University of California Santa Cruz
Computer Engineering

CE 240 – Introduction to Linear Dynamical Systems

Course Syllabus

Instructor

Prof. Bill Dunbar, E2 325, xt. 9-1031, dunbar@soe.ucsc.edu
Location/Time: Soc Sci 2, Rm 137, T H 12-1:45 PM
Office hours: T 2-4:00 PM

URLs

- Course web site: Course web site: Go here https://ecommons.ucsc.edu/xsl-portal, then click "Search Public Sites" to find CMPE 240.
- We will make extensive use of **Forums** that you will ONLY be able to access and add to IF you get a Cruz ID Gold account / password. Instructions for doing so can be found through the ecommons web page.

Course Description

Introduction to applied linear algebra and linear dynamical systems with applications to circuits, signal processing, communications, and control systems. Topics include the following: Least-squares approximations of over-determined equations and least-norm solutions of underdetermined equations. Symmetric matrices, matrix norm and singular value decomposition. Eigenvalues, left and right eigenvectors, and dynamical interpretation. Matrix exponential, stability, and asymptotic behavior. Multi-input multi-output systems, impulse and step matrices; convolution and transfer matrix descriptions. Control, reachability, state transfer, and least-norm inputs. Observability and least-squares state estimation.

Prerequisites

You should have seen the following topics: matrices and vectors, (introductory) linear algebra; differential equations, Laplace transform, transfer functions. Exposure to topics such as control systems, circuits, signals and systems, or dynamics is not required, but can increase your appreciation.

Enrollment restricted to graduate students; undergraduates may enroll if they have completed EE 103 and AMS 147.

Grading

Homework: 20%, Midterm: 35%, Final: 45%.

Homework Policy

Homework will be assigned and collected every Tuesday at the start of class. Collaborations are encouraged. However, all solutions handed in for credit must reflect your own work and understanding of the material. **If you do collaborate or receive help from anyone, you must credit them by placing their name(s) at the top of your paper.**

Text and Materials

With his permission, we will use a reader, notes and Matlab files developed by Stephen Boyd at Stanford. Reader is available here:
`http://www.stanford.edu/class/ee263/reader/ee263_course_reader.pdf`

Exams

An in-class or take home (haven't decided) midterm and final exam will be given. Dates TBA.

Course Outline by Lecture

1. Overview
2. Linear functions
3. Linear algebra review
4. Orthonormal sets of vectors and QR factorization
5. Least-squares
6. Least-squares applications
7. Regularized least-squares and Gauss-Newton method
8. Least-norm solutions of underdetermined equations
9. Autonomous linear dynamical systems
10. Solution via Laplace transform and matrix exponential
11. Eigenvectors and diagonalization
12. Jordan canonical form
13. Linear dynamical systems with inputs and outputs
14. Example: Aircraft dynamics
15. Symmetric matrices, quadratic forms, matrix norm, and SVD

16. SVD applications
17. Example: Quantum mechanics
18. Controllability and state transfer
19. Observability and state estimation
20. Summary and final comments