ELEE 4700/5700: Control Systems II

Professor Hill

University of Detroit Mercy, Fall 2012

Homework #8

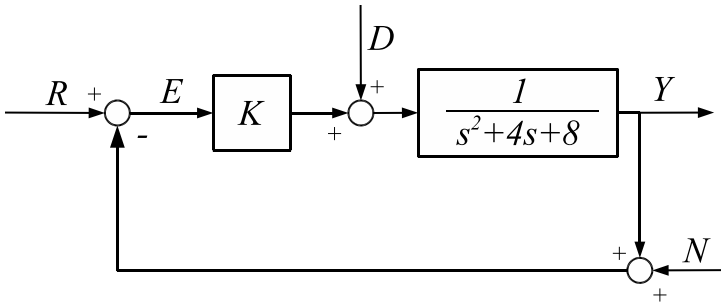
Assigned: November 21, 2012

Due: November 29, 2012

Read sections 2-4 to 2-6, and 9-4 to 9-6 of the book.

Recommended example problems: A-2-6, A-2-8, A-2-11, and A-2-12

1. Consider the feedback control system given below.



   (a) Design the proportional controller K so that the closed-loop system response to a unit step reference has an overshoot of 10%.

   (b) For this controller, calculate the sensitivity function $S(s)$ and the closed-loop transfer function $T(s)$. Plot the Bode diagrams for these two functions. Then repeat this process, but for a gain 10 times larger than the original gain K.

   (c) Simulate the closed-loop system without any noise and without a disturbance for a unit step reference. Plot the output y versus time.

   (d) Simulate the closed-loop system with a sinusoidal noise input of frequency 5 rad/sec and amplitude 0.1. Plot the output y versus time for the original gain K and a gain 10 times larger.

   (e) Simulate the closed-loop system with a step disturbance input that occurs at t = 5 seconds. Plot the output y versus time for the original gain K and a gain 10 times larger.

   (f) What is the effect of the gain on the noise and disturbance rejection? Is this what you expected? Explain.

2. Problem B-2-9, page 62. Solve by hand.

3. Problem B-2-11, page 62. Solve by hand.

4. Problem B-2-12, page 62. You may use MATLAB to do the matrix multiplication.

5. Show that the following state-space system is not controllable:

$$\dot{\mathbf{x}} = \begin{bmatrix} -3 & 1 \\ -2 & 1.5 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 1 \\ 4 \end{bmatrix} u$$

   Given $C = [\, 1 \;\; 1 \,]$ and $D = 0$, find the poles and zeros of its transfer function. What do you notice?