EE324, Control Systems Lab, Problem sheet 5
(Report submission date: 14th February 2021)

Q1) Plot the root locus of the following systems and observe the behavior of the closed-loop poles. Hint: use *evans* in Scilab.

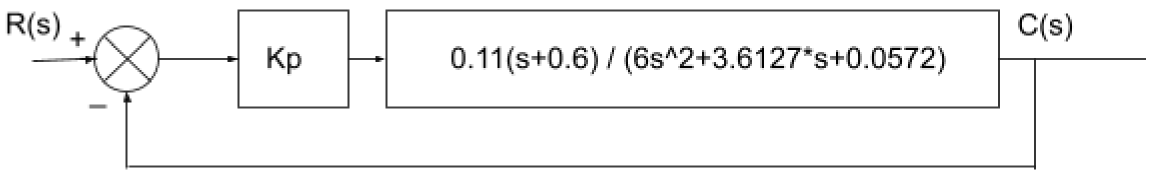
a) 10 / (s^3 + 4s^2 + 5s + 10) is the **closed** loop transfer function of a system with unity negative feedback.
b) (s + 1) / (s^2*(s + 3.6)) is the open-loop transfer function of a system. (In practical implementation, k has to be real, even though break-away/break-in points are allowed to be complex).
c) (s + 0.4) / (s^2*(s + 3.6)) is the open loop transfer function of a system.
d) (s+p) / (s*(s+1)(s+2)) vary the parameter p and comment on the stability of the system as p changes.

Q2) Design a transfer function (individual for each sub-part) such that:

a) The breakaway and breakin points coincide. Hint: Symmetric poles about the origin.
b) The number of branches at the breakaway or breakin point is more than 4.
c) The branches of the root locus coincide with their asymptotes.
d) The breakaway or break in points are complex numbers by following the steps given below.
    i) Consider a transfer function with no zeros and with poles as real and symmetric about the jw axis.
    ii) Now substitute s^2 with -s^2 (write the higher powers such as s^4, s^6 in terms of s^2) in the transfer function you have designed in part (i), and plot the root locus.
    iii) Now substitute s with s-k where k being a positive integer of your choice, in the transfer function you have designed in part (ii) and plot the root locus.

Q3) Design a Proportional controller (with gain Kp) in Scilab to cascade the given third-order system 1 / (s*(s^2 + 3*s +5)) to attain the required closed-loop time domain specification of 1.5 seconds as the rise time, on giving the step input. Also, find the minimum possible rise time for the given system (maintaining stability).

Q4) Design a Proportional controller in Scilab for the given second-order system to attain a steady-state error of 1 percent for step response. Plot the step response and root locus of the system and identify the Proportional gain (Kp) on the root locus for which the closed-loop system is marginally stable.



Q5): Consider a 3rd order system, with no zeros and 2 dominant poles, and the 3rd pole very left on the complex plane. Plot the root locus of the system, and then compare it to the root locus of the system when the leftmost pole is ignored. Till what value of K is the step response of the closed loops of both the systems similar.