UNIVERSITY OF CALIFORNIA, SANTA CRUZ
BOARD OF STUDIES IN COMPUTER ENGINEERING

CMPE-242:
APPLIED FEEDBACK CONTROL

WINTER 2015
T-Th 10:00 – 11:45 AM
CLASS: Jack Baskin Engineering, Rm #169

INTRODUCTION

This course provides advances in the design of linear feedback control systems for command-following error, disturbance rejection, stability, and dynamic response specifications. We review root-locus and frequency response design (Bode) techniques, Nyquist stability criterion, and the design of dynamic compensators. Topics include state-space techniques for modeling, full-state feedback regulator design, pole placement, and observer design. Digital control (z-transform) and optimal control (LQ) are introduced. Examples are drawn from electrical, mechanical, and aeronautical applications. Computer aided design with MATLAB and SIMULINK are used to motivate the material.

INSTRUCTOR:

GABRIEL HUGH ELKAIM
E-mail: elkaim@soe.ucsc.edu
Office: Engineering 2 (E2), 337B
Hours: T-Th 12:00-2:00 PM, or by appointment
Phone: (831) 459-3054 (Office)

TEXTBOOKS:

"Feedback Control of Dynamic Systems (7th Edition)" by Gene Franklin, J.D. Powell, Abbas Emami-Naeini, Prentice Hall; 7th edition (May 9, 2014), ISBN: 0133496597

Optional:

"Schaum's Outline of Feedback and Control Systems" by Allen Stubberud, Ivan Williams, and Joseph DiStefano, McGraw-Hill; 2nd Edition (October 1, 1994), ISBN: 0070170525

"Digital Control of Dynamic Systems, 3rd Edition" by Gene F. Franklin, J. David Powell, and Michael Workman, Ellis-Kagle Press, ISBN13: 978-0-9791226-0-6 (Soft Cover), ISBN13: 978-0-9791226-1-3 (Hard Cover), Available through *atlasbooks* or *powells* (see Piazza post for link and discount code)

"MATLAB & Simulink Student Version" by the MathWorks

PREREQUISITES:

EE-154/CMPE-241 Introduction to Feedback Control Systems (or equivalent)
Signals & Systems, Linear Algebra, Complex Numbers, Fourier Analysis

HOMEWORK

Attendance is highly recommended for the lectures as the material builds up quickly. Annotated lecture notes and videos of the lecture will be posted after class in a timely fashion (see note on video below).

There will be weekly homework assignments that are both required and graded. They are worth 15% of your overall grade, they are essential to mastering the material. There will one midterm exam and one final exam. The midterm and exam material will be based on homework and lecture material.

Homeworks will be cross-graded: that is, homeworks will be collected and then redistributed to the students and exchanged for grading along with the solution sets (including point distributions and grading instructions). Homeworks are due in my office, E2-337B, on Tuesday at 5:00 PM. The graded homeworks will be recollected on the following Tuesdays at 5PM, and will make up one third of the homework grade. Based on prior years' experience, it has been shown to improve students understanding of the material (pedagogy) by having the students make a grading pass with the solution sets in order to see where mistakes are being made.

GRADING

This course is based on a combination of the homeworks and exams.

HOMEWORKS,	15%
MIDTERM EXAMS	35%
FINAL EXAM	50%

WWW SITE, VIDEOS, AND WEBFORUM

Website: https://classes.soe.ucsc.edu/cmpe242/Winter15/

Check this site often as this is where the homework assignments, lecture notes, homework and test solutions, and lecture videos are posted. You are expected to read the material on the website.

Videos: As an experiment in teaching technology, the instructor will be capturing both the audio and screen from the course in real-time. This will later be posted to the website. While every attempt will be made to capture the classes, as this is a new technology, there are no guarantees. Also, while watching the video should be a great way to review course material, if you are not in class you cannot ask questions and/or clarifications. Further, if too few students show up for lectures, the instructor may restrict access to class videos.

Piazza: https://piazza.com/ucsc/winter2015/cmpe242/home

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, and the Instructor. Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email team@piazza.com.

ACADEMIC HONESTY

Academic honesty is a requirement for the course. All assignments must be your own independent work; this includes homework, midterm, and exam.

What is cheating? It is presenting work that is not yours as your own. You can, and are encouraged to, discuss and strategize with your colleagues on homework and to work together, but your work should be your own. Copying is NEVER acceptable.

If a student is caught cheating in either the class or the exams this will result in an immediate failure in the class. It will be reported to your college and your department. DO NOT CHEAT; it is not worth it.

SYLLABUS

The class is based fairly closely on the progress of the book (the new edition), we will be covering the first eight chapters (including supplemental material). You should be reading the chapters ahead of the class, as it will really help your understanding of the material.

CHAPTER 1,	Intro and History
CHAPTER 2,	Dynamic Models
CHAPTER 3,	Dynamic Response
	Convolution
	Laplace Transforms
	Block Diagrams
	Control Specifications
CHAPTER 4,	Basic Properties of Feedback
CHAPTER 5,	Root Locus Design
CHAPTER 6,	Frequency Response Design
	Frequency Response
	Nyquist
	Bode
	Compensation
CHAPTER 8,	Digital Control
CHAPTER 7,	State Space Design
	Pole Placement
	Estimation
	LQ(R/E/G) Design

MATLAB

This course will rely heavily on the use of MATLAB for homework, and as a tool to understanding control system behavior. MATLAB is available on the cluster computers in Baskin Engineering, as well as on the Solaris machines. You can also purchase a copy of the student version of MATLAB directly from the Mathworks (for under $100), which includes the control system toolbox, and is well worth the cost. Note that there are open source versions of equivalent programs, such as OCTAVE, which are perfectly acceptable, though the instructor has no expertise on them and therefore cannot help you troubleshoot.

ACKNOWLEDGEMENTS

I would also like to acknowledge Prof. Steve Rock of Stanford University, who teaches this material and has generously helped with the syllabus, the course material, and general inspiration. Prof. Rock combines the theory with real world stories in a way that makes controls engineering fun and completely enjoyable. I would also like to thank David Powell for his years of mentoring, and for providing discounts to his Digital Controls book.