Linear Control Systems

Code: EE-371	**Credit Hours:** 3-1

Course Description

It is the job of the of a control engineer to analyze existing systems, and to design new systems to meet specific needs. However, more frequently a controller unit needs to be designed to improve the performance of existing systems. When designing a system, or implementing a controller to augment an existing system, we need to model the system mathematically, analyze the mathematical model, design the system/controller, implement the system/controller and perform testing. This course covers all these aspects of the analysis and design of a control system.

Textbook:

1. Design of Feedback Control Systems, (Fourth Edition), by R.T. Stefani, C.J. Savant, B. Shahian, G.H. Hostetter, Oxford University Press, 2002, ISBN: 0-19-514249-
2. Control Systems Engineering (Fifth Edition), by N. Nise, Wiley-VCH, 2008, ISBN: 0-470-16997-42.

Prerequisites

Signals and Systems; prior study of ME-437 Mechanical Vibrations and EE-313 Electronic Circuit Design would be extremely helpful.

Assessment System for Theory

Quizzes	15%
Assignments	10%
Mid Terms	30%
ESE	45%

Assessment System for Lab

Lab performance	50%
Mid Exam / Project	20%
Final Exam	30%

Teaching Plan:

Week No	Topics	Learning Outcomes
1-2	**Basic Concepts, Modeling of Electrical, Electro-Mechanical Systems**	Analyzing different electrical and mechanical systems to derive transfer functions
3-4	**Transfer functions, Block Diagrams and Signal Flow Graphs**	Concept of block diagram and signal flow graphs, reduction of system using block diagram reduction and Mason's rule
5	**Response of First and Second Order Systems**	Analyzing transfer functions of first, second and higher order systems and deriving different transient and steady state parameters
6-8	**Asymptotic/BIBO Stability and Routh-Hurwitz Stability Criterion**	Pole zero plot, stability of system using Routh-Hurwitz criterion, Discussing stable, unstable and marginally stable systems
9	**MID TERM IN WEEK 9**	
10	**Performance Specifications of Linear Time-Invariant Control Systems**	Evaluating static error constants and steady state error
11-12	**Root Locus Analysis and Design**	Sketching root locus design and approximating higher order systems to second order systems
13-15	**Frequency Response Analysis**	Analyzing system frequency response and plotting asymptotic approximations to the frequency response of a system
16-17	**State Space Analysis**	Concept of state variables and state space equation and its application in system analysis
18	**End Semester Exams**	

Practical:

Experiment No	Description
1	Introduction to MATLAB
2	Introduction to Laboratory Trainer
3	System Interconnections and Response Analysis
4	Introduction to DC Motor Control Trainer
5	DC Motor Control Trainer Modeling (Part – a)
6	DC Motor Control Trainer Modeling (Part – b)
7	Pre Lab for Controller Implementation
8	Introduction to SISO toolbox
9	Controller + Case Study
10	DC Motor Control Trainer Speed Control (Part - a)
11	DC Motor Control Trainer Speed Control (Part - b)
12	Position Control
13	Root Locus
14	Design Project