ECE-320 Linear Control Systems
Homework 9

Due: Thursday November 11, 2004

1 For a unity feedback system with plant transfer function

$$G(s) = \frac{100}{s(0.04s+1)}$$

a) Determine a lead compensator so that the phase margin is approximately 50 degrees (to within ± 5 degrees). Use the **margin** command to be sure you have met the phase requirements, and plot the step response of the system.
b) Determine a lead compensator so that the phase margin is approximately 65 degrees (to within ± 5 degrees). Use the **margin** command to be sure you have met the phase requirements, and plot the step response of the system.
c) Estimate the percent overshoot and the settling time for both systems.

2 For a unity feedback system with plant transfer function

$$G(s) = \frac{4}{s(s+1)(s+2)}$$

Determine a lag compensator so that

- $K_v = 2$
- the phase margin is approximately 50 degrees (to within ±5 degrees)

Use the **margin** command in Matlab to be sure you have meet the requirements.

3 For a unity feedback system with plant transfer function

$$G(s) = \frac{4}{s(s+1)(s+2)}$$

Determine a lead compensator so that

- $K_v = 2$
- the phase margin is approximately 50 degrees (to within ± 5 degrees)
- the settling time is less than 4 seconds (2% criteria)

Use both the step response and the **margin** command in Matlab to be sure you have meet the requirements. (*You will probably need two compensators for this one.*)

4 For a unity feedback system with plant transfer function

$$G(s) = \frac{1}{(s+2)^2}$$

Determine a lag compensator so that

- $e_p \leq 0.04$
- the phase margin is approximately 50 degrees (to within ± 5 degrees)

Use the **margin** command in Matlab to be sure you have meet the requirements.

5 For the system described by

$$\dot{x} + e^{-x}\cos(y) = \dot{y} + y^2$$

show that the linearized transfer function is

$$H(s) = \frac{\Delta Y(s)}{\Delta X(s)} = \frac{s - e^{-x_0}\cos(y_0)}{s + e^{-x_0}\sin(y_0) + 2y_0}$$

6 For the system described by

$$\dot{y}(t) + \frac{1}{\sqrt{x(t)y(t)}} = y^2(t)$$

show that the linearized transfer function is

$$G(s) = \frac{\frac{1}{2}\frac{1}{x_0\sqrt{x_0y_0}}}{s - \frac{1}{2}\frac{1}{y_0\sqrt{x_0y_0}} - 2y_0}$$

7 For the system with transfer function given by

$$H(s) = \frac{3}{(s+1)^2(s+2)}$$

a) find the unit step response of the system $y(t)$
b) determine the position error e_p.

Ans. $y(t) = \frac{3}{2}u(t) - 3te^{-t}u(t) - \frac{3}{2}e^{-2t}u(t)$, $e_p = -0.5$, *though* $e_p = 0.5$ *is OK too.* Note the coefficient of $e^{-t}u(t)$ happens to be zero in this case.)