design cycle in development phase for embedded systems, use of ICE & software tools for development of ES, Issues in embedded system design.

TEXT BOOK

1. Embedded systems: Architectures, programming and Design – Rajkamal, TMH 200.

REFERENCE BOOK:

1. Programming for Embedded systems: Dream-Tech software Team-John Wiley-2002

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

ROBOTICS AND CONTROL
(Elective-II)

UNIT-I:

SPATIAL DESCRIPTIONS AND TRANSFORMATIONS: Introduction - Descriptions: positions, orientations and frames -Mappings: Changing descriptions from frame to frame - Operators: translations, rotations, transformations, Transformation arithmetic - Transform equations - More on representation of orientation - Transformation of free vectors - Computational considerations. Manipulator Kinematics Introduction - Link description - Link connection description - convention for affixing frames to links - Manipulator kinematics -Actuator space, Joint space and Cartesian space-Examples: Kinematics of two industrial robots-Computational considerations

UNIT-II:

INVERSE MANIPULATOR KINEMATICS: Introduction – Solvability -The notation of manipulator subspace when n<6 -Algebraic Vs. Geometric- Algebraic solution by reduction to polynomial - Pieper's solution when three axes intersect -Examples of inverse manipulator kinematics -The standard frames -solving a manipulator -Repeatability and accuracy -Computational considerations.

Jacobians: Velocities and Static Forces: Introduction- Notation for time varying position and orientation -Linear and Rotation of velocity of rigid bodies -More on angular velocity - Motion of the links of a Robot -Velocity " propagation" from link to link – Jacobians – Singularities- Static forces in Manipulators -Jacobians in the force domain - Cartesian transformation of velocities and static forces.

UNIT-III:

MANIPULATOR DYNAMICSL: Introduction, Acceleration of a rigid body, Mass distribution, Newton's Equation, Euler's equation, Iterative Newton –Euler dynamic formulation, Iterative Vs. Closed form, An example of closed form dynamic equations, The structure of the Manipulator dynamic equations, Lagrangian Formulation of manipulator Dynamics, Formulating manipulator dynamics in Cartesian space, Computational considerations. **:** Linear Control of Manipulators: Introduction, Feedback and closed loop control, Second order linear systems, Control of second order systems, Control law partitioning – Trajectory, Following control, Disturbance rejection, Continuous Vs. Discrete time control, Modeling and control of a single joint, Architecture of industrial robot controller.

UNIT-IV:

NON - LINEAR CONTROL OF MANIPULATORS: Introduction, Nonlinear and time, varying systems, multi - input, Multi-output control systems, the control problem for manipulators, Practical considerations, Present industrial robot control systems, Lyapunov stability analysis, Cartesian based control systems - adaptive control.

UNIT-V:

FORCE CONTROL OF MANIPULATOR: Introduction - Application of Industrial robots to assembly tasks - A frame work for control in partially constrained tasks - The hybrid position/force control problem - Force control of a mass - spring - The hybrid position / force control scheme - Present industrial robot control scheme.

TEXT BOOKS:

1. J. J. Craig, Introduction to Robotics, Addison Wesley, 1986.
2. Mark W. Sponge, Sethhutchinson and M. Vidyasagar Robot modeling and Control, Wiley student Edition, 2006.

REFERENCES:

1. Tsuneo Yoshikawa, Foundations of Robotics –Analysis and Control, Eatern economy Edition, 1990

2. Znihua Qu and Drasen M Dawson, Robust Tracking Control of Robot Manipulators, IEEE Press, 1996.
3. J. J. Craig, Adaptive Control of Mechanical Manipulators, Addison Wesley, Reading MA, 1988.

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

ADVANCED MICROPROCESSORS
(Elective-II)

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, and 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 systems, virtual memory, paging, segmentation.

UNIT-IV:

ADVANCED PROCESSORS: Architectural features of 80836,486 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:

MICROOCNTROLLER: Microcontrollers – 8051 architectures, hardware, interrupts, addressing modes, instruction set –programming-applications.

