EC4T1   **Control Systems**   **Credits: 3**

Lecture: 3 periods/week   **Internal assessment: 30 marks**
Tutorial: 1 period /week   **Semester end examination: 70 marks**

Prerequisites: Signals & Systems (EC3T3), Network Analysis and Synthesis (EC3T4)

Course Objectives:

- To give a basic idea about analysis of linear control systems.
- To emphasize the student about stability analysis of a system.
- To learn how to improve the performance of an existing system
- Enable an engineer to explore time domain and frequency domain tools to design and study linear control systems.

Learning Outcomes:

Student will be able to
- Represent a system in different models
- Recognize and analyze feedback control mechanisms
- Analyze a linear control system using various time and frequency domain tools
- Analyze the stability of a system based on transfer function.

UNIT- I

Introduction to Control Systems: Classification of control systems-examples, Feedback Characteristics, Mathematical models – electrical, translational and rotational mechanical systems
Transfer Function Representation: Block diagram representation of systems-Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

UNIT- II
Time Domain Analysis: Standard test signals - Time response of first order systems – Characteristic equation of feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants.
Compensators and Controllers: lead, lag and lead-lag compensators, Effects of proportional derivative (PD), proportional integral (PI) systems, Proportional Integral and Derivative(PID) Controllers.

UNIT- III
Stability Analysis in S-Domain: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability .
Root Locus Technique: The root locus concept - construction of root loci-effects of adding poles and zeros to open loop transfer function on the root loci.

UNIT- IV

Frequency Response Analysis: Introduction, Frequency domain specifications-Bode diagrams-Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots.
Stability Analysis in Frequency Domain: Polar Plots, Nyquist Plots Stability Analysis.

UNIT- V

State Space Analysis : State Space Analysis of Continuous Systems Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization-Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Learning Resources

Text Books:

1. Control Systems Engineering – I. J. Nagrath and M. Gopal, New Age International (P) Limited, Pub. 2nd edition., 2005
2. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 3rd ed., 1998.

References:
1. Automatic Control Systems 8th edition–B. C. Kuo– John wiley and son's., 2003
2. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd., 3rd ed., 1998.
3. Control Systems Engg. , Nise– John wiley , 3rd Edition 2000