University Of California, Berkeley
Department of Mechanical Engineering

ME 190L Practical Control System Design: A Systematic Loopshaping Approach (1unit)

Elective Course

Syllabus

CATALOG DESCRIPTION

After a review of basic loopshaping, we introduce the loopshaping design methodology of McFarlane and Glover, and learn how to use it effectively. The remainder of the course studies the mathematics underlying the new method (one of the most prevalent advanced techniques used in industry) justifying its validity.

COURSE PREREQUISITES

ME 132 or Electrical Engineering 128 (El Engineering 20 may suffice) or similar introductory experience regarding feedback control systems. The student should understand basic properties of feedback systems, be comfortable with transfer function and differential equation descriptions of systems, and be familiar with typical feedback objectives such as disturbance rejection, command following, noise insensitivity and closed loop stability.

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

Notes and slides in class, both based on “A Loop Shaping Design Procedure Using H_∞ Synthesis,” IEEE Transactions on Automatic Control, vol. 37, no. 6, pp. 759-769, June 1992, and Robust Controller Design Using Normalized Coprime Factor Plant Descriptions, Springer-Verlag Lecture Notes in Control and Information Sciences, vo. 138, 1990, both authored by D. McFarlane and K. Glover.

COURSE OBJECTIVES

The students will fully learn a design technique that is not covered in any undergraduate textbook. This will be (likely) the first exposure to the IEEE Transactions on Automatic Control, and they will learn that the current literature is often dense and challenging to read but may offer significant insight into the problems being addressed.

TOPICS COVERED

1. Review of SISO loopshaping, how main design objectives are captured the open-loop loopshape, Bode phase formula
2. The McFarlance/Glover loopshaping methodology; claims, examples, comparisons to other designs

3. Limitations and conservation laws in feedback systems
4. Small gain theorem
5. Coprime factor plan description and coprime factor robustness tests
6. H_∞ design problem: statement, solution, available software
7. The McFarlane/Glover loopshaping theorem for single-input, single-output systems; statement and derivation

CLASS/LABORATORY SCHEDULE

One hour of lecture per week.

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

The loopshaping technique taught in this course is the most prevalent advanced technique used in industry. Undergraduates who complete this course will be well suited to design single-input, single-output control laws for a variety of processes, including aerospace, electromechanical, hydraulic, pneumatic and chemical manufacturing. Moreover, the use of sophisticated numerical tools to enable advanced design is prevalent in industry, and this class reinforces notation.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

The course addresses objective 1 in an obvious manner. The course addresses the life-long learning aspect of objective 3, as the student will fully learn to design technique that is not covered in any undergraduate textbook (and not properly covered in any graduate textbook either). This will be (likely) the first exposure to the IEEE Transaction son Automatic Control, and they will learn that the current literature is often dense and challenging to read, but may offer significant insight into the problems being addressed.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

- Weekly graded homework assignments: 70%
- 1 midterm quiz, 15%
- 1 final exam, 15%

PERSON(S) WHO PREPARED THIS DESCRIPTION: Andrew Packard Jan. 29, 2007