

MAE 143B

Linear Control

Designation: Required course

Catalog Data:

MAE 143B Linear Control

Analysis and design of feedback systems in the frequency domain. Transfer functions. Time response specifications. PID controllers and Ziegler-Nichols tuning. Stability via Routh-Hurwitz test. Root locus method. Frequency response: Bode and Nyquist diagrams. Dynamic compensators, phase-lead and phase-lag. Actuator saturation and integrator windup.

Prerequisites: MAE 143A or CENG 100 (Grade C- or higher).

Prerequisites by Topic: Differential equations, signals and systems, Laplace transform and transfer functions.

Textbook, Required Materials: Franklin, Powell, and Emami-Naeini, *Feedback Control of Dynamic Systems*, 5th edition, Prentice Hall, 2006.

Class/Laboratory Schedule: two 110-minute lectures per week

Course Topics:

1. Transfer functions and block diagram algebra.
2. Time response specifications.
3. PID controllers and Ziegler-Nichols tuning.
4. Steady-state response and system types.
5. Stability via Routh-Hurwitz test.
6. Root locus method.
7. Frequency response: Bode and Nyquist diagrams.
8. Dynamic compensators, phase-lead and phase-lag.
9. Actuator saturation and integrator wind-up.

Course Objectives:

(Numbers in parenthesis refer to MAE Program Outcomes)

Objective 1: To teach the students the mathematical methods for analysis of performance and stability of feedback systems (1a, 5e, 11k)

Objective 2: To introduce the students to the basics of design of feedback control systems (1a, 3c, 5e, 11k)

Objective 3: To introduce the students to elementary applications of control systems from a broad array of problems in aerospace and mechanical engineering (1a, 3c, 5e, 11k)

Methods of Evaluation:

1. Homework assignments
2. Examinations

Performance Criteria:

(Numbers in parentheses refer to the methods of evaluation used to assess student performance.)

Objective 1:

1.1 Students will demonstrate understanding of how to find a closed loop transfer function of a complex block diagram involving feedback interconnections (1, 2)

1.2 Students will demonstrate the ability to select system parameters to meet performance specifications in time domain and to achieve closed-loop stability (1, 2)

Objective 2:

2.1 Students will demonstrate understanding of how to select the controller gain, as well as the poles and zeros of phase-lead and phase-lag compensators, to place closed-loop poles in a desired region in the complex plane (1, 2)

2.2 Students will demonstrate the ability to determine phase and gain margins in Bode and Nyquist plots (1, 2)

2.3 Students will demonstrate the understanding of how to obtain the information needed to apply the Ziegler-Nichols tuning rules for PID controllers (1, 2)

Objective 3:

3.1 Students will demonstrate the ability to relate examples from basic control applications to control objectives, choices of control inputs and outputs, and choices of compensator types for particular applications (1, 2)

Contribution of Course to Professional Component:

Engineering Science

Prepared by: Miroslav Krstic, July 2007

Revised: Miroslav Krstic, April 2008 via Teaching Work Group Meeting