ECE 4/551: Control Systems Design I

Catalog Description

State space description of linear systems. Controllability and observability. Controller and observer design by pole placement. Optimal control, linear quadratic regulator, linear quadratic estimator (Kalman filter), linear quadratic Gaussian with loop transfer recovery design procedures. Also offered for graduate-level credit as ECE 551 and may be taken only once for credit.

Credit hours: 4

Goals

This course introduces modern control theory for the feedback design of continuous-time single-input single-output (SISO) and multi-input multi-output (MIMO) systems. Students will learn to apply modern control principles to the design of continuous-time control system and operate software (Matlab/Simulink) that aids in the design process.

Prerequisites

ECE 317, MTH 261 or MTH 343.

Course Coordinator and Committee

James McNames (coordinator)
Fu Li
John Lipor
Mark Martin
Martin Siderius
Richard Tymerski

Textbooks

Design of Feedback Control Systems, R. Stefani, B. Shahian, C. Savant, and G. Hostetter, 4th Edition, Oxford University Press, 2002.

Classical and Modern Control System Design by Example, R. Tymerski, F. Rytkonen and A Chuinard. To be published.

The course instructor may choose to use a different textbook. Please check with your instructor before purchasing.

Learning Outcomes

At the end of this course, students will be able to:

1. Understand matrix forms: phase variable, dual-phase variable, Jordan
2. Understand concepts of stability, controlability and observability
3. Pole placement design of control systems
4. Understand and apply integral control design
5. Understand and apply observer design; full and reduced order
6. Optimal controller and observer design (LQR, LQE (Kalman filter), LQG, LQG/LTR)

Topical Outline

- State Space equations, solution of
- State space to transfer function transformations, state transformation, realizations
- Stability, eigenstructure
- Controllability, Observability
- Controller design, pole placement
- Integral control / internal model principle
- Full-order observer design
- Duality, separation principle
- Reduced-order observer design
- Introduction to optimal and robust control topics

Course Structure

The class meets for four hours of lecture each week. The grade is based on in-class exams, in-class quizzes, a final exam, and a project (involving Matlab/Simulink). For details of the grading criteria, please see the syllabus provided by your instructor.

Relevant Student Outcomes

The following program outcomes are supported by this course:

(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
(2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
(5) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

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