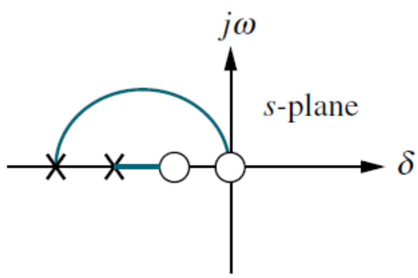
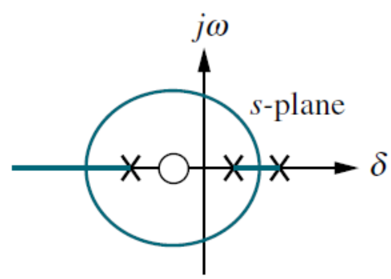
# XMUT315 Control Systems Engineering

# Tutorial 7: Analysis with Root Locus Diagram

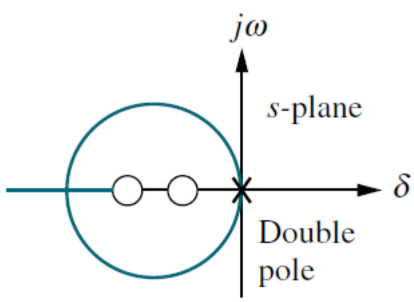
1. For each of the root loci shown in the figure below, describe briefly whether, or not the sketch can be a root locus. If the sketch cannot be a root locus, explain why. Give all reasons. [16 marks]



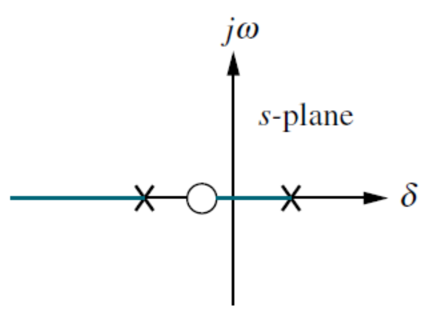

(a)



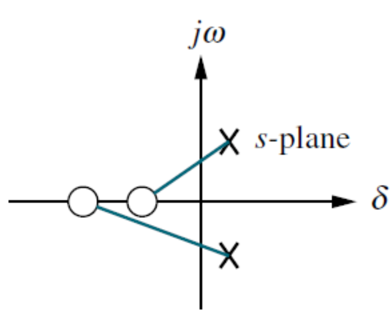

(b)

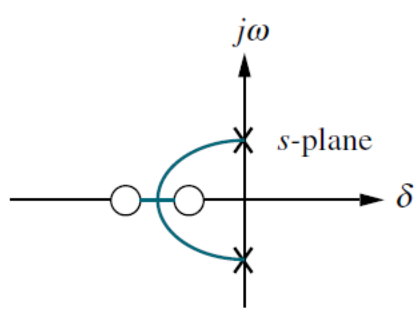



(c)

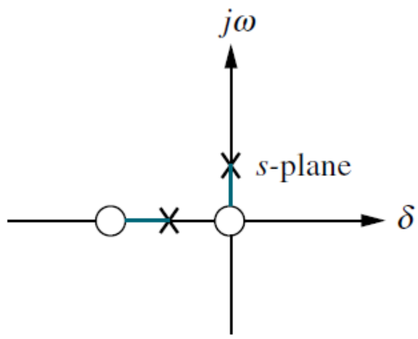


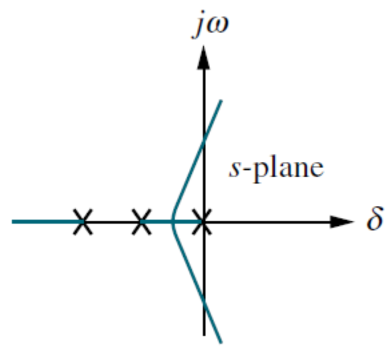

(d)



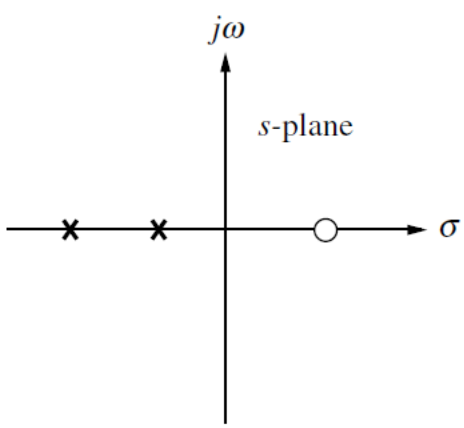
(e) (f)



