JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech. (CONTROL ENGINEERING/ CONTROL SYSTEMS)
EFFECTIVE FROM ACADEMIC YEAR 2017- 18 ADMITTED BATCH

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Modern Control Theory	25	75	4	0	0	4
PC-2	Digital Control Systems	25	75	4	0	0	4
PC-3	Estimation of Signals and Systems.	25	75	4	0	0	4
PE-1	1. Intelligent Control 2. System Dynamics and Control 3. Process Modelling and Simulation	25	75	3	0	0	3
PE-2	1. Instrumentation and Control 2. Advanced Microprocessors 3. DSP Processor Architecture and Applications	25	75	3	0	0	3
OE-1	***Open Elective – I**	25	75	3	0	0	3
Laboratory I	Control System Engineering lab-I	25	75	0	0	3	2
Seminar I	Seminar -I	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Optimal Control Theory	25	75	4	0	0	4
PC-5	Adaptive and Learning Control	25	75	4	0	0	4
PC-6	Embedded Systems and Control	25	75	4	0	0	4
PE-3	1. Programmable Logic Controllers and Applications 2. Non-linear Systems 3. Robust Control	25	75	3	0	0	3
PE4	1. Advanced Digital Signal Processing 2. Real Time Systems 3. Robotics and Control	25	75	3	0	0	3
OE-2	***Open Elective - II**	25	75	3	0	0	3
Laboratory II	Control System Engineering lab-II	25	75	0	0	3	2
Seminar II	Seminar -II	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

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

OPTIMAL CONTROL THEORY (Professional Core - IV)

Prerequisite: Control Systems

Course Objectives:

- To provide a basic knowledge of the theoretical foundations of optimal control
- To develop skills needed to design controllers using available optimal control theory and software
- To implement optimization methods for optimal control.

Course Outcomes: After the completion of this course, the student will be able to

- Understand the design and implement system identification experiments
- Apply input-output experimental data for identification of mathematical dynamical models.
- Apply singular value techniques to analyze the robustness of control systems.
- Incorporate frequency-domain-based specifications into multivariable control system designs.
- Apply H-infinity methods to design controllers

UNIT - I:
Static optimization: An overview of optimization problem - concepts and terms related to optimization - constrained and unconstrained problems and their solutions using different techniques; such as Gradient method, steepest and decent method, conjugate gradient method and Newton's method

UNIT - II:
Convex optimization: Convex set and convex function - convex optimization problem - quadratic optimization problem - Karush - Kuhn - Tucker (KKT) necessary and sufficient conditions for quadratic optimization problem.

UNIT - III:
Primal and dual optimization problem: Interior point method for convex optimization - linear programming - primal and dual problems and basic concept of multi– objective optimization problem.

UNIT - IV:
Dynamic Optimization: Concept of functional, different types of performance indices, Calculus of variation to optimal control problem - Fundamental concepts of functional involving a single and multiple independent functions, necessary and sufficient conditions for optimal solution of problem

UNIT V:
Formulation of optimal regulator control problem: State the linear quadratic regulator problem and derive the solution of optimal regulator control problem; remarks on weighting matrices, solution of Riccati equation by iterative method and eigen-value and eigen vector methods.

TEXT BOOKS:

1. Jasbir S. Arora, Introduction to optimum design, Elesevier, 2005.
2. D.S. Naidu, Optimal control systems, CRC Press, First edition, 2002.
3. Ravindran, K. M. Ragsdell, and G. V. Reklaitis, Engineering optimization: Methods and applications, Wiley India Edition.

REFERENCES:

1. Donald E. Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition, 1970.
2. Arturo Locatelli, Optimal control: An Introduction, Birkhauser Verlag, 2001.
3. S. H. Zak, Systems and Control, Indian Edition, Oxford University, 2003.
4. Niclas Anreasson, Anton Evgrafov and Michael Patriksson, An introduction to continuous optimization, Overseas Press (India) Pvt. Ltd.

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

ADAPTIVE AND LEARNING CONTROL (Professional Core - V)

Prerequisite: Control Systems

Course Objectives:

- To present an overview of theoretical and practical aspects of adaptive control
- To understand and apply adaptive controls in practical and industrial control systems.

Course Outcomes: After completion of this course, the student should be able to:

- Design and implement system identification experiments
- Utilize input-output experimental data for identification of mathematical dynamical models.
- design adaptive controls using system identification methods

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 .

