# GUJARAT TECHNOLOGICAL UNIVERSITY

## INSTRUMENTATION & CONTROL ENGINEERING (17)

CONTROL SYSTEM

**SUBJECT CODE:** 2141708

B.E. 4th Semester

**Type of course:** Core

**Prerequisite:**

1. Calculus
2. Ordinary differential equations
3. Complex variables
4. Linear system concepts
5. Laplace transform

**Rationale:** To prepare students Basics of Control Engineering

**Teaching and Examination Scheme:**

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

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

**Content:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | BASIC CONCEPTS OF SYSTEMS AND CONTROL LOOPS:<br>-Types of systems, continuous, discrete, Linear Time Variant, Linear Time invariant, Lumped and Distributed parameter systems, Linear vs non-linear systems, Systems with delay, Open loop control system with examples, Close loop control system With examples and it's merits over open loop system Effect of both on stability, gain And Speed response of system. | 2 | 5 |
| 2 | Laplace Transformation and Inverse Laplace Transformation: A Brief Overview., understanding transfer functions, problems | 2 | 5 |
| 3 | MATHEMATICAL MEDELING<br>Mathematical Modeling of some real world systems: DC Servo Motors, Liquid Level Systems, Thermal Systems, Introduction to modeling using State Space. Block Diagrams and Signal Flow Graph Analysis. Block diagram reduction techniques. Modeling of gear system, Mechanical-Electrical Analogy, linearization techniques. | 14 | 20 |

| | | | |
|---|---|---|---|
| 4 | TRANSIENT AND STEADY STATE RESPONSE: Introduction: Type and Order of The Systems, Transient Response Analysis, First and second order systems, Unity Feedback Systems, Stability Criteria, BIBO Stability, relative and absolute stability, Routh-Hurwitz Criteria for Stability, Steady State Errors, Impulse and Step, Ramp, Responses of first and second order systems, Analysis of Transient Response Specifications: peak overshoot, settling time, rise time, peak time etc., mathematical analysis and problems. | 10 | 15 |
| 5 | ROOT LOCUS TECHNIQUES: Plot Locies of root from transfer function, Stability criteria and system response study from root locus, problems | 8 | 15 |
| 6 | FREQUENCY RESPONSE TECHNIQUES : Nyquist criteria, Nyquist plots, Bode plots and effect of gain margin, phase margin on system parameters, Bandwidth, Polar plot and stability criteria, Nichol chart and it's application., constant M, N circles, understanding systems with delay and their analysis in frequency domain, problems | 12 | 25 |
| 7 | Introduction to state space analysis. Modeling in state space, transfer function to state space and vice versa. Eigen values, state transition matrix., problems | 6 | 15 |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | |
|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level |
| 21 | 21 | 14 | 7 | 7 |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. NAGRATH & GOPAL : Control system engineering, New age International Publication (1996)
2. B.C. KUO : Automatic control systems, Prentice Hall of India Ltd, 1995
3. OGATA KATSUHIKO : Modern Control Engineering, PHI,1996

**Course Outcomes**:

After studying this subject students will be able to:
1. Control system modeling: modeling of electric, mechanical and electromechanical systems, using differential equations, transfer functions, block diagrams, and state variables;

2. Control system analysis: analysis of properties of control systems, such as sensitivity, stability, tracking, in time and frequency domains

**List of Practical:**

1. Introduction to Matlab/Scilab
2. To find Unit step, ramp, impulse response of first and second order system using matla/scilab.
3. To derive the open loop and closed loop poles and zeros for varieties of the systems. Draw their Pole-zero map and check the system stability.
4. To draw the step response of overdamped, under damped and critically damped system for the second order system having different value of damping factor.
5. To find out time domain specification of second order system using matlab/Scilab.
6. To study state space presentation of a system. And to convesion from TF to State Space etc.
7. To plot root locus for a given system using matlab/Scilab. To derive the value of gain from Root Locus for system marginal stability.
8. To draw Bode plot for a given system using Matlab/Scilab. Derive GM, PM and stability from the plot.
9. To draw Nyquist plot for a given system using matlab/Scilab.

**Major Equipment:**

MATLAB/SCILAB software

**List of Open Source Software/learning website:**

http://nptel.ac.in/video.php?subjectId=108102043

http://en.wikibooks.org/wiki/Control_Systems/Root_Locus
http://en.wikibooks.org/wiki/Control_Systems/Bode_Plots
http://en.wikipedia.org/wiki/Nyquist_stability_criterion

**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.