Course Description

This is a course covers the analysis and design of control systems with emphasis on modeling, state variable representation, computer solutions, modern design principles, and laboratory techniques. The following topics will be covered:

1. Modeling and dynamic response
2. Root locus design method
3. Frequency response design methods
4. State-space design methods

*** The course will be taught jointly by instructors from UIUC and ZJUI this semester*
You may find material from UIUC website: https://courses.engr.illinois.edu/ece486/fa2023/

Course Objective

As a first course in feedback control of dynamic systems, a design-oriented approach is stressed to develop the ability and interest in continued study of advanced topics. The course familiarizes learners with basic concepts in lecture and homework providing a foundation for further development beyond the fundamentals of the subject. Computer-based analysis is combined with a modern accompanying laboratory to provide a realistic setting for mastering several important design methodologies.

Course Team

Instructors： Profs. M.-A. Belabbas (belabbas@illinois.edu) and Liangjing Yang (liangjingyang@intl.zju.edu.cn)
TAs: Tiexin Wang; Yunze Shi; Tanhong Pu, Yizhou Huang

Office Hours

Tues 10-11am, 2-3pm; ZJUI building B306 or Instructional Control Lab E205 (Even weeks)

Grading Policy

Class Participation- 5%; Homework- 20%; Lab- 30%; Midterm Exams- 20%; Final Exam- 25%
Graduates: Class Participation- 5%; Homework- 20%; Midterm Exams- 20%; *Project- 55%*

Prerequisite

ECE 210. Basic knowledge of complex numbers and linear algebra is a plus.

Reference Textbook

Franklin, Powell, and Emami-Naeini, Feedback Control of Dynamic Systems, Prentice Hall.

Lectures:

Week	Topic	Ref.
1	Introduction to feedback control	Ch. 1
	State-space models of systems; linearization	Sections 1.1, 1.2, 2.1–2.4, 7.2, 9.2.1
2	Linear systems and their dynamic response	Section 3.1, Appendix A
	Transient and steady-state dynamic response with arbitrary initial conditions	Section 3.1, Appendix A
3	National Holiday Week	
4	System modeling diagrams; prototype second-order system	Sections 3.1, 3.2, lab manual
	Transient response specifications	Sections 3.3, 3.14, lab manual
5	Effect of zeros and extra poles; Routh-Hurwitz stability criterion	Sections 3.5, 3.6
	Basic properties and benefits of feedback control; Introduction to Proportional-Integral-Derivative (PID) control	Section 4.1-4.3, lab manual
6	**Review A**	
	Term Test A	
7	Introduction to Root Locus design method	Ch. 5
	Root Locus continued; introduction to dynamic compensation	Ch. 5
8	Lead and lag dynamic compensation	Ch. 5
	Lead and lag continued; introduction to frequency-response design method	Sections 5.1-5.4, 6.1
9	Bode plots for three types of transfer functions	Section 6.1
	Stability from frequency response; gain and phase margins	Section 6.1
10	Control design using frequency response	Ch. 6
	Control design using frequency response continued; PI and lag, PID and lead-lag	Ch. 6

11	Nyquist stability criterion	Ch. 6
	Nyquist stability criterion continued; gain and phase margins from Nyquist plots	Ch. 6
12	**Review B**	
	Term Test B	
13	Introduction to state-space design	Ch. 7
	Controllability, stability, and pole-zero cancellations; similarity transformation; conversion of controllable systems to Controller Canonical Form	Ch. 7
14	Pole placement by full state feedback	Ch. 7
	Observer design for state estimation	Ch. 7
15	Joint observer and controller design by dynamic output feedback; separation principle	Ch. 7
	In-class review	Ch. 7
16	**END OF LECTURES: Revision Week**	
	Final	

Labs:

Week	Topic
2	Lab 0: Introduction MATLAB and Simulink
4	Lab 1: Analog Simulation
6	Lab 2: Digital Simulation
8	Lab 3: Closed Loop Systems
10	Lab 4: DC Motor & PID Control
12	Lab 5: Control Design Using Frequency Method
14	Lab 6: Control Design using State-Space Model