UNIT - III
Self Tuning Regulators (STR) - different approaches to self tuning - Recursive parameter estimation - implicit STR - Explicit STR. STR design based on pole - placement technique and LQG theory.

UNIT - IV
Adaptive control of nonlinear systems - Adaptive predictive control - Robustness of adaptive control systems - Instability phenomena in adaptive systems.

UNIT - V
Concept of learning control systems. Different types of learning control schemes. LTI learning control via parameter estimation schemes. Convergence of learning control.

TEXT BOOKS:

1. K. J. Astrom and Bjorn Wittenmark, “Adaptive control”, Pearson Edu., 2nd Edition.
2. Sankar Sastry, “Adaptive control”.
3. K. S. Narendra and A. M. Annaswamy, Stable Adaptive Systems, Prentice Hall INC, 2012.

REFERENCES:

1. V. V. Chalam, “Adaptive Control System - Techniques & Applications”, Marcel Dekker Inc.
2. Miskhin and Braun, Adaptive control systems, McGraw Hill
3. Karl Johan Åström, Graham Clifford Goodwin, P. R. Kumar, “Adaptive Control, Filtering and Signal Processing”
4. G. C. Goodwin, “Adaptive control”.

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

EMBEDDED SYSTEMS AND CONTROL (Professional Core - VI)

Prerequisite: Microprocessors and Interfacing Devices

Course Objectives

- To Comprehend the general embedded system concepts , design of embedded hardware and software development tools
- To explain the basics of real time operating and embedded systems
- To describe key issues such as CPU scheduling, memory management, task synchronization, and file system in the context of real-time embedded systems.

Course Outcomes: Upon the completion of the subject, the student will be able to

- Gain knowledge and skills necessary to design and develop embedded applications based on real time operating systems.
- Analyze and design embedded systems and real time systems
- Define the unique design problems and challenges of real time systems
- Identify the unique characteristics of real time operating systems and evaluate the need for real time operating system
- Explain the general structure of a real time system and understand and use RTOS to build an embedded real time system

UNIT – I

An Introduction To Embedded Systems: An Embedded system, processor in the system, other hardware units, software embedded into a system, exemplary embedded systems, embedded system – on – chip (SOC) and in VLSI circuit. Processor and memory organization – Structural Units in a Processor, Processor selection for an embedded system, memory devices, memory selection for an embedded systems, allocation of memory to program cache and memory management links, segments and blocks and memory map of a system, DMA, interfacing processors, memories and Input Output Devices.

UNIT – II

Devices And Buses For Device Networks: I/O devices, timer and counting devices, serial communication using the “I2 C” CAN, profibus foundation field bus. and advanced I/O buses between the network multiple devices, host systems or computer parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X and advanced buses.

UNIT - III

Device Drivers And Interrupts Servicing Mechanism: Device drivers, parallel port and serial port device drivers in a system, device drivers for internal programmable timing devices, interrupt servicing mechanism

UNIT – IV

Programming Concepts And Embedded Programming In C, C++, Vc++ And Java: Inter process communication and synchronization of processes, task and threads, multiple processes in an application, problem of sharing data by multiple tasks and routines, inter process communication.

UNIT - V:
Hardware: software co-design in an embedded system, embedded system project management, embedded system design and co-design issues in system development process, design cycle in the development phase for an embedded system, use of target systems, use of software tools for development of an embedded system, use of scopes and logic analysis for system, hardware tests. Issues in embedded system design.

TEXTBOOKS

1. Embedded systems: Architecture, programming and design by Rajkamal, TMH
2. Embedded system design by Arnold S Burger, CMP

REFERENCES

1. An embedded software primer by David Simon, PEA
2. Embedded systems design: Real world design be Steve Heath; Butterworth Heinenann, Newton mass USA 2002
3. Data communication by Hayt.

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

PROGRAMMABLE LOGIC CONTROLLERS AND APPLICATIONS (PE – III)

Prerequisite: No Prerequisite

Course Objectives:
- It is to provide and ensure a comprehensive understanding of using advanced controllers in measurement and control instrumentation.
- To illustrate about data acquisition - process of collecting information from field instruments.
- To analyze Programmable Logic Controller (PLC), IO Modules and internal features.
- To Comprehend Programming in Ladder Logic, addressing of IO.
- To apply PID and its Tunning.

Course Outcomes:
- Describe the main functional units in a PLC and be able to explain how they interact.
- They should know different bus types used in automation industries.
- Development of ladder logic programming for simple process.
- At the end of each chapter, review question, problems given to reinforce their understanding of the concepts.

