GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRONICS (10)

DIGITAL CONTROL

SUBJECT CODE: 2161007

B.E. 6th SEMESTER

Type of course: Introduce the Fundamental concepts, principles and application of digital control system analysis and design to the under graduate student.

Prerequisite: Knowledge of topics of control systems and discrete system. S-domain, frequency domain, analyzing and solving linear digital systems.

Rationale: This course explores the fundamentals of discrete control systems and optimal control. The course has two primary focuses:

(1) Understanding and predicting system behavior, and

(2) Design and analysis of optimal control systems.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	**Introduction to Discrete Time Control System** Basic building blocks of Discrete time Control system, Sampling Theorem, Z transform and Inverse Z transform for applications for solving differential equations, Mapping between the S-plane and the Z-plane, Impulse sampling and Data Hold.	6	14-16
2	**Pulse Transfer Function and Digital PID Controllers** The pulse transfer function, pulse transfer function of Closed Loop systems, Pulse transfer function of Digital PID controller, Velocity & Position forms of Digital PID Controller, Realization of Digital Controllers, Deadbeat response and ringing of poles	6	14-16
3	**Design of Discrete Time Control System by conventional methods** Stability analysis in Z-plane, Jury stability criterion, Bilinear transformations,Design based on the root locus method, Digital Controller Design using Analytical Design Method.	8	18-22
4	**State Space Analysis of Discrete Time Control System** State space representation of discrete time systems, Solution of discrete time state space equations, Pulse transfer function matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization, Discretization of continuous time state space equations, Similarity transformations.	7	15-18

5	**Pole Placement and Observer Design** Concept of Controllability and Observability, Useful transformations in state space analysis and design, Stability improvement by state feedback, Design via pole placement, State observers.	**7**	**15-18**
6	**Optimal Control** Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State Quadratic Optimal Control.	**6**	**14-16**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	**15%**	**20%**	**20%**	**15%**	**15%**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition.
2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill.
3. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition
4. Digital control of Dynamic Systems by G.F.Franklin, J.David Powell, Michael Workman 3rd Edition, Addison Wesley .
5. Digital Control Engineering by M. Gopal, Wiley Eastern Ltd.
6. Digital Control by Kannan Moudgalya, John Wiley and Sons.
7. Digital Control Systems by Contantine H. Houpis and Gary B. Lamont, Second Edition, McGraw-Hill International.

Course Outcome:

At the successful completion of this course, a student will be able to:

1. Understand the role of digital computers in control system design and applications
2. Be familiar with Z-transform and sampled data systems.
3. Be able to design digital controller using root locus method.
4. Appreciate the issues associated with the implementation of digital controllers.
5. An ability to use modern engineering techniques for analysis and design.
6. Understand the idea behind digital control as compared to analog control.
7. Model systems in discrete form and understand sampling and data reconstruction.
8. Evaluate discrete time closed loop system transfer function with data hold transfer function included.
9. Map S-plane to Z-plane and vice versa.

List of Experiments:

1) Find the Response of the Discrete Time Control System for any two standard inputs.
2) Unit step Response of Discrete Time Control System using Digital PID controller.
3) Design of deadbeat controller for Discrete Time Control System.
4) Determine effect of sampling period on stability of Discrete Time Control System.
5) Discretization of continuous time state equation.
6) Investigation of the controllability and Observability of a system.
7) Design of control system using pole placement technique.
8) Design of State observer.
9) Design of Discrete Time Control System based on minimization of quadratic performance index.
10) The solution of steady state quadratic optical control using riccati equation.

Use SCILAB/MATLAB or other equivalent software as a simulator.

Design based Problems (DP)/Open Ended Problem:

Any problem related with digital control design.

Lab Work: MATLAB/SCILAB based assignments and simulations covering design, analysis and modelling of Digital design control systems relevant to curriculum.

List of Open Source Software/learning website:

Ng-spice/MATLAB, www.nptel.com

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.