AEM4321/EE4231: Automatic Control Systems

Instructor:
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Course Information:
Textbook (Recommended): K. Ogata, Modern Control Engineering, Prentice Hall, 5th Edition, 2010
Webpage: https://www.aem.umn.edu/courses/aem4321/fall2012/
University Policy Statements: http://www.aem.umn.edu/teaching/syllabi.shtml
Prerequisites: AEM4303, ME3281, EE3015, or instructor consent

Catalog Description:
Modeling, characteristics, and performance of feedback control systems. Stability, root locus, frequency response methods. Nyquist/Bode diagrams. Lead-lag, PID compensators. Digital implementation, hardware considerations.

Course Objectives:
Develop an understanding of the elements of classical control theory as applied to the control of aircraft and spacecraft. In particular understand: the concept of feedback and its properties; the concept of stability and stability margins; and the different tools that can be used to analyze the previous properties. Finally gain a working knowledge of the basic linear design techniques, in particular as applied to spacecraft and aircraft.

Note: This course is cross-listed between AEM and EE. The tools presented in this course can be used to analyze a variety of systems. The practical examples will span across mechanical, electrical, and aerospace engineering.

Homework:
Homeworks will be assigned approximately once every two weeks. They will always be due on Wednesday by 4:00pm. Homeworks should be handed in to the AEM4321 dropbox in the office at 107 Akerman Hall. Homeworks grades will be reduced by 50% for each day beyond the deadline. Homeworks will not be accepted if they are more than two days late. **Please clearly label your name and your section (AEM4321 vs. EE4231) on the front page of the homework.**

Exams:
There will be two exams and one final exam. The first exam will be occur in early October and the second exam will be occur in early November. Dates will be finalized during the semester.

Scholastic Dishonesty:
Cheating, whether it is on your problem sets or exams, is absolutely unacceptable. Please refer to the Student Conduct Code at:
http://www1.umn.edu/regents/policies/academic/Student_Conduct_Code.pdf

Grading:
Letter grades for the course will be assigned using the following scale:

A	90.0 - 100
A-	87.0 - 89.9
B+	83.0 - 86.9
B	80.0 - 82.9
B-	77.0 - 79.9
C+	73.0 - 76.9
C	70.0 - 72.9
C-	67.0 - 69.9
D+	63.0 - 66.9
D	60.0 - 62.9
F	below 60.0

This is only a rough scale. This scale may be adjusted depending on the performance of the class. Any adjustments to the scale will only lower the cut-offs to achieve a specified grade; cut-offs will not be raised beyond those listed here. Grades will be weighted as follows: Homeworks 20%, Exam 1 25%, Exam 2 25%, and Final Exam: 30%. Students can check their posted grades at: `http://www.aem.umn.edu/srs`

Course Outline:

Lectures (Hrs, Approx.)	Topics
6	Motivation for control. Review of differential equations, linear systems, impulse response and Laplace transformations. Definition of stability. Introduction to state equations and transfer functions.
6	Stability and performance specifications. Interpretation of poles and zeros of transfer functions. Time domain response of second order system. Command tracking and system type. Routh/Hurwitz test.
6	Frequency response and frequency domain methods. Nyquist stability test. Bode plots. Phase and gain margins. Bode phase formula. Lead/lag compensation.
6	Robustness. Uncertainty and performance weights. Robust stability test. Robust performance test. Loop shaping necessary and sufficient conditions. Bode integral formula. PID controllers.
2	Root locus technique.
2	State space techniques. Introduction to multivariable control.

Disclosure Statement:
Prof. Peter Seiler is a consultant for MUSYN, a company that produces some of the design and analysis software for automatic control systems taught in this class.