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 logic gates programming in the Boolean algebra system, conversion examples Ladder diagrams for process control Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT- III:
PLC Registers: Characteristics of Registers module addressing holding registers input registers, output registers. PLC Functions Timer functions and industrial applications counters counter function industrial applications, Architecture functions, Number 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 – Principle and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI
2. Digital Design by Morris Mano, PHI, 3rd Edition 2006.

REFERENCE BOOKS:
1. Programmable logic Controllers, Frank D. Petruzella, 4th Edition, McGraw Hill Publishers.
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth & F.D Hackworth Jr. – Pearson, 2004.

3. Programmable logic controllers and their Engineering Applications, 2nd Edition, Alan J. Crispin.

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

NON LINEAR SYSTEMS (PE - III)

Course Objectives:
- To provide various methods of analysis and design of nonlinear control systems.
- To introduce nonlinear deterministic dynamical systems, and their applications to nonlinear circuits and control systems.

Course Outcomes: Upon the completion of this course, the student will be able to
- Know control systems of practical importance are inherently nonlinear,
- Analyze nonlinear systems and controllers.
- Apply various stability criteria to control systems

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

REFERENCES:
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 Engg. / Control Sys.)
ROBUST CONTROL (PE – III)

Prerequisite: Control Systems
Course Objectives:

- To understand the concepts of optimal and robust control,
- To enable to analyze and design a robust Control System.

Course Outcomes: Upon the completion of this course, the student will be able to

- Have knowledge on Parametric Optimization
- Acquire knowledge of Calculus of variations, Pontryegans Max/min Principle, learn Dynamic Programming in Continuous and Discrete Time
- Apply iterative methods of optimization,
- Analyze and design a robust Control System.

UNIT - I
Overview and Preliminaries: Overview on Robust control, Basics from Matrix Algebra, Norms of signals and systems (L_2, H_2, L_∞, H_∞). Convex Optimization: Convexity, Convex sets, Affine function, Linear matrix inequality (LMI), Projection lemma, S-procedure, Semi-definite programming, Feasibility problem, Minimization problem, Generalized eigen value problem, Programming in MATLAB.

UNIT - II
System properties and stability: Well-posedness, Causality, Passivity, Bounded-realness, Positive-realness, Internal stability, Bounded-Input-Bounded-Output stability, Finite-gain stability.

UNIT - III
Robust performance and Linear Fractional Transformation: Robust performance and limitations due to physical constraints, Linear Fractional Transformation (LFT), Uncertainties, Riccati equation and inequality. Useful Lemmas and Theorems in Robust Control: KYP Lemma, Bounded-real lemma, Positive-real lemma, Small-gain theorem, Passivity theorem.

UNIT - IV
H-infinity controller synthesis: Generalized H-infinity controller synthesis problem, Controller design via LMI approach. H-infinity Loopshaping Design: Four-block problem, Loopshaping concept, Weight selection, Controller synthesis via LMI.

UNIT - V
Mu Analysis and Synthesis: Robust stability and performance problems, structured singular value, D-scaling problem, D-K Iteration.

TEXT BOOKS:

1. Da-Wei Gu Petko Petkov, Mihali M Konstantinov, Robust Control Design with MATLAB, Springer – 2013.
2. Sigurd Skogestad, Ian Postlethwaite, Multivariable Feedback Control: Analysis and Design, John Wiley, 2005.
3. Kemin Zhou, John Constock Doyle, Kith Glovr, Robust and Optimal Control, PH Inc., 1996

REFERENCES:

1. Michael Green, David J.N. Limebeer, Linear Robust Control, PH Inc., 1995.
2. Uwe Mackenroth, Robust Control Systems : Theory and Case Studies, Springer, 2013.
3. S.O. Reza Moheimani, Perspective in Robust Control, Sprinter, 2001.

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

ADVANCED DIGITAL SIGNAL PROCESSING (PE – IV)

Prerequisite: Digital signal processing

Course Objectives:

- To emphasize the advanced concepts of digital signal processing and the mathematical basis of discrete time signal analysis.
- To introduce the implementation of DSP algorithms and power spectrum analysis.

Course Outcomes: Upon the completion of this course, the students will be able to

- Solve the various types of practical problems of DSP processors.
- Develop DSP based real time systems.
- Design and analyze various filters.

UNIT– I:
Digital Filter Structures: Block diagram representation – Equivalent Structures – FIR and IIR digital filter Structures All 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.

