ASEN 5014 LINEAR CONTROL DESIGN

Course Description: Modeling, analysis, and design of continuous-time control systems using the state space approach. Vector spaces, linear operators, and linear equation solution theory are used to describe system solutions and their stability, controllability, and observability properties. State observers and state feedback control are developed, along with an introduction to linear-quadratic optimal control. Robustness to model uncertainty is addressed.

Instructor:

, ASEN 3200 or equivalent)

Textbook:

Modern Control Theory, W. L. Brogan, 3rd ed. Prentice-Hall, 1991.
ISBN 0-13-589763-7

Class Web Page:

http://canvas.colorado.edu

Syllabus Outline

Topics	**Weeks**
Introduction: Fundamental Questions	1
State Space Model Construction	1
Linear Spaces, Mappings	5
Midterm Exam 1	
State Space System Solutions	3
Lyapunov Stability	1
Midterm Project 1	
Controllability and Observability	2
State Observation and Feedback Control	2
Optimization and Robustness	1
Project 2 (in lieu of final exam)	

Course Policies and Grading

Exam: Take home, involving both analysis and computation. Questions are designed to measure grasp of concepts, rather than memorization or repetition of homework problems. Honor system applies. Make up exams must be arranged in advance (at least two weeks).
Office hours: Regular times (to be arranged) held by instructor. Other times are available by appointment.

Course Purpose and Learning Objectives

Linear systems are models for physical processes having dynamics. Although physical systems are usually non-linear, linear models are simpler, and can often provide reasonable approximations. They have the added benefit of a very complete theoretical understanding of their behavior and of how control can change behavior.

The purpose of this course is to provide an understanding of the theory of linear systems from the state space perspective, with specific application toward feedback control design. Although mathematics (particularly linear algebra) is the language by which the theory is described, this is not a mathematics course. The theorem/proof format is avoided in favor of an exposition of the main ideas and use of these ideas to demonstrate key theoretical results. The geometry and insight behind matrix algebra, in particular, is stressed. However, expect to learn a little math in the process. Careful use of terminology is necessary to understand the ideas, and to do well on exams. Students will select an example application for an individual final project to apply the ideas developed in class.

The understanding sought in this course is a foundation for further graduate work in various fields, particularly nonlinear dynamical systems, estimation and data analysis, and advanced control systems. It introduces standard viewpoints, methods, and terminology used in the applied and research literature. It also provides the basis for understanding how many computational analysis and design tools work.

The main learning objectives of Linear Control Design are

- ¶ Develop some expertise with the state space modeling/analysis/design approach, learning to see dynamical systems in a new way with new concepts, vocabulary, tools, and insights.
- ¶ See linear algebra in a new light, where matrices are representations of linear operators, and these operators have simple geometry and corresponding insights. This understanding is used widely (both within control and many other applications).
- ¶ Glimpse how optimization can be used to design control systems ``automatically''.
- ¶ Understand how applications of this theory can be limited by inaccuracy in system models.

General Policies

Accommodation For Disabilities
If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website and discuss your needs with your professor.

Religious Holidays
Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must let the instructors know of any such conflicts within the first two weeks of the semester so that we can work with you to make reasonable arrangements. See campus policy regarding religious observances for full details.

Classroom and On-Campus Behavior
Students and faculty each have responsibility for maintaining an appropriate learning environment, not only while in class, but also while working outside of class such as in labs and study areas. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. We will gladly honor your request to address you by an alternate name or gender pronoun. Please advise us of this preference early in the semester so that we may make appropriate changes to our records. For more information, see the policies on classroom behavior and the student code.

Discrimination and Harassment
The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, w6 168.14 Tm 0 g 0 G [(lea)-5(rnin)-2(g)6(,)-3(w)12(6 168.14 n44 1 246.05W* n BT /F3 12