AME 451: Linear Control Systems I

Lecture:	*MW 5-6:20*
Discussion	*F 11-11:50*
Instructor:	*H. Flashner*
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Office:Zoom
Office hours: TBD

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:	15%
Midterm (TBD):	25%
Project	10%
Final (TBD):	50%

Textbook: R. Dorf and R. H. Bishop, *Modern Control Systems* , 13th Edition, Prentice-Hall, 2017.

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 and SIMULINK*

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) Tuning of comercial controllers

(f) 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) Tuning of commercial controllers

   (b) Lead compensation

   (c) Lag compensation

   (d) Lead-lag compensation

   (e) System design using the *MATLAB* program *SISOTOOL.*

9. *State Space Methods (Chapters 3 and 11)*

   (a) State space representation of dynamic systems (*Sections 3.2 and 3.3*)

   (b) Time response and state transition matrix *(Section 3.7)*

   (c) State feedback and observer design *(Sections 11.3 and 11.4)*