TEXT BOOKS:

1. Sanjit K. Mitra, Digital signal processing – TMH second edition
2. Alan V. Oppenheim, Ronald W, Shafer, Discrete Time Signal Processing – PHI 1996 1ST Edition reprint
3. John G. Proakis, Digital Signal Processing principles – Algorithms and Applications – PHI – 3RD edition 2002.

REFERENCES:

1. S Salivahanan. A. Vallavaraj C. Gnanapriya, Digital Signal Processing – TMH – 2nd reprint 2001.
2. Lourens R Rebinarand Bernold, Theory and Applications of Digital Signal Processing.
3. Auntoniam, Digital Filter Analysis and Design, TMH.

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

REAL TIME SYSTEMS (PE - IV)

Course Objectives:
- To introduce multi tasking techniques in real time systems
- To introduce the theory of formal verification methods and techniques used for real time and hybrid systems.

Course Outcomes: Upon the completion of this course, the student will be able to
- identify multi tasking techniques in real time systems
- evaluate the performance of soft and hard real time systems
- analyze multi task scheduling algorithms for periodic, aperiodic and sporadic tasks
- design real time operating systems and hybrid systems.
- know the methods and techniques used in industries for the verification of Real Time & Hybrid systems.

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. Jane W S Liu, Real- Time Systems, Pearson Education, 1st edition.

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

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

ROBOTICS AND CONTROL (PE - IV)

Course Objectives:

- To understand basic mathematics involved in the design of robotic manipulators, robotic configurations
- To introduce necessary mathematical models to estimate position, velocity, and force required to operate these robotic manipulator.
- To understand various robotic manipulators and the design criteria for linear and non-linear systems.

Course Outcomes: Upon the completion of this course, the student will be able to

- Develop the skills of mathematics and modeling techniques for the design of position, velocity, acceleration, and force of robotic manipulators.
- Design and analyze linear and non-linear control systems.

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.

UNIT - II:
Manipulator Kinematics and Inverse 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 - III:
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 - IV:
Manipulator Dynamics: 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 - V:
Non - Linear Control & Force 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. A frame work for force control of a spring mass systems.

TEXT BOOKS:

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, Wiley Publications, 2005.
2. J. J. Craig, 'Introduction to Robotics', Addison Wesley, 1986.
3. 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.

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

CONTROL SYSTEM ENGINEERING LAB - II

Course Objectives:

- To acquire knowledge on control aspects of an electrical system.
- To become familiar with the use of simulation tools for the purpose of modeling, analysis and design of systems

Course Outcomes: Upon the completion of this course, the student will be able to

- Represent various discrete time systems
- Analyze the given system by Transfer function and state space approach using suitable software.
- Design various controllers and compensators to improve system performance and test them in the laboratory as well as using suitable software.
- Model the given system and its stability Analysis

1) Illustrate the Effect Of Feedback On Disturbance & Control System design
2) Obtain the realization of PID controller and verify the results through computer simulations.
3) Obtain the realization of classical compensators and verify the results through computer simulations.
4) Find a vector *x* that is a local minimum to a scalar function *f*(*x*) subject to constraints on the allowable *x*: $\min_x f(x)$such that one or more of the following holds: *c(x) ≤ 0, ceq(x) = 0, A·x ≤ b, Aeq·x = beq, l ≤ x ≤ u*.
5) Minimize the integral subject to the fixed endpoint conditions (the constraint on the problem)
6) Find the minir $I = \int_{x_1}^{x_2} f(x, y, y')dx$ jiven $y(x_1) = a$ $y(x_2) = b$ l point and variable end pc
7) Obtain the optimal control for finite state and infinite state regulator problem.
8) Implementation of Adaptive control based on MIT rule and Liapunov theory.
9) Consider the process$G(s) = \frac{1}{s(s+a)}$, where a is an unknown parameter. Assume that the desired closed-loop system is $G_m(s) = \frac{w^2}{s^2+2\xi ws+ w^2}$. Construct continuous and discrete-time indirect self tuning algorithms for the system.
10) Obtain the solution of finite time and infinite time state regulator problem.
11) Program to interface keypad with 89C51. Whenever a key is pressed, it should be displayed on LCD.
12) Program to interface seven segment display unit with 89C51.
13) Program to interface Stepper Motor with 89C51 to rotate the motor in clockwise and anti clockwise directions.
14) Generation of PWM Signal

Note: : Minimum of Ten experiments out of which six experiments related to core courses are to be conducted.