Name______________________ ECE 3510 Homework RL6 Due: Tue, 3/19/24

A.Stolp b

Root Locus Gain Design

1. Choice of gain. Each root-locus plot below shows a number of closed-loop pole locations labeled "a", "b", "c", etc.. Each plot has at least two poles. In answering the questions below consider all the closed-loop poles, not just the pole at the labeled location. That is, consider where the other pole(s) are when the gain places the labeled pole at the labeled location. Use a 2nd order approximation in all cases and neglect the partial-fraction coefficients of the poles

   i) List the closed-loop pole locations (labeled "a", "b", "c", etc.) in order of gain factor, smallest to largest.

   ii) List the closed-loop pole locations in order of speed of response (measured as the time to get within 4.4% of the final step resonse). List them slowest to fastest.

   iii) List the closed-loop pole locations which would result in a step response with absolutely no overshoot.

   iv) List the closed-loop pole locations (not listed in part b) in order of % overshoot. List them least to most.

   v) List the closed-loop pole locations in order of steady-state error to a step input. List them worst to best. (most error to least)

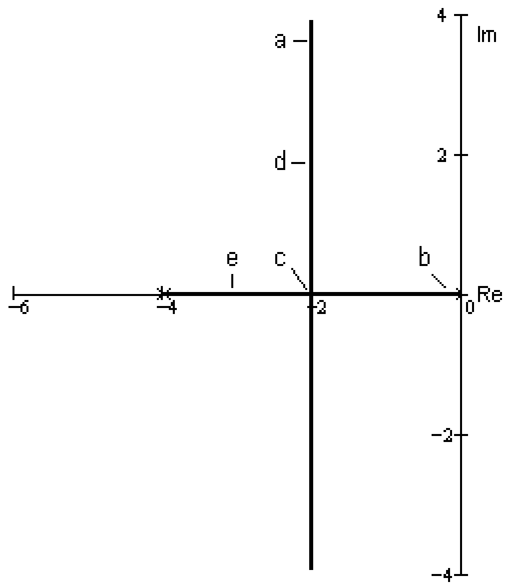
a) i)

ii)

iii)

iv)

v)



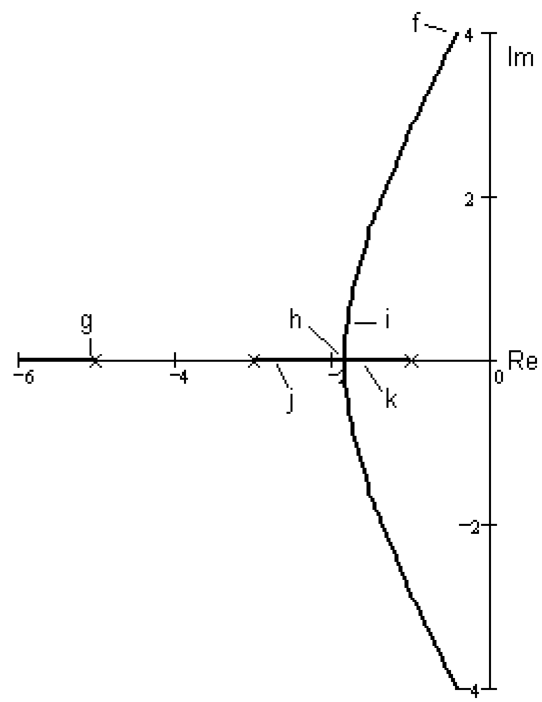
b) i)

ii)

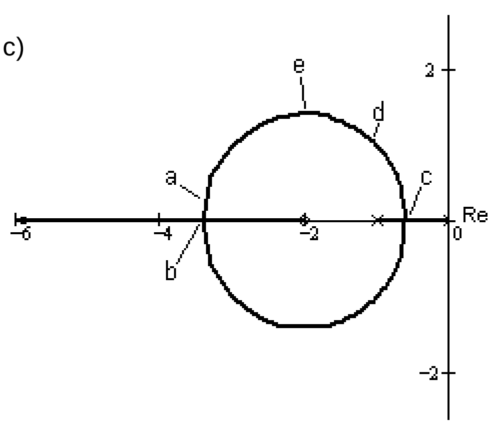
iii)

iv)

v)



c)



i)

ii)

iii)

iv)

v)

Answers Problem 2 on back ==>

1. a) i) b, e, c, d, a ii) b, e, c, a, d OR b, e, a, c, d iii) b, e, c iv) d, a

   v) all will result in $e_{ss}(\infty) = 0$ because of open-loop pole at origin. If that were not so then list in order of gain.

   b) i) g, j, k, h, i, f ii) f, g, j, k, h, i iii) g, j, k, h, iv) i, f v) same as i)

   c) i) c, d, e, a, b ii) c, d, e, b, a iii) b, c iv) a, e, d

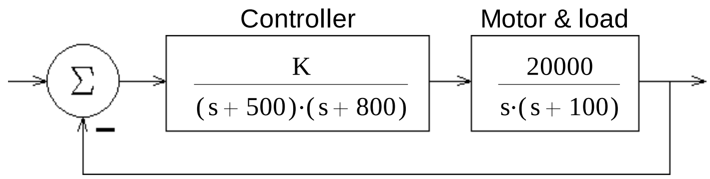
   v) all will result in $e_{ss}(\infty) = 0$ because of open-loop pole at origin. If that were not so then list in order of gain.

2. a) 102300 b) 11.14% c) $K < 715000$

2. Nise 3rd & 4th: Ch.8, problem 46. 5th ed.: Ch.8, prob 55, 6th: Ch.8, p 57. Read sec 4.6 in Nise book

Modify eq. 4.42 to: $T_s = \dfrac{4}{\zeta \cdot \omega_n} = \dfrac{4}{|a|}$ Modify eq. 4.38 (all ed.) to: $\%OS = e^{-\pi \cdot \left|\frac{a}{b}\right|}$

The system of this problem:



a) Find K to yield a settling time of 0.1 second.
If you find that more than one value of K will work, choose the highest K. Usually this results in the best steady-state error. In this case that should not theoretically matter because of the motor's pole at 0, but in reality, it still will.

b) What is the resulting overshoot?

c) What is the range of K that keeps the system stable?