ME 746 Homework 5

1. No Matlab please!

(a) Manually construct the Bode plot of the plant $G(s) = \frac{K(s+1)}{s\ \ *(0.2s+1)}$ for K=1.

(a) Construct accurate asymptotic approximations of both the magnitude and phase plots.

(b) Using the Nyquist criterion in the Bode plot, determine the optimal gain K for which the closed loop system will have the highest phase margin.

2. The Bode plot on the next page depicts an open-loop system G(s) with P-controller K = 1, where

$$G(s) = \frac{5K}{(s+1)^2 * (0.1s+1)}$$

A phase margin of 30 degrees (mark it in the plot) is desired for closed loop control.

(a) Determine the P-controlled system’s gain K at the desired phase margin. Mark the P-controller gain in the Bode plot, and label it clearly.

3. The open-loop transfer function of a system is given as:

$$G(s) = \frac{K}{s(s^2+4)\ (s+9)}$$

Draw all branches and asymptotes of the root locus, and indicate in each branch the directions of the R.L for increasing K. Determine the locations of all imaginary axis crossings if they exist. Determine the range of K, if any, for which the closed loop system is asymptotically stable.

4. A feedback system consisting of a plant and a lead compensator is given in Fig. 4.

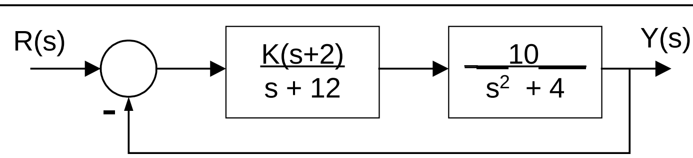

Figure 4 Feedback System

(a) Define the range $0 < K < \infty$ for which the closed loop is asymptotically stable when using P-control only.

(b) Perform a root locus analysis of the system of Fig. 3. Determine all asymptotes and sketch the RL plot. **Label and scale all axes**.

(c) We wish to obtain the largest closed loop damping possible. In the RL plot, sketch the approximate location of the desired closed loop poles and determine the approximate ζ and ω_n of the system. (angle of dep. from upper complex pole is approx. 130^o)