ME 8281 Advance Control Systems Design
Department of Mechanical Engineering
University of Minnesota

Spring 2008

Instructor: Perry Li
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Class schedule:MW 12:20-2:10

Office Hours: F 9:00-10:00am @CCEFP (tentative), talk to me immediately after class, or by appointment.

Course URL: `http://www.me.umn.edu/education/courses/me8281/`

Overview

This is a first graduate level course on control systems with an emphasis on controller design. Prerequisite materials assumed are generally covered in an undersgraduate level control systems e.g. ME5281 at UMn, which covers classical SISO control, and an introduction to states space control concept.

About 2/3 of the course will deal mainly with linear systems (or linearized systems), and the rest of the class will be concerned with some nonlinear systems.

In class and homework examples will be taken from various application domains and research projects. We will rely heavily on MATLAB for analysis, design and simulations of these systems.

Homework assignments will consist of theory (pen and paper) and design / simulation (using Matlab). There will a significant term project, and a final.

Grading

Homeworks - 50%
Final - 30%
Project - 20%

Textbooks

- Goodwin, Graebe, Salgado, "Control System Design", Prentice Hall. 2001.

We will not follow the book strictly, but will pick topics from the book for at home reading, examples, homeworks and discussion etc. Notes, course materials, and papers will be handed out or posted on the course website from time to time. Other recommended texts for reference are:

Recommended Texts

1. Glad and Ljung, "Control Theory - Multivariable and Nonlinear methods" Taylor and Francis, 2000. *fairly comprehensive, useful reference, but may approach the theory in a different way*

as in class.

2. Franklin, Powell, Emami-Naeini, "Feedback control of dynamic systems", Addison-Wesley, 3rd edition+, 1994. *Excellent undergraduate text.*

3. Desoer and Callier, "Linear Systems Theory", Springer-Verlag, 1991 *Linear systems text using geometric ideas.*

4. Anderson, Moore, "Optimal Control - Linear Quadratic Method", Prentice-Hall, 1989. [out-of-print]. *Excellent text on Linear Quadratic Control.*

5. Doyle, Francis, Tannenbaum, "Feedback control theory", McMillan, 1992. *Good introduction to robust control ideas and loop shaping*

6. Khalil, "Nonlinear Systems", Prentice-Hall, 2nd+ Ed. 1996. *Fairly comprehensive on nonlinear systems analysis, and some control design ideas.*

7. Slotine, Li, "Applied Nonlinear Control", Prentice Hall. 1991. *Introductory book (i.e. readable) on nonlinear control.*

Course Outline

1. Review of states space modeling, linearization of nonlinear sytsems
2. Response of linear systems
3. Controllability and observability - concepts and tests
4. Balanced realization / model reduction
5. Robustness and performance tradeoff (Loop shaping design)
6. State feedback and observer output feedback
7. Linear Quadratic Regulator (LQR) [loop transfer recovery (LTR)]
8. Kalman filter and LQG
9. Trajectory tracking control
10. Input Shaping
11. Internal model control and repetitive control
12. Introduction to Lyapunov stability theory
13. Feedback linearization
14. Sliding mode control
15. Parameter estimation - introduction to system identification
16. Lyapunov based adaptive control.