MEM 355 Performance Enhancement of Dynamic Systems - Fall 2020
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Textbook & Software

Kwatny and Chang, Introduction to Control Systems Engineering, Cognella.

We will be using the First Edition of the book which became available Summer 2020. It can be obtained directly from Cognella https://store.cognella.com/82377-1B-002

MATLAB Tutorial: http://www.engin.umich.edu/group/ctm/basic/basic.html

Schedule & Assignments

Week 1 – week of Sep 21 Introduction & Fundamentals (Chapter 1, Sections 7.1, 7.2)
Week 2 – week of Sep 28 Intro to Frequency Domain Design (Sections 7.3, 7.4, 7.5, 7.6, 7.7)
Homework 1: P7.1 a, b, c (Due- Fri, Oct 2)
Week 3 – week of Oct 5 Steady-State Errors (Section 8.2) & Root Locus Preliminaries (Sections 8.3, 8.4)
Homework 2: P7.2 a, b, c (Due- Fri, Oct 9)
Week 4 – week of Oct 12 Design via Root Locus (8.3, 8.4, 8.5, 8.6, 8.7)
Week 5 – week of Oct 19 Robust Stability (9.1, 9.2, 9.3)
Homework 3: P8.1 a, b, c, d, e (Due – Fri, Oct 23)
Week 6 – week of Oct 26 Robust Stability, (9.4, 9.5, 9.6)
Homework 4, P9.1 a thru i (Due – Fri, Oct 30)
Week 7 – week of Nov 2 State Feedback Design: Pole Placement, Controllability (Sections 10.1, 10.2, 10.3,10.4)
Homework 5 P10.1 a thru f (Due – Fri, Nov 6)
Week 8 – week of Nov 9 State Feedback Design: LQR (Section 10.5)
Homework 6 P10.7 a, b, c (Due – Fri, Nov 13)
Week 9 – week of Nov 16 Observability and Observers (Sections 11.1, 1.2, 11.3)
Homework 7 P11.1 a thru c (Due – Fri, Nov 20)
Week 10 – week of Nov 23 Minimal Realizations (Sections 11.4, 11.5)
Final Project (Due Fri, Dec 4)
Week 11 – week of Nov 30 LQG Control (Section 11.6)

Grading:
Homework (7): 70%,
Final Project (take home): 30%

Course Goals

- Define the control system design problem and develop a preliminary appreciation of the tradeoffs involved and requirements for robust stability and performance.
- Develop concepts and tools for ultimate state error analysis.
- Develop the relationship between time domain and frequency domain performance specifications, e.g, rise time, overshoot, settling time, sensitivity function and bandwidth.
- Develop frequency domain design methods, including: the root locus method, Nyquist & Bode methods, and stability margins.
- Provide an introduction to state space design: controllability and observability, pole placement, design via the separation principle (time permitting).
- Emphasize computational methods using MATLAB.

What you should know going in.

- Basics of complex variables and Laplace transform
- Concepts of state space and transfer function models of a linear system.
- The meaning of poles & zeros
- The frequency transfer function and Bode Plots
- Block diagram manipulation
- Eigenvalues & eigenvectors, modal analysis and similarity transformations.
- Stability and Routh table.
- Basic ability to use MATLAB.

What you should know going out.

- Understand why automatic control is essential in modern technology and useful for a mechanical engineer
- Recognize the value of integrated control and process design
- Understand the key concepts of control system design
- Be able to solve simple control problems
- Recognize difficult control problems
- Understand the relevant mathematical theory

Relationship to Program Outcomes:

Outcomes a – k	Conter	Explanation	Evidence
a. An ability to apply knowledge of mathematics, science and engineering	**2**	Students develop a general understanding of controlling dynamical systems, and the ability to design such controllers. They are required to integrate and apply their knowledge of mathematics, science, and engineering.	Homework, Exams, and projects
b. An ability to design and condu experiments as well as to analyze and interpret data	**0**	The course requires the students to interpret experimental data in the form of mathematical models of systems.	
c. An ability to design a system, component or process to meet desired needs	**2**	Students are introduced to control design for contemporary problems with specific objectives and performance goals.	Lectures, homework, project
d. An ability to function on multidisciplinary teams	**1**	Project requires team work.	Project
e. An ability to identify, formula and solve engineering problems	**2**	The problems require students to identify, formulate and solve engineering problems.	Homework, Project
f. An understanding of professio and ethical responsibility	**0**	NA	NA
g. An ability to communicate effectively	**1**	Written report for the final project.	Project
h. The broad education necessa to understand the impact of engineering solutions in a global/societal context	**1**	Homework and in class problems relate to meaningful engineering design problems.	Classroom discussion and homework.
i. A recognition of the need for and an ability to engage in lifelong learning	**1**	History and continuing evolution of control concepts, design methods and tools are emphasized.	Classroom discussion.
j. A knowledge of contemporary issues	**1**	Contemporary examples used in class discussions, homework and project.	Lecture materials, homework, project
k. An ability to use the techniqu skills and modern engineering tools necessary for engineering practice	**1**	Computer tools (MATLAB) employed throughout..	Homework. Project

Academic Policies:

Drexel University policies regarding 1) academic integrity, 2) plagiarism, 3) cheating, 4) Disability statement, and 5) drop policy:

http://www.drexel.edu/provost/policies/academic_dishonesty.asp

http://www.drexel.edu/studentlife/community_standards/overview/

http://www.drexel.edu/oed/disabilityResources/students

http://www.drexel.edu/provost/policies/course_drop.asp

Add/Drop and Withdraw Policies:

Add/Drop - http://drexel.edu/provost/policies/course-add-drop/

Withdrawal - http://drexel.edu/provost/policies/course-withdrawal/

Drexel Policy on Cheating (from the Provost's website):

"Cheating is an act or an attempted act of deception by which a student seeks to misrepresent that he or she has mastered information on an academic exercise that he/she has not mastered.

Examples include, but are not limited to:

- Copying from another student's test paper
- Allowing another student to copy from a test paper
- Unauthorized use of course textbook or other materials, such as a notebook to complete a test or other assignment from the faculty member
- Collaborating on a test, quiz, or other project with any other person(s) without authorization
- Using or processing specifically prepared materials during a test such as notes, formula lists, notes written on the students clothing, etc. that are not authorized
- Taking a test for someone else or permitting someone else to take a test for you"

Please don't plagiarize or cheat; it isn't worth it. *Cheating will result on a grade of zero for the assignment.*

Statement for Students with Disabilities:

Students with disabilities requesting accommodations and services at Drexel University need to present a current accommodation verification letter (AVL) to faculty before accommodations can be made. AVL's are issued by the Office of Disability Resource (ODR). For additional information, contact ODR at 3201 Arch Street, Suite 210.

215-895-1401 (Voice), or ***215-895-2299*** (TTY).
http://www.drexel.edu/oed/disabilityResources/

All exam accommodations are to be scheduled at ODR.

Student must submit forms a minimum of one week before exams. No exceptions.