

Department of Mechanical Engineering
2.14 Analysis and Design of feedback Control Systems

Fall Term 2003
Problem Set 3

Assigned: Sept. 17, 2003

Due: Sept. 24, 2003

Reading: Nise, Chapter 4 (4.1 — 4.8)

Problem 1: The poles of a closed-loop system move around the s -plane as the controller parameters vary. We will show that as the controller gain increases, one of the closed-loop poles approaches any open-loop zero in a system. The question is: What happens to the contribution of that pole to the transient response as it approaches the zero? Consider a first order system with a transfer function:

$$G(s) = \frac{s + a + \epsilon}{s + a}$$

that indicates a zero displaced from the pole by ϵ .

(a) Find the system step-response by expressing $G(s)$ in its partial fractions:

- (i) Find the step response of the system $1/(s + a)$.
- (ii) Use the differentiation property of linear systems to find the step response of the system $s/(s + a)$.
- (iii) Combine the two responses.

(b) How is the step response affected by the pole-zero separation ϵ ? What happens to the step-response as $\epsilon \rightarrow 0$?

Problem 2: Matlab/Simulink exercise: Nise (4th Ed.), Ch. 4, Cyber Exploration Laboratory - Experiment 4.2 (p. 249)