TEXT BOOKS:

1. Intel microprocessors, architecture, programming and interfacing 8086/8088, 80186,80836 and 80846-BARRY b.Brey.PHI-5th edition-2001
2. Advanced microprocessors-TABAK-McGraw-Hill Inc 2ns edition.
3. Advanced microprocessors and peripherals A.K. Ray and K M Bhurchandani TMH
4. Microprocessors, Nilesh B. Bahadure, PHI Learning PVT. Ltd.

REFERENCE BOOKS:

1. 8051 microcontroller – architecture programming & applications-K.J.Ayala-penram Intl.
2. Programming & customizing the 8051 microcontroller – Myke Pretko – TMH,1st edition ,1999
3. The 8088 and 8086 microprocessor-W.A.Triebel &Avtar singh-PHI,4th edition 2002.
4. Microprocessors and Interfacing N. Senthil, Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah Oxford University press.
5. Microprocessors, Pc Hardware and Interfacing, n. Mathivanan, PHI Learning PVT. Ltd.
6. Microprocessors and Microcontrollers, Aechitecture, Programming and System Design, Krishna Kant, PHI Learning PVT. Ltd.

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M. Tech – I Year – I Sem. (Control Sys. / Control Engg.)

CONTROL ENGINEERING AND SIMULATION LAB

Any ten experiments form the following can be conducted:

1. Determinations of Transfer function of DC motor.
2. Time Response Characteristics of a Second order System (Typical RLC network).
3. Characteristics of Synchros:
   (a) Synchro transmitter characteristics.
   (b) Implementation of error detector using synchro pair.
4. Determination of Magnetic Amplifier Characteristics with different possible connections.
5. Process Control Simulator:
   (a) To determine the time constant and transfer function of first order process.
   (b) To determine the time response of closed loop second order process with Proportional Control.
   (c) To determine the time response of closed loop second order process with Proportional-Integral Control.
   (d) To determine the time response of closed loop second order process with Proportional-Integral-Derivative Control.
   (e) To determine the effect of disturbances on a process.
6. To study the compensation of the second order process by using:
   (a) Lead Compensator.
   (b) Lag Compensator.
   (c) Lead- Lag Compensator
7. Realization of AND, OR, NOT gates, other derived gates and ladder logic on Programmable Logic Controller with computer interfacing.
8. To determination of AC servomotor Characteristics.
9. To study the position control of DC servomotor with P, PI control actions.
10. Temperature controller using PID
11. Linear System Analysis(Time domain analysis, error analysis) using MATLAB
12. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system using MATLAB.
13. State space model for classical transfer function using MATLAB-Verification.
14. Microprocessor based stepper motor control.
15. Transfer function of DC generator.

TEXT BOOKS:

1. PSPICE reference guide – Microsim, USA
2. MATLAB and its tool books user's manual and –Mathworks, USA.

REFERENCE BOOKS:

1. Simulation of electrical and electronics circuits using PSPICE-By M.H.Rashid.M/s PHI publications.
2. PSPICE A/D user's manual – Microsim USA

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M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

OPTIMAL CONTROL THEORY

UNIT-I:

Optimal control law, the principal of optimality, application of their optimality principle to decision making, an optimal control system. Recurrence relation of dynamic programming, computational procedure for solving control problem, characteristics of dynamic programming solution.

UNIT-II:

Discrete linear regulator problem. Hamilton –jocobi-bellman equation. Continuous linear regulator problems, necessary and sufficient conditions examples.The calculus of variations & Pontrygin's minimum principle**:** Fundamental concepts, functional of a single function, functional involving several independent functions, necessary conditions for optimal control, linear regulator problem.

UNIT-III:

Pontrygin's minimum principle and state inequality constrains, minimum time problems, minimum control effort problems. Iterative numerical techniques for finding optimal controls and trajectories**:** Two point boundary value problems, method of steepest descent algorithm, variation of extremalas, variation of extremal algorithm, gradient projection algorithm

UNT-IV:

The nature of the state estimation problem, non-statistical estimation design with full estimator dimension, non-statistical estimation with reduced estimator design.

