Assignment 2, EE302, Submission by ~~11am~~ midnight
Control Systems 22nd Feb 2021

(Note: No extension of deadline is feasible. Don't bother asking please)

Q-1: Use Routh table method to obtain number of ORHP/jR/OLHP roots of

$$p(s) := 3s^7 - 9s^6 + 6s^5 - 4s^4 + 7s^3 - 8s^2 + 2s - 6$$

Q-2: Consides the polynomial

~~$p(s) = 12s^7 - 4s^6 - 3s^5 - s^4 + 12s^3 - 4s^2 - 3s + 1$~~

$$12s^7 - 4s^6 - 3s^5 + s^4 - 12s^3 + 4s^2 + 3s - 1$$

Find count of OLHP, jR, ORHP for p(s) using Routh table.

Q-3: Consider the polynomial

$$p(s) = s^6 - s^4 - 7s^2 + 7s - 6.$$

Use epsilon method (if only 1st entry of some row becomes zero) to obtain OLHP, jR, ORHP count of roots.

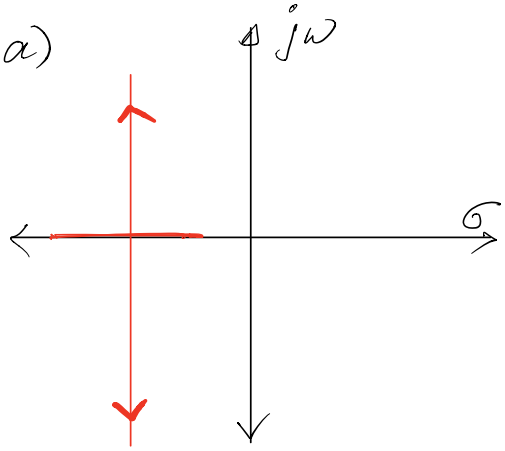
Q-4: For p(s) in Q-3, use reverse coefficient polynomial and check if we still get 0 in 1st column of some row (just 1st column).

check if conclusion is the same for p(s) of Q-3 and the one with coefficients "reversed"

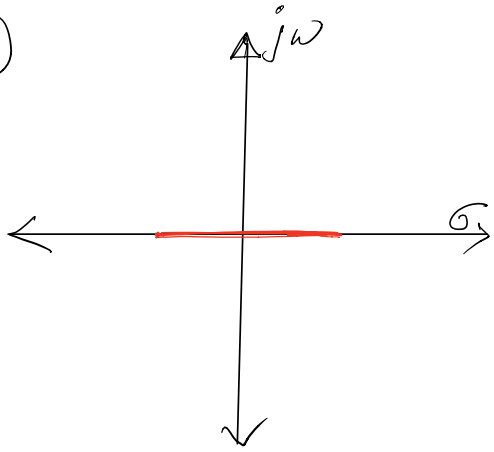
Q5

QN> Give one example each of a system with the given root locus diagram marked in red. Note that the locations of the poles / zeroes are intentionally not shown. Please make educated guesses.

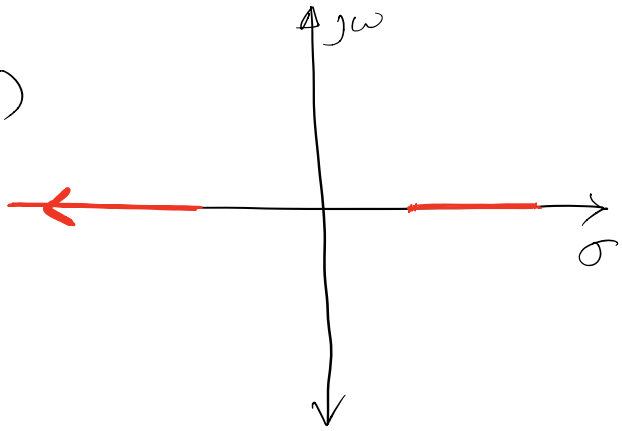
a)



