The University of Texas at Austin
Department of Electrical and Computer Engineering

EE362K: Introduction to Automatic Control

Fall, 2019 Unique: 16510

Lectures:

Time: TTh, 3:30 – 5:00 PM

Location: BUR 136

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Course Overview: The concept of feedback is central in the study of systems and control. Feedback loops are common in nature, even in the most basic biological phenomena from the macroscopic (i.e. population dynamics, climate, etc.) to microscopic (i.e. regulation of glucose levels, temperature regulation, etc.) scales. In engineering, feedback plays a critical role in mechanical, electronic, chemical and digital systems. More generally, systems theory and feedback are central to understanding, analyzing, and designing systems with interconnected components. It is important to understand not only if a system can be controlled, but in what frequency range and under what conditions.

The purpose of this class will be to gain a basic intuition for and understanding of linear feedback systems and develop the mathematical tools to understand the basics of design and analysis of single-input single-output feedback control systems.

Official Course Description: Analysis of linear automatic control systems in time and frequency domains; stability analysis; state variable analysis of continuous-time and (to less extent) discrete-time systems. Important topics we will cover include:

Course Outline:

- **Part 1 – Fundamentals: Modelling and simulation**
  - What is a dynamical system? Control? Feedback?
  - State space representation of linear systems.
  - Mathematical tools
    - Linear algebra review
    - Solving ODEs (numerically & analytically)
    - Convolution
    - Using MATLAB
- **Part II – State feedback systems**
  - Controllability and state feedback
  - Observability and output feedback
  - Design of state/output feedback systems
  - Performance measures: stability, disturbance rejection, noise attenuation, and tracking (overshoot, steady state error, rise time, etc.)
- **Part III Frequency Response of linear systems**
  - Transfer functions
  - Block diagrams
  - Proportional Integral Derivative (PID) Control
  - Frequency response design: Bode, Root Locus and Polar plots
  - Stability & gain/phase margins in the frequency domain
  - Common real-world control issues
  - Control design strategies

A significant amount of time will be used to present interesting examples illustrating the basic concepts from many disciplines to develop a broad and general perspective on the applicability and impact feedback control principles.

Course Prerequisites: The prerequisites for this class are: Electrical Engineering 313 and Mathematics 340L with a grade of at least C in each. Much of what we cover in this class is cumulative. Thus, these prerequisites are strict. Indeed, this class draws heavily on previous work in linear algebra, transforms, and differential equations. In addition to these, many assignments will require use of

MATLAB. You do not need to have prior exposure to MATLAB, but knowledge of basic programming will be helpful. If you have any concerns or feel that you have acquired the perquisite skills through other avenues, please contact the instructor.

Homework and Exams: In this class there will be approximately 6-8 homework assignments; three mid-term exams, and a final exam. Attendance will be taken during class and will be considered as part of the class participation in the weighting below. **Late homework cannot be accepted as homework results are discussed in future lectures and solutions are posted.** I have found that attention to the homework is the best way to learn controls is to create controllers. Thus, the weighting will be as follows:

- Homework: 30%
- 3 Midterm Exams: 15% each
- Final Exam: 20%
- Class participation: 5%

Text and References: The primary textbook utilized for the course is *Feedback Systems: An Introduction for Scientists and Engineers*, by Karl J. Astrom and Richard M. Murray. This book is *free*, and has a wiki.

www.cds.caltech.edu/~murray/amwiki/Main_Page

The course follows this book closely. If you prefer, hard copies of the book are available online and (hopefully) at the Co-op.

If you prefer a book that covers the same topics in a more traditional textbook format, I recommend (as an option/not required) *Dynamic and control of engineering systems* by Bohdan Kulakowski, John Gardner, and Lowen Shearer, Cambridge, 3rd Edition.

If you find either the Matrix algebra or numerical solver lectures to be insufficient (or you just want to learn more), there are many great texts on both subjects. But two good ones are:

- *Linear Algebra Done Right* by Sheldon Axler.
- *Numerical Methods for Engineers with MATLAB* by Chapra and Canal

Course Policies: *Collaboration* with other students is encouraged. All work submitted for credit, however, must be your own. This includes any MATLAB code required for the assignments. Late homework assignments will not be accepted. ***Any evidence of plagiarism or other forms of scholastic dishonesty will be grounds for a failing grade in the course.***

Homework assignments are a significant portion of the class grade as understanding controls is facilitated by creating controllers. Assignments must be neat and easy for the grader to follow. ***Unclear, undocumented, or unorganized assignments may be returned without credit.***

Class Attendance is in your best interest and sign-up sheets will be passed around at the beginning of each lecture. Also note, ***some material not specifically covered in the text will be presented in lecture.***

Disabilities: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4241 TDD or the College of Engineering Director of Students with Disabilities at 471-4382.