EECS 128 Introduction to Control Design Techniques
Problem Set 3

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These problems will be solved in class on Tuesday (Oct 14). Please solve them before coming to Tuesday's class.

Problem 1.

Consider the open loop system:

$$G(s) = \frac{5}{(s+2)(s+3)}$$

We would like the system to have a bandwidth of at least 6 rad/s, a phase margin of 45°, and a steady state error to unit step inputs of no more than 0.05. Design a compensator to achieve this.

Problem 2. The open loop transfer function of a unity feedback system is

$$G(s) = \frac{K}{s(1+s/5)(1+s/20)} \tag{1}$$

Design a compensator for $G(s)$ so that the closed loop system satisfies the following specifications: Steady state error to unity ramp input is less than 0.01; Phase Margin = $45° \pm 3°$; steady state error for sinusoidal inputs with $\omega < 0.2$ rad/sec is less than 1/250; and, noise components introduced with the input signal at frequencies greater than 100 rad/sec are to be attenuated at the output by at least a factor of 100 (no special noise filter is to be added). Verify your design using MATLAB.

Problem 3. Consider the unity feedback system of Figure 1, where $G(s)$ is the plant and K is a proportional (or series gain) compensator.

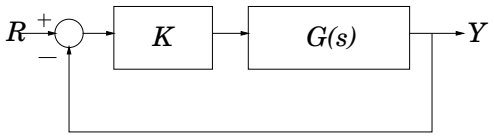

Figure 1: Unity Feedback System.

Let

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

(a) In the s-plane, sketch the locus of roots of the closed loop system of Figure 1 as K varies from 0 to ∞.

(b) Determine the range of K for which the steady state error to a unit step is less than or equal to 0.2.

(c) At what value of K does the closed loop system have poles on the $j\omega$-axis? Having found this, determine the range of K for which the gain margin is greater than or equal to 3 (a gain of 3 corresponds to 9.5dB).

(d) Thus, is it possible to achieve both the steady state error and requirement and gain margin requirement with the proportional gain K?