UNIT-V:

Description of plants noise statistics, statement of optimal estimation problem, information 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.

TEXT BOOKS:

1. Jasbir S. Arora, Introduction to optimum design, Elesevier, 2005.
2. A Ravindran, K.M. Ragsdell, and G.V. Reklaitis, Engineering optimization : Methods and applications, Wiley India Edition.
3. Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition, 1970.

REFERENCE BOOKS:

1. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002.
2. Arturo Locatelli, Optimal control: An Introduction, Birkhauser Verlag, 2001.
3. S.H.Zak, Systems and Controll, Indian Edition , Oxford University, 2003.
4. Niclas Anreasson, Anton Evgrafov and Michael Patriksson, An introduction to continuous optimization, Overseas Press (India) Pvt. Ltd.
5. Optimal control systems-A.P. Sage
6. Optimal Theory and application –Dr.S.S.Rao-eastern Willy- First edition

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M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

ADAPTIVE CONTROL THOERY

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 - Model Reference Adaptive System Design based on Gradient method, Design of stable adaptive controllers based on Kalman - Meyer - Yakubovich Lemma, Lyapunov theory, Hyper stability theory - 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 (STR) - different approaches to self tuning - Recursive parameter estimation - implicit STR - Explicit STR. hybrid STR, hybrid predictor design and algorithms. STR design based on pole - placement technique and LQG theory - Gain scheduling. - Stability of adaptive control algorithms.

UNIT-IV:

Adaptive control of nonlinear systems - Adaptive predictive control - Robustness of adaptive control systems - Instability phenomena in adaptive systems. Concept of learning control systems. Different types of learning control schemes. LTI learning control via parameter estimation schemes. Convergence of learning control. Fuzzy logic adaptive control ,stochastic adaptive control –multi decision problems-dual control.

UNIT-V:

Case Studies: Robotic manipulators, Aerodynamic curve identification, Electric drives, Satellite altitude control, regulators, power system, electrical generator.

TEXT BOOKS:

1. K.J.Astrom and Bjorn Witten mark, Adaptive control, Pearson Edu., 2nd Edn.
2. Sankar Sastry, Adaptive control.

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REFERENCE BOOKS:

1. V.V.Chalam, Adaptive Control System - Techniques & Applications, Marcel Dekker Inc.
2. Miskhin and Braun, Adaptive control systems, MC Graw Hill
3. Karl Johan Åström, Graham Clifford Goodwin, P. R. Kumar, Adaptive Control, Filtering and Signal Processing
5. G.C. Goodwin, Adaptive control.
6. Narendra and Anna Swamy, Stable Adaptive Systems.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

NEURAL NETWORK AND FUZZY SYSTEMS

UNIT-I:

Biological neuron Vs artificial neuron, structure and activation functions – Neural network architectures –learning methods, stability and convergence .Single layer networks –Mcculloh–pitts neuron model, Perceptron training and algorithm, delta learning, widrow-Hoff learning rules, limitations, adaline and modification.

UNIT-II:

Multilayer networks, architectures and modeling, BP algorithm, radial basis functions. Unsupervised learning-Winner all learning, out star learning, Counter propagation networks, self organizing networks-Kohonen.

UNIT-III:

Grossberg, Hamming NET, MAXNET, Hopfiled networks, recurrent and associative memory, BAM and ART architectures Fuzzy sets and systems – geometry of fuzzy sets – theorems – fuzzy and neural function estimators – FAM system architectures – Uncertainty and estimation – Types of uncertainty.

UNIT-IV:

Measures of Fuzziness – Classical measures of uncertainty – measures of Dissonance – confession specificity – knowledge base defuzzifictuon.

UNIT-V:

Application to load forecasting, load flow, fault detection-unit commitments, LF control – economic dispatch, Neuro-Fuzzy controllers.

TEXTBOOK:

1. Artificial neural networks – B.Yegna Narayana –phi -1st edition 1999.
2. Neural networks – Simon Haykin – prentice hall international inc.1999.

