Course Syllabus

EE482 Linear Control Systems (4.0 units)
EE-Systems, University of Southern California
Fall Semester, 2024
Dr. Richard Y. Chiang (chiangr@usc.edu)

Control systems are the invisible threads of human technology for thousands of years. The concept of feedback enables millions of ancient and modern applications in every engineering field on this planet and beyond to outer space.

EE482 is the basic first-hand control course that teaches the fundamental theory and tools applying to model, analyze and design control systems. It's the most important entry course and fundamental knowledge to build your control career upon.

The course will focus on the analysis of linear time-invariant (LTI) control systems: essence of feedback, stability of LTI systems; frequency response, modeling lumped mass systems via LaPlace transform, control design compensation methods such as root locus, Bode design as well as Single-Input-Single-Output (SISO) robustness issues.

COURSE MATERIALS

Textbook, *Modern Control Systems,* 14th ed, by Dorf and Bishop, 2021. Lecture notes power point pdf files, MATLAB tools and published papers where applicable.

Prerequisite: EE 301

LECTURER

Richard Y. Chiang, PhD, Sr. Specialist, Control Analysis Department, Aerospace Corp, El Segundo, California, and ex-Boeing Technical Fellow, Boeing Satellite Development Center, El Segundo, California. Dr. Chiang is a nationally and internationally recognized expert in robust control system design and system identification. He is the leading author on the MATLAB software, Robust Control Toolbox, of which more than 30,000 copies have been sold worldwide across industries and academia for the last 30 years. His control design methodology has become the universal standard in the field.

Dr. Chiang began his career 40 years ago as a control system analyst at Garrett AiResearch. During the 1990s, he also worked for Northrop Aircraft on F-18 supermaneuver flight control and at JPL on large space structure vibration control. Since joining Boeing in the late '90s, he has designed attitude control systems for 15+ satellites and analyzed system stability for 20 programs. He has taught senior control courses (EE 482, EE 543) at USC and has given control seminars at DEC, Northrop, General Dynamics, and JPL in the 1990s and several at Boeing from 2002 to the present. During 2004~2019, he also taught several short courses on Robust Control,

Spacecraft Dynamics, Control and Estimation at UCLA Extension. Dr. Chiang has published 17 journal papers and 50+ conference papers, and has 10 issued U.S. patents and five patent applications pending related to digital spacecraft control system design.

COURSE OUTLINE

- Big picture of a control system
  - — What is a control system?
  - — Control design objectives (why are we doing this?)
  - — Brief history of classical/modern control theory
- Basics Tools to Model a Control Systems
  - — LaPlace transform
  - — Inverse LaPlace transform
  - — MATLAB Control Toolbox
- Modeling a Liner Control System
  - — Mass-Spring-Damper systems
  - — Block diagram manipulation
- Characteristics of Feedback Control Systems
  - — Five feedback control objectives
- Analysis of Linear Control System
  - --- Nyquist stability theorem
  - --- Root locus
  - --- Frequency response
- Design of a Linear Control System
  - --- Design objectives & specifications
  - --- Root locus and Bode design procedures
  - --- Types of compensators (PID, lead/lag, notch filters)
  - --- SISO design (root locus, Bode response)
- Advanced Topics
  - --- Robust control concept
  - --- Digital control systems
- Linear control design project for a two-mass-spring benchmark problem
- Lab Exercises

For more information call instructor Richard Y. Chiang at 310-951-0382 (cell). Email: chiangr@usc.edu