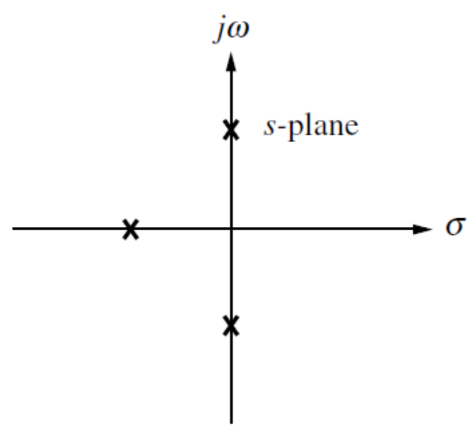




(g) (h)

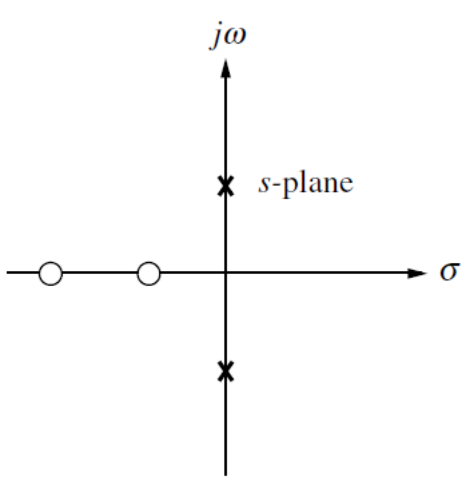
2. Sketch the general shape of the root locus for each of the open-loop pole-zero plots shown in the figure below. [30 marks]



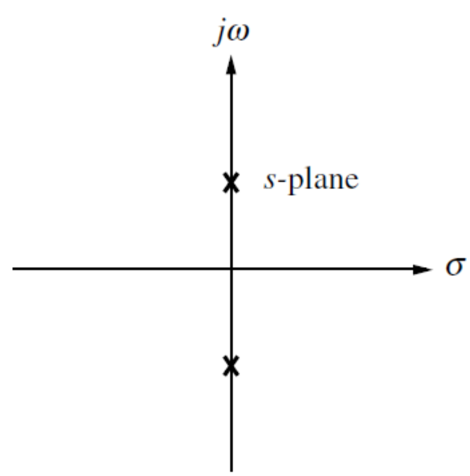

(a)



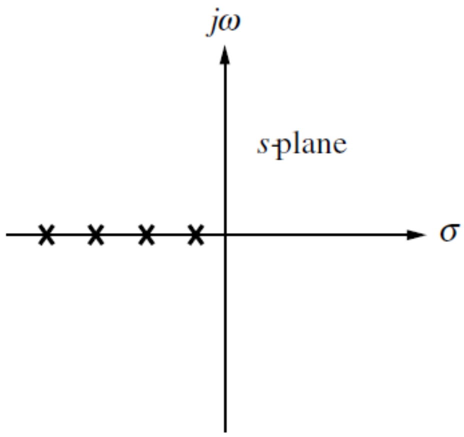

(b)



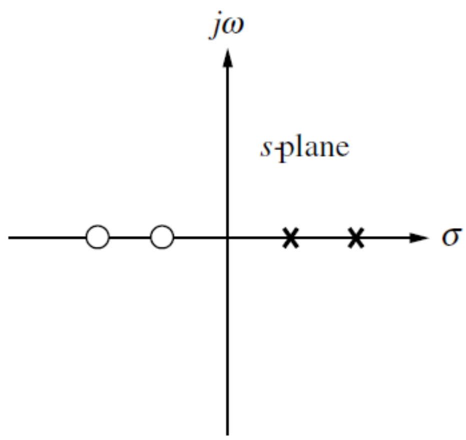

(c)




(d)

