ECE 766-866 - Nonlinear Control Systems

Old Dominion University
Department of Electrical and Computer Engineering
Spring Semester 2012

Instructor

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Office Hours

Time: By arrangement
Location: Kaufman Hall, Room 231K

Lectures

Time: Tuesday 13:30-16:10
Location: Kaufman Hall, Room 233 (Systems Research Laboratory)

Prerequisites

ECE 601 or an equivalent linear systems course

Course Webpage

http://www.ece.odu.edu/~gray/classes/ece766-866

Textbook

References


Course Objectives

The goal of this course is to show how a nonautonomous nonlinear state space system can be analyzed in a differential geometric context in order to produce a feedback control law for achieving stability, tracking performance and disturbance rejection. The mathematical background is developed on a need-to-know basis assuming only a familiarity with multivariable calculus and linear algebra. Specifically, methods for *feedback linearization* are developed for control applications. It is shown for a general class of nonlinear systems that there exists a nonlinear state feedback law which renders the closed-loop system *exactly* (i.e., without Taylor series approximations) linear from input-to-output or in some cases even linear in the state after a coordinate transform is applied. Once the system has been linearized in this manner, the standard theory and design methods for linear systems apply directly.

Grading Policy

Homework - 20 %
Midterm Exam 1 - 25 % (week 6, February 14, 2012)
Midterm Exam 2 - 25 % (week 12: March 27, 2012)
Final Exam - 30 % (final exam week, May 1, 2012)

Course Policies

1. Homework will be assigned on a regular basis. Solutions will be provided on the day the homework is collected, therefore no late homework is accepted. Collaboration on homework assignments is strongly encouraged as long as each student writes their final solutions in their own words.
2. All examinations will be done outside of class. These are to be worked on an individual basis. The Old Dominion Honor Pledge must be observed at all times. All questions regarding examinations should be directed only to your instructor.
3. Grades and handouts will be available on the class webpage. Check it regularly.
Honor System

The Honor System at Old Dominion University is based on individual integrity. In registering for ECE 766-866, you have agreed to adhere to the following Honor Pledge:

“I pledge to support the Honor System at Old Dominion University. I will refrain from any form of academic dishonesty or deception, such as cheating or plagiarism. I am aware that as a member of the academic community it is my responsibility to turn in all suspected violators of the Honor Code. I will report to an Honor Council hearing if summoned.”

Course Outline

1. Local Decompositions of Control Systems - Chapter 1
   - A Geometric View of Linear Control Systems
   - Coordinate Transformations, Lie brackets, Lie Derivatives and Distributions
   - The Frobenius Theorem
   - Invariant Distributions
   - Local Decompositions of Control Systems
   - Local Reachability and Observability
   - A Global Perspective

   - Local Coordinate Transformations
   - Exact Linearization via Nonlinear Feedback
   - Zero Dynamics
   - Local Asymptotic Stabilization
   - Asymptotic Output Tracking
   - Disturbance Decoupling

3. Nonlinear Feedback Theory for Multivariable Systems - Chapter 5
   - Local Coordinate Transformations
   - I/O Exact Linearization Using Vector Relative Degree
   - The Noninteracting Control Problem
   - State Space Exact Linearization
   - I/O Exact Linearization Without Using Vector Relative Degree
   - Achieving Vector Relative Degree via Dynamic Extension