GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2910904
Semester – I
Subject Name: Control System Theory

Type of course:

Prerequisite:

Rationale: Automatic control of industrial processes is essential for increasing the output and in turn the profit of an industry. As a result, most of the companies are using automatic control of the machineries and processes. As an engineer, a student must know the basics of automatic control system. This subject is intended to supplement the basic skill of an engineer.

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)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to control problem** Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.	05	15
2	**Time Response Analysis** Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.	12	25
3	**Frequency-response analysis** Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.	08	20
4	**Introduction to Controller Design** Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.	12	25
5	**State variable Analysis** Concepts of state variables. State space model. Diagonalization of State	06	15

	Matrix. Solution of state equations. Eigen values and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.		

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**30**	**20**	**20**	**10**	**-**

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:

- M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
- B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
- K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
- J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

Course Outcomes:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Understand the fundamental of feedback control system.	15
CO-2	Understand time response specifications and determine the (absolute) stability of a closed-loop control system	25
CO-3	Determine the time and frequency-domain responses of first and second-order systems to step and other standard inputs.	25
CO-4	Design controller as per given specifications using different techniques	20
CO-5	Express and solve system equations in state-variable form (state variable models).	15

List of Open Source Software/learning website:

- E-materials available at the website of NPTEL- http://nptel.ac.in/