

MAE 170 INTRODUCTION TO CONTROL SYSTEMS

(Required for AE and ME; Elective for CE and MSE)

- Catalog Data:** **MAE 170: Introduction to Control Systems (Credit Units: 4) F.**
Feedback control systems. Modeling, stability, and systems specifications. Root locus, Nyquist, and Bode methods of analysis and design.
Prerequisites: Mathematics 2D, Physics 7B, MAE80, each with a grade of C- or better; and MAE106. MAE H170 and MAE170 may not both be taken for credit. (Design units: 2)
- Textbook:** Dorf and Bishop. *Modern Control System*, 10th Edition, Addison-Wesley, 2004.
- References:** Leonard and Levine. *Using Matlab to Analyze and Design Control Systems*, Benjamin/Cummings, 1995.
- Coordinator:** Athanasios Sideris
- Course Outcomes:** Students will:
Identify plant, sensors, actuators, and reference signals in a control system.
Compute the transfer function of a system from its ODE and/or step response and the response of a transfer function using Laplace transforms.
Simplify block diagrams.
Calculate % overshoot, rise time, settling time in the step response of a 2nd order system / estimate for systems with a dominant 2nd order component.
Compute error constants and steady-state errors for step/ramp/parabolic inputs.
Determine stability by pole location and the Routh-Hurwitz criterion.
Specify locations for closed-loop poles to satisfy transient response specifications.
Sketch the Root Locus of a given transfer function.
Design PID or lead/lag controllers to achieve transient response and tracking specs via the Root Locus method.
Sketch the Bode plot of a given transfer function.
Determine closed-loop stability via the Nyquist stability criterion.
Specify frequency response characteristics (Phase and Gain Margins, error constants, crossover and bandwidth frequencies) to satisfy transient and steady-state response specifications.
Design PID or lead/lag controllers to achieve transient response and tracking specs via the frequency response compensation.
Use MATLAB to: simplify a block diagram, plot system response, draw root locus and select gain to place closed-loop poles, draw Bode/Nyquist plots and identify PM, GM, crossover and bandwidth frequencies.
- Prerequisites By Topic:** Dynamics
- Lecture Topics:** Laplace transform and block diagrams
Properties of feedback
Performance specification

Stability and Tracking
Root locus design method
Bode techniques
Frequency response design method
PID Control Design
Design via lead and lag networks

Class Schedule: Meets for 3 hours of lecture and 1 hour of discussion each week for 10 weeks.

Computer Usage: MATLAB with the Control System Toolbox.

Laboratory Projects:

Professional Component: Contributes toward the Mechanical Engineering Topics courses and Major design experience.
Contributes toward the Aerospace Engineering Topics course and Major design experience.

Relationship to Program Outcomes: This course relates to Program Outcomes a, c, e, and k as stated at:

<http://undergraduate.eng.uci.edu/degreeprograms/mechanical/mission>

Design Content Description

Approach: The students learn basic control design techniques. Using Matlab, they use iteration, simulation and trial and error techniques to design controllers to meet performance specifications. Many of these problems are open-ended since there are many possible control designs that meet the performance criteria. Design problems are a major component of each portion of the elements of the grade.

Lectures: 100%

Laboratory Portion: 0%

Grading Criteria:		<u>% Engr. Sci</u>	<u>% Engr. Design</u>
Homework:	10% =	5%	5%
Midterm Exam:	40% =	20%	20%
Final Exam:	<u>50%</u> =	20%	30%
	100%		

Estimated ABET Category Content:

Mathematics and Basic Science: ___ credit units or ___%

Engineering Science: 2 credit units or 50 %

Engineering Design: 2 credit units or 50 %

Prepared by: Athanasios Sideris **Date:** July 2007

CEP Approved: Fall 2004