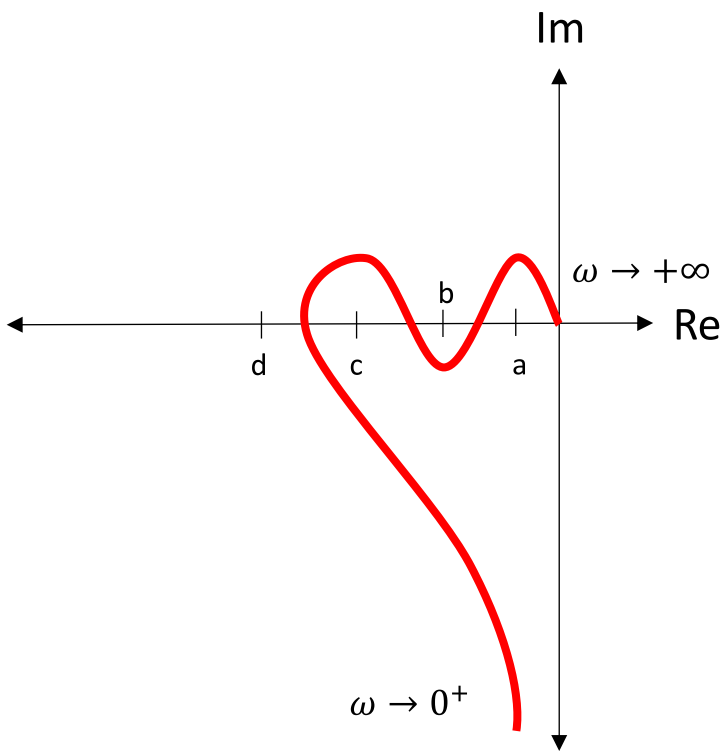
PROBLEM SET

APRIL 2019

Problem 1) The figure below shows the polar plot of an open loop transfer function with a single pole at the origin, plus other poles and zeros in the left half plane.

a) Complete the Nyquist diagram and,
b) Determine the stability of the closed loop system for each of the four cases when the point –1 is at (a), (b), (c) and (d).
c) Now suppose that the open loop transfer function has 3 poles at the origin, instead of 1. What does the Nyquist plot look like now?



Problem 2) Consider the unity feedback system with

$$G(s) = K\frac{s+1}{s(s+4)(s-1)}$$

a) Sketch the root locus of the system

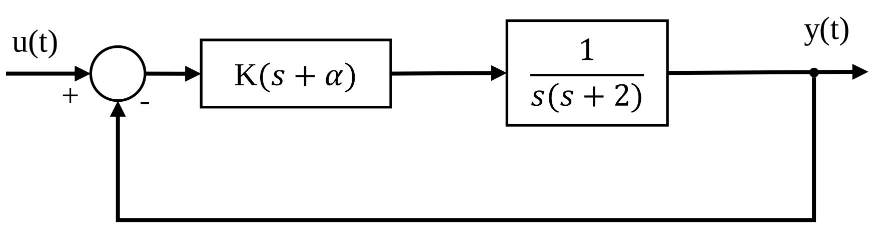
b) Determine the stability range for the parameter K, where $K \geq 0$

Problem 3) For the system given in **Problem 2**

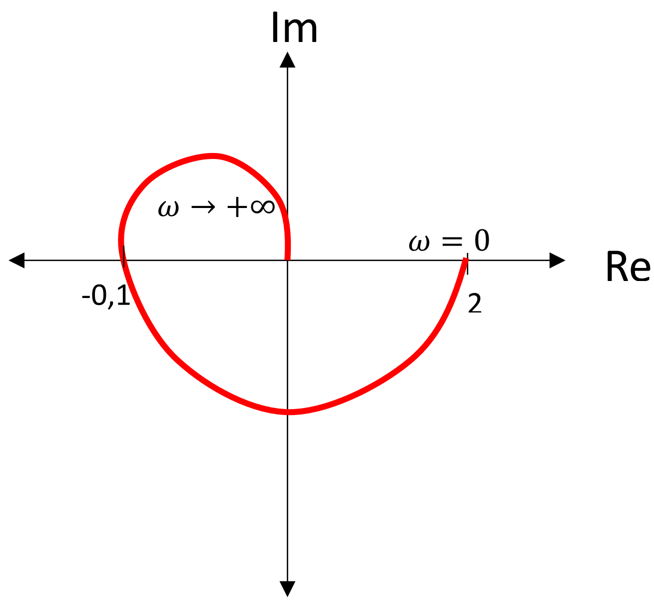
a) Sketch the Nyquist plot.
b) Determine the stability range for the parameter K based on the Nyquist criterion $-\infty \prec K \prec \infty$.

Problem 4)

a) Design a PD controller for the system below such that the closed loop system has a (%5) settling time of 1.5 sec and an overshoot of % 4.32.
b) Without changing the position of the zero that you found in part (a), find the minimum possible value for the settling time that can be achieved by varying the gain.



Problem 5) Consider a unity feed-back system with an open loop transfer function G(s). Polar plot of G(s) is given below.



a) What is the type of the system?
b) Determine the static position and velocity error constants K_p, and K_v.
c) Determine the number of asymptotes in the root locus.
d) Determine the gain margin of the system.