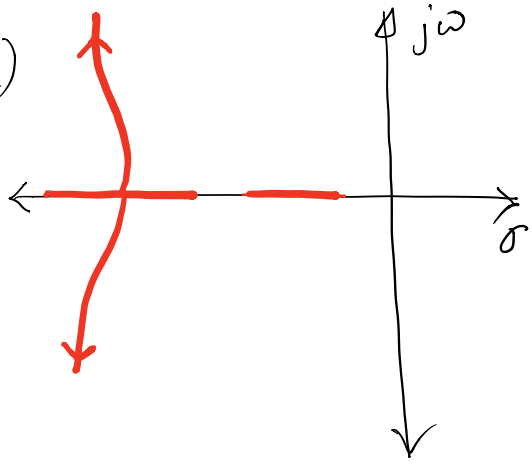
b)



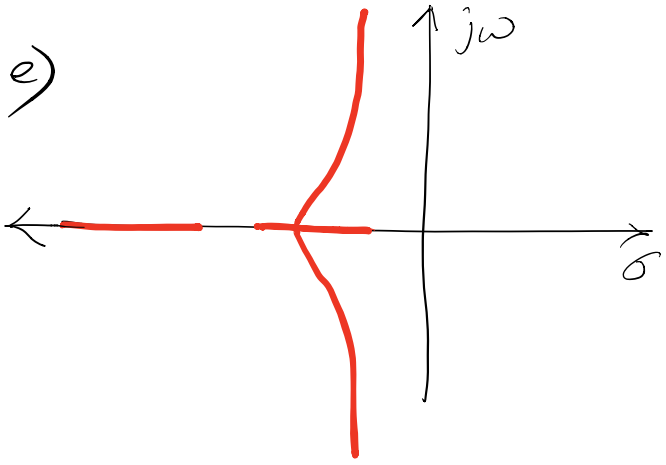
c)



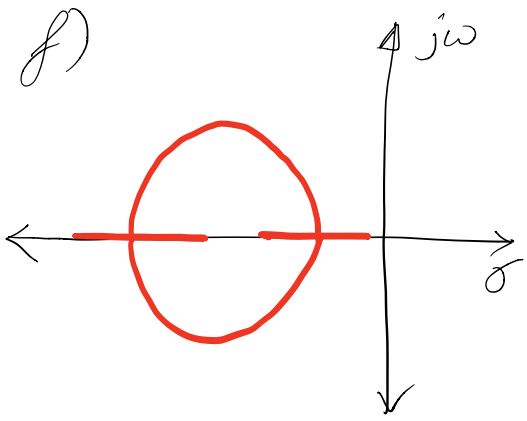
d)

