Linear Control Systems

Code EE- 371	Credit Hours 3-1

Course Description

This course introduces students to the principles of linear control systems, focusing on their application in engineering design and analysis. The course covers both time-domain and frequency-domain modeling, including transfer functions, state-space representations, and block diagram reduction. Students will learn about the transient and steady-state responses of first- and second-order systems, as well as stability analysis using techniques like the Routh-Hurwitz criterion and root locus. The course also includes frequency response methods, such as Bode and Nyquist plots, to assess system stability and performance. Additionally, students will explore compensator design, including Lead-Lag and PID controllers, to improve system behavior. Practical examples will be used throughout to highlight the importance of control system design in real-world applications.

Text Book:

1. Norman S. Nise. Control Systems Engineering, 6th Ed. 2016.

Reference Book:

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 13th Ed. 2016.
2. K. Ogata, Modern Control Engineering, 5th Ed.

Prerequisites

NIL

ASSESSMENT SYSTEM FOR THEORY

Quizzes	10%
Assignments	10%
Mid Terms	30%
ESE	50%

Teaching Plan

Week No	Topics	Learning Outcomes
2	Introduction to control system Modeling in the frequency domain	Introduction to control system and its performance parameters Open loop and closed loop control system Objectives for analyzing and designing control system System models Transfer function modeling Developing transfer functions using Laplace Transform of Electrical Circuits, translational and rotational mechanical systems Demonstrate the transfer function of DC motor
3-5	Modelling in the Time domain Reduction of Multiple Sub-Systems	Time-domain modeling State variables. state equations and output equations State Space representation to model electrical and mechanical systems Carry out conversion of a transfer function to state space model Carry out conversion of a state space model to transfer function Block diagram reduction for sub systems Different configurations used in reduction Signal Flow Graphs Mason's rule to simplify signal flow graph to single transfer function
6	**MID TERM IN WEEK 9**	
7-8	Transient response of a system Stability of Linear System	System response using Pole Zero Diagram Transient response of first order Systems Transient response of Second Order Systems Transient response of Under damped second order systems Stability of a linear system Difference between stability of linear and non-linear systems Routh-Hurwitz criterion to check stability of a linear system Analyzing the stability of a linear systems Analysis of special stability cases
9	**MID TERM EXAM**	
10-16	Steady State errors Root Locus Techniques	Steady State Errors Steady State errors for unity feedback systems System types based on integrators and analyzing the steady-state error using these types. Root locus Rules to sketch root locus and analyze the system stability

17-18	Frequency response techniques Compensator Design	Bode plot and Nyquist plot to sketch frequency response of a system Analyzing the system stability using Nyquist criterion of stability Designing Lead-Lag compensators to improve the transient and steady-state error of a system Designing a PID controller to improve the transient and steady-state error of a system
19		**End Semester Exams**