CSU Course Syllabus: Fall 2024
ECE611 - Nonlinear Control Systems
TR 9:30am-10:45am, Wagar 107

Instructor: Dr. Peter M. Young, Engr B114, Ext. 1-5406,
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Office Hours: TR 11:30am-12:30pm, Engr B114

Course Book: *Nonlinear Systems*
Khalil, 3rd Edition

Recommended Additional Reference Books:

Nonlinear Control Systems
Isidori

Robust Adaptive Control
Ioannou and Sun

System Identification
Ljung

Prerequisites: ECE412

Grading and Exams:

Midterm Exam	30%
Final Exam	40%
Computer & Lab Projects	20%
Homework Assignments	10%

Course Schedule: Homework problems will usually be assigned every other week (due two weeks later). In addition there will be a number of special computer projects. You are expected to work on all these problems yourself, but *reasonable* collaboration is allowed.

No collaboration is allowed for the Midterm and Final Exams. Both exams will be take-home, open-book and open-notes.

Course Objective: The students will learn how to analyze the stability and performance properties of nonlinear systems, and also how to design nonlinear feedback controllers. The skills developed will be based on both extensions of linear tools as well as the latest direct nonlinear methods.

ECE611 Course Outline

This course will be lecture-based, with both homework assignments and exams. In addition a number of computer projects will be assigned.

Introduction and Background

Introduction to nonlinear and time-varying systems. Mathematical background, including vector spaces and norms. $\mathcal{L}_p$ norms for signals, induced norms for systems, and the Lebesgue $\mathcal{L}_p$ spaces. Existence and uniqueness of solutions to nonlinear differential equations.

Stability Analysis

Techniques for the stability analysis of nonlinear and time-varying systems. Internal stability of feedback systems. Phase plane portraits. Lyapunov stability theorems. Popov and circle criteria for nonlinear feedback systems. Passivity and small gain for nonlinear operators.

Design Techniques

Overview of design for nonlinear systems. Jacobian linearization and gain scheduling. Introduction to feedback linearization and extensions of optimal control techniques. Direct design methods.