University of Massachusetts Lowell
Department of Electrical and Computer Engineering

EECE 4130 Linear Feedback

Problem set 6

1. Determine the root loci for the closed-loop unity negative feedback system $H(s) = 1$

$$G(s) = \frac{K}{s(s+1)(s^2+4s+5)}$$

a. Evaluate the real-line root locus and directions of closed-loop pole migration with increasing gain K.

b. Determine the asymptotes and intercept

c. Determine the conditions for system stability, $j\omega$ axis crossing and gain.

d. Determine breakin/breakaway points

e. Determine arrival/departure angles

2. Determine the root loci for the closed-loop unity negative feedback system $H(s) = 1$

$$G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$$

a. Evaluate the real-line root locus and directions of closed-loop pole migration with increasing gain K.

b. Determine the asymptotes and intercept

c. Determine the conditions for system stability, $j\omega$ axis crossing and gain.

d. Determine breakin/breakaway points

e. Determine arrival/departure angles

f. By adjustment of the gain K locate the closed-loop poles on the root loci such that the dominant closed-loop poles have a damping factor equal to 0.5.

3. Consider the closed-loop unity negative feedback system where the uncompensated feed forward gain is

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

a. The error in the response is defined as $e = x - y$ where x is the input and y is the output. Design a compensator $H(s)$ such that the steady-state error $e(\infty)$ for a unit-step input is equal to zero. $H(s)$ must yield a stable closed-loop response.

b. The unit-step response of the closed-loop system is to have an overshoot ≤ 25% and a setting time of less than 2 seconds to reach an amplitude within 10% of the steady state response.