REFERENCE BOOKS:

1. Neural networks and fuzzy system – Bart Kosko – 2nd edition, 2001.
2. Neural network fundamentals with graphs, algorithms & applications – N.K.Bose and Liang –McGraw hill, 1996.
3. Fuzzy logic with fuzzy applications – T.J.Rosee-Mcgraw hill Inc .1997.
4. Fuzzy Logic and Neural Networks, M. Amirthavalli, Scitech Publications India Pvt. Ltd.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

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

UNIT- II:

MODELS FOR DETERMINISTIC DISTURBANCES AND REFERENCES : Internal Model principle for disturbance and for reference tracking, feed forward control-cascade control, dealing with Constraints and SISO Controllers Parameterizations: windup, anti windup scheme, state saturation, introduction to model predictive control, preview-open loop inversion revisited.

UNIT-III:

AFFINE PARAMETERIZATION: The stable case PID synthesis by using the affine paramertization, affine parametization for systems having time delays, undesirable closed loop poles, affine parameterization: the unstable open loop case. Analysis of MIMO control loops: Preview –motivational examples, models for multi variable systems, the basic MIMO control loop.

UNIT-IV:

CLOSED LOOP STABILTY : Steady state response for steps inputs, frequency domain analysis, Robustness issues-problems, Exploring SISO Techniques in MOMO 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-anti windup-revisited-what is model predictive control –stability-linear models with quadratic cost function-state estimation and disturbance prediction.

TEXT BOOKS:

1. MATLAB control system toolbox
2. Control system design – Graham C Good win-Stefan F.Graebe Mario E.Salgado-Pearson Publications-2003

REFERENCE BOOK:

1. Computer aided design of control systems-by Resenbrock (Academic press)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

NONLINEAR SYSTEMS
(Elective-III)

UNIT-I:
Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non - linear systems using phase plane technique.Existence of limit cycles. Linearization: Exact linearization, input - state linearization, input - output linearization.

UNIT-II:
Linear versus nonlinear systems - Describing function analysis: Fundamentals, common nonlinearities (saturation, dead - zone, on - off non - linearity, backlash, hysteresis) and their describing functions.Describing function analysis of nonlinear systems. Reliability of describing method analysis. Compensation and design of nonlinear system using describing function method.

UNIT-III:
Concept of stability, stability in the sense of Lyapunov and absolute stability. Zero - input and BIBO stability. Second (or direct) method of Lyapunov stability theory for continuous and discrete time systems.Aizerman's and Kalman's conjecture. Construction of Lyapunov function - Methods of Aizerman, Zubov, Variable gradient method. Lure problem.

UNIT-IV:
Popov's stability criterion, generalized circle criterion, Kalman - Yakubovich - Popov Lemma. Popov's hyperstability theorem.

UNIT-V:
Concept of variable - structure controller and sliding control, reaching condition and reaching mode, implementation of switching control laws. Reduction of chattering in sliding and steady state mode. Some design examples of nonlinear systems such as the ball and beam, flight control, magnetic levitation and robotic manipulator etc.

TEXT BOOKS:

1. J. E. Slotine and Weiping LI, Applied Nonlinear Control, Prentice Hall,
2. Hassan K. Khalil, Nonlinear Systems, Prentice Hall, 1996

REFERENCE BOOKS:

1. Sankar Sastry, Nonlinear Systems Analysis, Stability and Control.
2. M. Vidyasagar, Nonlinear Systems Analysis, Prentice - Hall International editions,1993.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

DISTRIBUTED CONTROL SYSTEMS
(Elective-III)

UNIT-I:

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

UNIT-II:

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

Supervising Control systems, multi layer hierarchical structure, system decomposition, open loop co-ordination strategies, model reality differences,

UNIT-III:

closed loop co-ordinate strategies, integrated system, Optimization of parameter (ISOPE), double interactive systems.

