16.31 Homework 1

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1. Plot the root locus diagram for positive values of K for the solutions of the equation

$$s^3 + (5 + K)s^2 + (6 + K)s + 2K = 0$$

2. The open loop transfer function of a closed-loop control system with unity negative gain feedback is

$$G(s) = \frac{K}{s(s + 3)(s^2 + 6s + 64)}$$

Plot the root locus for this system, and then determine the closed-loop gain that gives an effective damping ratio of 0.707.

3. A unity gain negative feedback system has an open-loop transfer function given by

$$G(s) = \frac{K(1 + 5s)}{s(1 + 10s)(1 + s)^2}$$

Draw a Bode diagram for this system and determine the loop gain K required for a phase margin of 20 degs. What is the gain margin?

A lag compensator

$$G_c(s) = \frac{1 + 10s}{1 + 50s}$$

is added to this system. Use Bode diagrams to find the reduction in steady state error following a ramp change to the reference input, assuming that the 20 deg phase margin is maintained.

4. Plot the Nyquist diagram for the plant with the unstable open-loop transfer function

$$G(s) = \frac{K(s + 0.4)}{s(s^2 + 2s - 1)}$$

Determine the range of K for which the closed-loop system with unity negative gain feedback which incorporated this plant would be stable.