University of California, Santa Barbara

Department of Electrical and Computer Engineering

Course Syllabus

ECE 147C Control Systems Design Project 5 units

(Elective)

Instructors:

Hespanha, Kokotovic, Smith

Catalog Description:

Students are required to design, implement, and document a significant control systems project. The project will be implemented in hardware or in high-fidelity numerical simulators. Lectures and laboratories cover special topics related to the practical implementation of control systems.

This course is part of the design sequences: 147A-147C and 147B-147C.

This course will be taught during the Spring quarter.

Prerequisites:

ECE147A or ME155A or ME173

Detailed description:

The objective of this course is to provide students with the necessary knowledge to design, implement, and document a control engineering project. The course has three components: lectures, prepared laboratories, and a design project.

The lectures and laboratories cover a range of special topics related to the practical implementation of control systems that are not covered in ECE147A/ME155A or ECE147B/ME155B. These include: time/energy optimal designs, model identification and parameter estimation, Lyapunov-based designs, model reduction, robustness with respect to modeling errors, delays, non-minimum phase processes, actuator and sensor limitations, measurement noise, etc.

For the project the students are required to work in groups to carry out a significant control design, which requires them to address the issues covered in the lectures.

The syllabus, schedule of lectures, reading material and all other information relevant to the course will be continuously posted at the course's web page.**Text, References, and Software:**

No single textbook. The course will be based on a collection of modules and papers provided by the instructor.

Matlab with Simulink, Stateflow, and Control systems toolbox, Mathworks, Inc.

Modelica Simulator Dymola, Dynasim, Inc.

Assessment format:

Laboratories – 40%; Final Project – 60%.

Course Goals:

After the successful completion of the course, the students are expected to:

1. Model identification and parameter estimation
   1.1. Be able to perform least-square parameter identification of an auto-regressive model
   1.2. Be able to perform basic nonparametric identification in the time domain (impulse and step response analysis)
   1.3. Be able to perform basic nonparametric identification in the frequency domain (sine-wave testing and correlation)
2. Optimal control

2.1. Be able to use LQR/LQG for the state-space design of controllers for LTI systems
2.2. Be able to implement and test a state-space controller

3. Robust Control
   3.1. Be able to evaluate stability of SISO linear systems using Nyquist-plots
   3.2. Be able to use small-gain concepts for the stability analysis of SISO linear systems
4. Lyapunov-based control designs
   4.1. Be able to use Lyapunov's method to establish boundedness for the state of nonlinear systems
   4.2. Be able to design a feedback linearization controller for a fully actuated 2nd order mechanical system
   4.3. Be able to design controllers for triangular nonlinear systems using backstepping (with and without nonlinearity cancellation)
5. Design, implementation, and reporting
   5.1. Be able to work as a team to carry out a design project
   5.2. Be able to write a concise technical report describing a control design
   5.3. Be able to present a technical design orally

Class/Laboratory Hours:

Two 75minute lectures, three hours of laboratory work, and three hours of laboratory preparation per week.

Contribution to Program Outcomes:

Course goal	P1	P2	P3	P4	P5	P6
1.1	*	*	*			
1.2	*	*	*			
1.3	*	*	*			
2.1	*	*	*			
2.2		*	*	*		
3.1	*	*				
3.2	*	*	*			
4.1	*	*				
4.2	*	*	*			
4.3	*	*	*			
5.1				*	*	
5.2					*	
5.3					*	

Professional Component:

The lectures are essentially focused on topics related to the practical implementation of control systems, which are likely to arise in the professional career of controls engineers. The course is heavily project-oriented and the students will be required to design, implement, document, and present a significant control systems project.

Prepared by: João P. Hespanha **Date: April 4, 2006**