Real time control systems: Design techniques and tools-MASCOT, Structured development of real time system,

UNIT-IV:

Fault tolerance in mixed hardware-software systems- fault detection, measures-fault detection mechanism-Damage confident and assessment.

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 BOOKS:

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

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

PROCESS DYNAMICS AND CONTROL
(Elective-III)

UNIT-I:
Introduction to Process Control, Illustrative Example, Classification of Control Strategies, Process Control and Block Diagrams, Control and Modeling Philosophies, Dynamic versus Steady - state Models, General Modeling Principles, Models of Several Representative Processes, Solution of Dynamic Models and the Use of Digital Simulators.

UNIT-II:
Development of a Transfer Function, Linearization of Nonlinear Models, Response of Integrating Process Units, Poles and Zeros and their Effect on System response, Time Delays, Approximation of Higher - Order Systems, Interacting and Non interacting Processes, Transfer function Models for Distributed Systems, Multiple - Input, Multiple - Output (MIMO) Processes.

UNIT-III:
Feedback Controllers Stirred - Tank Heater Example, Controllers, and Digital Versions of PID Controllers, Transducers and Transmitters, Final Control Elements, Accuracy in Instrumentation.
Block Diagram Representation, Closed - Loop Transfer functions, Closed - Loop Responses of Simple Control Systems, General Stability Criterion, Routh-Stability Criterion for time delay systems, Direct Substitution method, Root Locus Diagrams.

UNIT-IV:
Performance Criteria for Closed - Loop Systems, Direct Synthesis Method, Internal Model Control, Design Relations for PID Controllers, Comparison of Controller Design Relations.
Guidelines for Common Control Loops, Trail and Error Tuning, Continuous Cycling Method, Process Reaction Curve Method, troubleshooting Control Loops.

UNIT-V:
Introduction to feed forward Control, Ratio Control, and Feed forward Controller Design based on Steady - State Models, Controller Design based on Dynamic Models, Tuning Feed forward Controllers, Configurations for Feed forward - Feedback Control. Process Interactions and Control Loop Interactions, Pairing of Controlled and Manipulated Variables, Strategies for Reducing Control Loop Interactions, Decoupling Control Systems, Multivariable Control Techniques.

TEXT BOOKS:

1. Dale E. Seborg, University of California, Santa Barbara, Thomas F. Edgar, University of Texas at Austin, Duncan A. Mellichamp, University of California, Santa Barbara, Process Dynamics and Control, John Wiley & Sons, 1989.
2. Dale E. Seborg, University of California, Santa Barbara, Thomas F. Edgar, University of Texas at Austin, Duncan A. Mellichamp, University of California, Santa Barbara, Process Dynamics and Control, John Wiley & Sons, 2nd Edition, 2004.

REFERENCE BOOKS:

1. Brian Roffel, Ben Betlem, Process Dynamics and Control Modeling for Control and Prediction, John Wiley & Sons Ltd., 2007.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

ADVANCED DIGITAL SIGNAL PROCESSING
(Elective-IV)

UNIT–I:
DIGITAL FILTER STRUCTURES: Block diagram representation – Equivalent Structures – FIR and IIR digital filter Structures AII pass Filters-tunable IIR 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 Low pass high pass – Band pass, and Band stop- 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 in Low –order IIR filters- Low –Sensitivity Digital filter – Reduction of Product round-off errors feedback – Limit cycles in IIR digital filter – 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 and 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 1^{ST} Edition reprint
3. Digital Signal Processing principles – algorithms and Applications- john G. Proakis – PHI – 3^{RD} edition 2002.
4. Digital Signal Processing – S Salivahanan. A. Vallavaraj C. Gnanapriya – TMH – 2^{nd} reprint 2001.
5. Theory and Applications of Digital Signal Processing –Lourens R Rebinarand Bernold.
6. Digital Filter Analysis and Design Auntoniam – TMH.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

REAL TIME SYSTEMS
(Elective-IV)

UNIT-I:

Introduction to Real - time systems: Typical examples of RTS, Characteristic features of RT applications. Structural, Functional and Performance requirement of Reactive RTS. Distinctive features from Non - RT and Off - line system. Modeling RTS: Representation of time, Concurrency and Distributedness in discrete event systems.

