

AME 451: Linear Control Systems I

Time: MW 5-6:20
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Homework: Will be assigned *every* Wednesday and will be due *the following* Wednesday

Grading: The final grade will be according to the following formula :

Homework:	20%
Midterm (October 7):	30%
Final (December 9):	50%

Textbook: R. Dorf and R. H. Bishop, *Modern Control Systems* , 12th Edition, Prentice-Hall, 2011.

Course Outline

1. Introduction (Chapter 1)
 - (a) Input-output relations
 - (b) Dynamic systems, actuators, sensors, and controllers
 - (c) Flow of information and functional diagrams
 - (d) Open-loop and closed-loop (feedback) control systems
2. Review: Modeling of Dynamic Systems (Chapter 2)

- (a) Modeling of dynamic systems in time domain
 - i. Mechanical systems
 - ii. Fluid- and heat- flow systems
 - iii. Electrical circuits
 - iv. Electromechanical systems
 - (b) Modeling in Laplace Domain
 - i. Laplace transforms of elementary functions
 - ii. Inverse Laplace transform
 - (c) Transfer function representation of dynamical systems
 - (d) Block diagram manipulations
 - (e) Simulation of control systems using *MATLAB*
3. Performance of Control Systems (Chapters 4 and 5)
- (a) Characteristics of feedback systems
 - i. Error signal analysis
 - ii. Sensitivity to parameter variations
 - (b) Transient response specifications
 - (c) First-order systems
 - (d) Second-order systems
 - (e) Root location and transient response
 - (f) Steady-state errors and system type
 - (g) Simplification of linear systems
 - (h) Control system characteristics using *MATLAB*
4. Stability of Linear Systems (Chapter 6)
- (a) Definition of stability
 - (b) Routh-Hurwitz stability criterion
 - (c) Application of Routh-Hurwitz criterion to system synthesis
 - (d) System stability using *MATLAB*
5. Root-Locus Analysis (Chapter 7)
- (a) The root-locus concept
 - (b) Rules for the construction root-locus plots
 - (c) Root-locus analysis using *MATLAB*

- (d) Control actions
 - (e) Control design
6. Frequency Domain Analysis (Chapters 8)
- (a) Frequency response of linear systems
 - (b) Log Magnitude and phase (Bode) diagrams
 - (c) Polar (Nyquist) plots (notes)
 - (d) Nichols plots
 - (e) Frequency response using *MATLAB*
7. Stability in Frequency Domain (Chapter 9)
- (a) Nyquist stability criterion
 - (b) Relative stability measures
 - (c) Stability in frequency domain using *MATLAB*
 - (d) Performance measures in frequency domain
 - (e) Stability of systems with time delays
8. Design and Compensation Techniques (Chapter 10, Notes)
- (a) Lead compensation
 - (b) Lag compensation
 - (c) Lead-lag compensation
 - (d) Tuning of commercial controllers
 - (e) System design using the *MATLAB* program *SISOTOOL*.