CONTROL SYSTEMS

PROF. C.S. SHANKAR RAM
Department of Design Engineering
IIT Madras

INTENDED AUDIENCE : Undergraduate engineering students (electrical engineering, electronics engineering, mechanical engineering, aerospace engineering, chemical engineering, automobile engineering)

PRE-REQUISITES : 2nd year undergraduate students in engineering. Prefer that they have completed a course on engineering mathematics that teaches complex variables and Laplace transform.

INDUSTRIES APPLICABLE TO : Automotive companies

COURSE OUTLINE :
Course Objective: To provide a basic understanding of the concepts and techniques involved in designing control schemes for dynamic systems. Learning Outcomes: At the end of this course, one should possess in-depth knowledge of concepts from classical control theory, understand the concept of transfer function and use it for obtaining system response, analyze dynamic systems for their stability and performance, and design controllers (such as Proportional-Integral-Derivative) based on stability and performance requirements.

ABOUT INSTRUCTOR :
Prof. C. S. Shankar Ram is currently a professor in the Department of Engineering Design, Indian Institute of Technology Madras, Chennai, India. He received his Bachelor of Engineering (B. E.) in Mechanical Engineering from Motilal Nehru Regional Engineering College, Allahabad, India, and his M. S. and Ph. D. from Texas A&M University, USA. His research interests are in the areas of dynamics and control with applications to automotive and transportation systems. He teaches courses on Control Systems, Fundamentals of Automotive Systems and Control of Automotive Systems at IIT Madras.

More details can be found at: https://ed.iitm.ac.in/~shankarram/

COURSE PLAN :

Week 01 : Introduction to Control, Classification of Dynamic Systems, Closed Loop Control System with Feedback, Mathematical Preliminaries – Complex Variables, Laplace Transform.

Week 02 : Standard Inputs, Free and Forced Response, Transfer Function, Poles and Zeros.

Week 03 : Response to various Inputs, Effect of Poles, Notion of Bounded Input Bounded Output (BIBO) stability.

Week 04 : Effect of Zeros, Closed Loop Transfer Function, Dynamic Performance Specification, First Order Systems.

Week 05 : Second Order Systems, Unit Step Response of Underdamped Second Order Systems, Concepts of Rise Time, Peak Time, Maximum Peak Overshoot and Settling Time.

Week 06 : Controllers – Proportional (P), Integral (I) and Derivative (D) Blocks, Examples of PID controller design.

Week 07 : Routh's Stability Criterion, Use in Control Design, Incorporation of Performance Specifications in Controller Design, Analysis of Steady State Errors.

Week 08 : Root Locus and its Application in Control Design.

Week 09 : Frequency Response, Bode Plots, Nyquist Plots.

Week 10 : Nyquist Stability Criterion, Relative Stability – Gain and Phase Margins.

Week 11 : Control System Design via Frequency Response – Lead, Lag and Lag-Lead Compensation.

Week 12 : Case Studies.