GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3144103
Semester – IV
Subject Name: AUTOMATIC CONTROL SYSTEM

Type of course: Engineering

Prerequisite: Zeal to learn the subject

Rationale: To develop comprehensive knowledge and understanding of classical and modern control theory, industrial automation, and systems analysis. Control engineering is a diverse and rapidly expanding discipline which has become increasingly important in a wide range of industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Basic concepts of control system:** Terminology - plant, process, system, disturbances, controlled variable, manipulated variable etc., Block diagram of basic control system, application areas with examples. Classifications of control systems, Concept of superposition for linear systems with examples.	5
2	**Mathematical modelling of systems:** Translational and rotational mechanical, electrical, thermal, hydraulic and pneumatic systems, Force voltage and force current analogy, Position servo mechanism. Block diagram and signal flow graph representation of physical systems along with rules, properties, comparison and limitation, Mason's gain formula	11
3	**Time response analysis:** Standard test signals along with examples of their usage, steady state errors for step, ramp and parabolic inputs, analysis of first and second order systems, Transient response specifications with numerical examples, Basic control actions and two position, proportional, PI, PID and rate feedback controllers, Limitations of time domain analysis.	9
4	**Frequency response analysis:** Need of frequency response analysis, Sinusoidal response of linear system, methods used in frequency response, Frequency domain specifications, Polar plot, Bode plot.	8

5	**Stability:** Concept of stability, types of stability, Routh's stability criterion, Nyquist Stability, Nyquist stability criterion, special cases with numerical examples, stability of closed loop system, concept of root locus, open loop and closed loop transfer poles, step by step procedure for root loci, numerical examples.	8
6	**State space analysis:** State space representation, state variables, state, state vector, state space, formulation of state space equations for mechanical and electrical systems, advantages over classical technique.	5

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**15**	**15**	**10**	**10**	**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:

1. Modern control theory, Katsuhiko Ogata, Pearson Education International, Fifth edition.
2. Control system engineering, Norman S Nise, John Wiley & Sons, Inc., Sixth edition
3. Modern control systems, Richard C. Dorf, Robert H Bishop, Pearson Education International, Twelfth edition.
4. Automatic control systems, Farid Golnaraghi, Benjamin C Kuo, John Wiley & Sons, Inc., Nineth edition
5. J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 5th Edition, 2007

Course Outcomes:

On completion of this course students will:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Understand the methodology for modelling dynamic systems with concept of stability	25
CO-2	Know the transfer function, signal flow graph representation of linear systems & their controlling actions	25

CO-3	Understand concept of time, frequency response as well as concept of state-space models and their relation to frequency domain models	25
CO-4	Control system of hydraulic and pneumatic system	25

List of Experiments:

1. Development of block diagram of various physical systems given by instructor ex. Toster system, watt governor etc
2. Introduction to simulation software like MATLAB/LABVIEW
3. Generating standard test signals i.e. step, ramp, unit impulse on a simulator
4. Modelling of physical system using simulation software
5. Given a system transfer function, plot the location of the system zeros and poles using simulation software
6. Obtaining frequency response of a common emitter amplifier and plotting on a Bode plot.
7. Simulation of root locus plot using simulation software
8. Plotting phase magnitude plot of a given transfer function with a simulator.
9. Performance measurement of first and second order system using simulation system as given by instructor
10. Introduction of programmable logic controller and ladder diagram
11. Stability Analysis (Root locus, Bode, Nyquist) of Linear Time Invariant System.

Major Equipment:

1. Ng-spice/MATLAB/ LABVIEW

List of Open Source Software/learning website:

1. https://nptel.ac.in