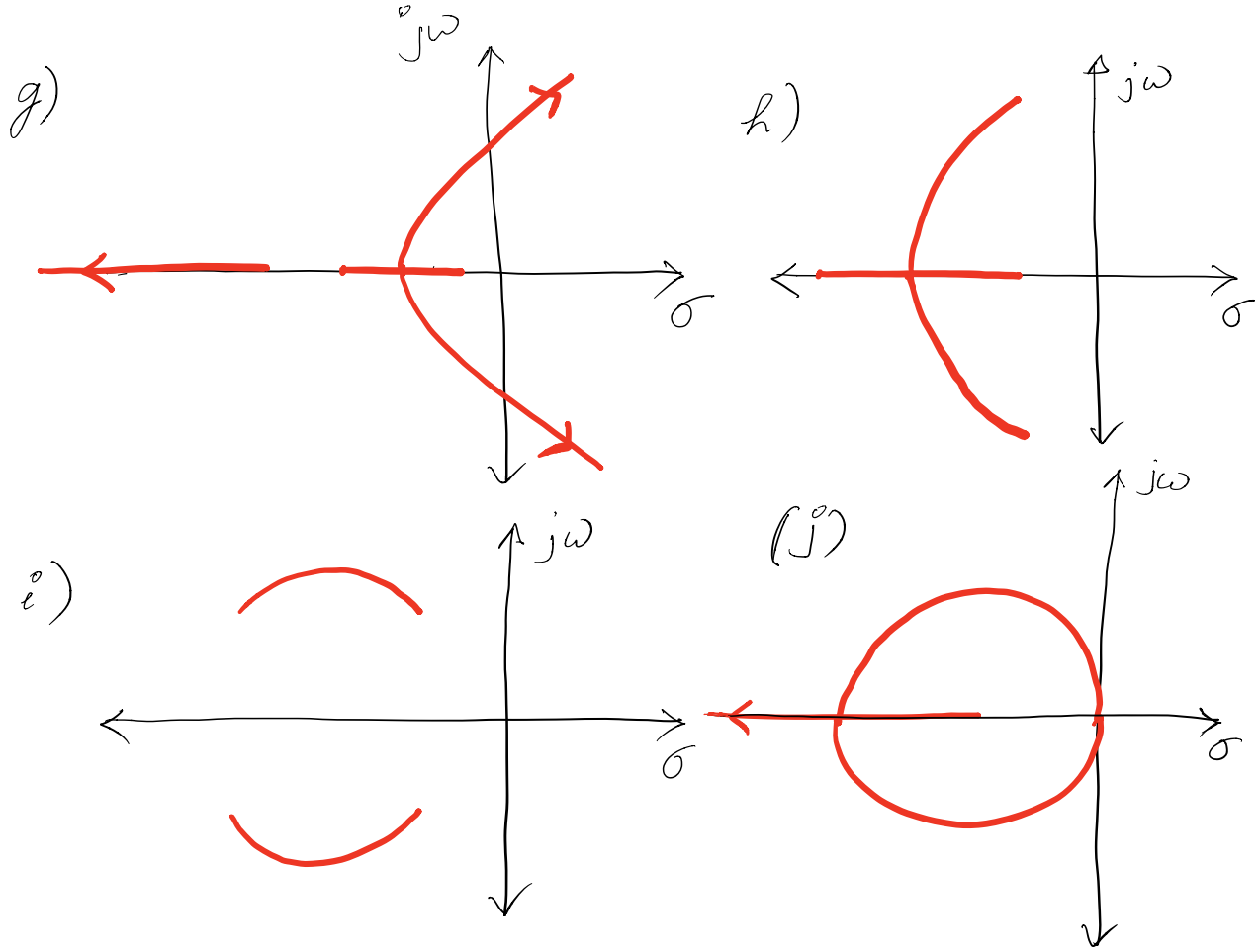


e)



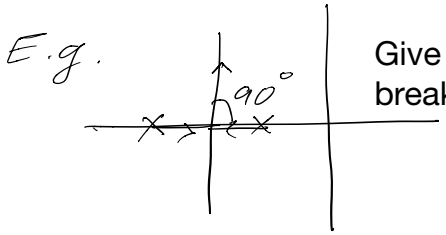
f)





Let us call the angle at which a particular branch of the root locus leaves / arrives at the real axis, the breakaway / breakin angle.

In the fig. the breakaway angle is 90 degrees.



Give two examples of transfer functions where the breakaway/breakin angle is not equal to 90 degrees.

Consider the transfer function

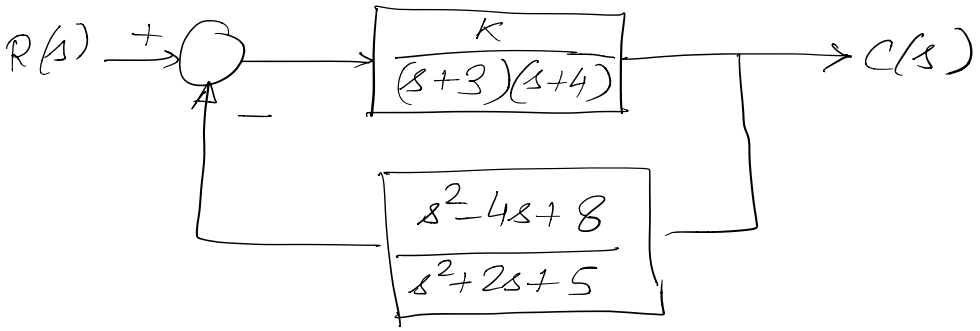
$$G(s) = \frac{K(s^2 + 2s + 2)}{(s^2 - 2s + 2)(s + 2)}$$

Assume that the transfer function is connected in unity negative feedback configuration, and it is known that for

$$K = 2.72$$

at least one of the poles lie on the imaginary axis. Using root locus based arguments calculate the range of K for closed loop stability.

Q8 For the system shown below, use a computer to do the following:



a) plot the root locus

b) Find the imaginary axis crossing and the gain, K, at the crossing.

c) Find the real axis breakaway point.

d) Find the angle of arrival to the complex zeros

e) Find the closed loop zeros

f) Find the gain K for a closed loop step response with 30% overshoot. Is the 2nd order approximation valid?