UNIT-II:

Hierarchical representation of complex DES. Input, Output and Communication. Examples of modeling practical systems as RT DES. Modeling programs as RTS. Analyzing RTS: Analyzing logical properties of DES such as Reachability, Deadlock etc. Analyzing timing related properties, Specification and Verification of RT DES properties.

UNIT-III:

Temporal logic, Model checking. Example of checking safety and timing properties of industrial systems. Requirements and features of real - time Computing Environments: Real - time Operating Systems, Interrupts, clock, Device support.

UNIT-IV:

Real time System, Multi tasking, Static and Dynamical Scheduling of resource Allocation, Real - time Programming.

UNIT-V:

Real - time process and applications, Distributed Real - time systems.

TEXTBOOK:

1. Real- Time Systems, 1/e,Pearson publisher,Jane W S Liu 1st edition.

REFERENCE BOOK:

1. **Real**-**Time Systems**: Theory and Practice, Computer Science,Engineering and Computer Science,Higher Education,Rajib Mall, Pearson Education, **India.**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

INTELLIGENT AND KNOWLEDGE BASED SYSTEMS
(Elective - IV)

UNIT-I:
Problem solving: State space representation, problem reduction, constraint satisfaction networks. Heuristics. Knowledge Representation, Predicate calculus, resolution-refutation, Prolog.

UNIT-II:
Rule based systems: forward and backward chaining. Handling of uncertainty: probabilistic techniques, fuzzy logic. Reasoning with incomplete information: non monotonic reasoning. Elements of temporal logic.

UNIT-III:
Structured Knowledge Representation schemes: Semantic Networks, Frames, Inheritance and default reasoning. Description Logic.

UNIT-IV:
Expert Systems: Architecture of the expert systems. Expert system shells. Knowledge acquisition. Consistency of the knowledge base. Planning.

UNIT-V:
Case studies. Distributed AI and agent based systems

TEXT BOOK:

1. Pratihar D.K., Jain L.C., An introduction to intelligent autonomous systems, *Intelligent Autonomous Systems: Foundation and Applications,* edited by D.K. Pratihar, L.C. Jain, Springer-Verlag, Germany, pp. 1-4, 2010

REFERENCE BOOKS:

1. Hui N.B., Pratihar D.K., Design and development of intelligent autonomous robots, *Intelligent Autonomous Systems: Foundation and Applications,* edited by D.K. Pratihar, L.C. Jain, Springer-Verlag, Germany, pp. 29-56, 2010

2. Vundavilli P.R., Pratihar D.K., Gait planning of biped robots using soft computing: an attempt to incorporate intelligence, *Intelligent Autonomous Systems: Foundation and Applications,* edited by D.K. Pratihar, L.C. Jain, Springer-Verlag, Germany, pp. 57-85, 2010

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M. Tech – I Year – II Sem. (Control Sys. / Control Engg.)

SIGNAL PROCESSING LAB

1. To study the architecture of DSP chips – TMS 320C 5X/6X Instructions.
2. To verify linear convolution.
3. To verify the circular convolution.
4. To design FIR filter (LP/HP) using windowing technique
   a) Using rectangular window
   b) Using triangular window
   c) Using Kaiser window
5. To Implement IIR filter (LP/HP) on DSP Processors
6. N-point FFT algorithm.
7. MATLAB program to generate sum of sinusoidal signals.
8. MATLAB program to find frequency response of analog LP/HP filters.
9. To compute power density spectrum of a sequence.
10. To find the FFT of given 1-D signal and plot.

TEXT BOOKS:

1. Digital signal processing-Sanjit K.Mitra-TMH second edition
2. Discrete time signal processing – LA N V.OPPHENHEIM,RONALD W.Shafer-PHI 1996 1st edition reprint

REFERENCE BOOK:

1. Digital signal processing principles – algorithms and applications-John G.Proakis-PHI-3rd edition2002.