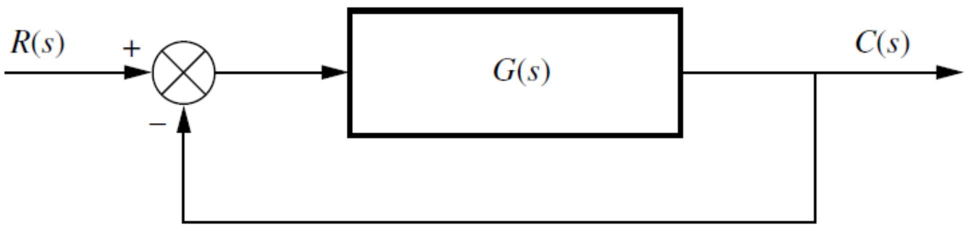



(e)




(f)

3. Sketch and simulate in MATLAB the root locus for the unity feedback system shown in the figure below for the following transfer functions:




a. System 1 [10 marks]

$$G_1(s) = \frac{K(s+2)(s+6)}{s^2+8s+25}$$

b. System 2 [10 marks]

$$G_2(s) = \frac{K(s^2+4)}{(s^2+1)}$$

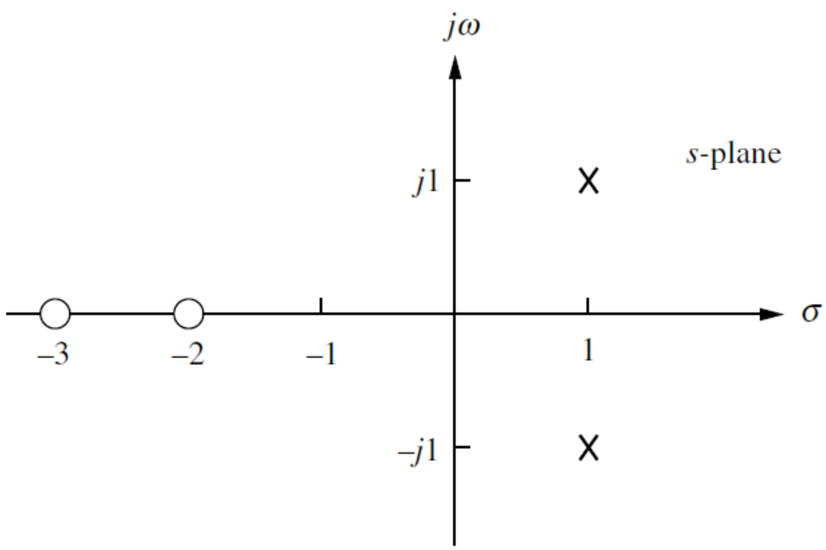
c. System 3 [10 marks]

$$G_3(s) = \frac{K(s^2+1)}{s^2}$$

d. System 4 [10 marks]

$$G_4(s) = \frac{K}{(s+1)^3(s+4)}$$

4. For the open-loop pole-zero plot shown in the figure below, perform the following tasks.




a. Sketch the root locus diagram of the system. [10 marks]

b. Determine the break-in and break-away points with differentiation method. [12 marks]

c. Repeat part (b) without differentiation. [12 marks]

5. For a given system, its transfer function is as shown below,

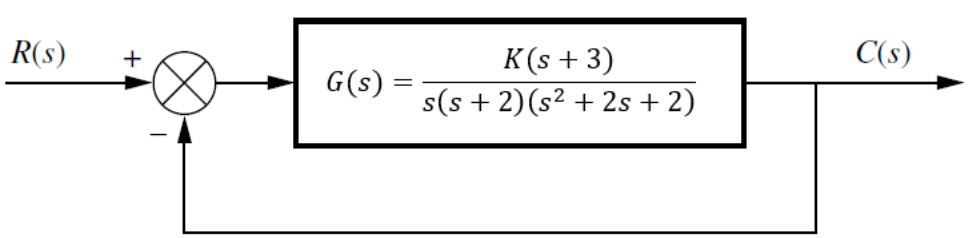
$$G(s) = \frac{K}{s(s+4)(s^2+6s+64)}$$

a. Sketch the root locus diagram of the system. [5 marks]

b. Determine the location and the gain of the system when it crosses the y-axis. [20 marks]

c. Determine the location and the gain of the system when it crosses the y-axis without using Routh-Hurwitz analysis method. [20 marks]

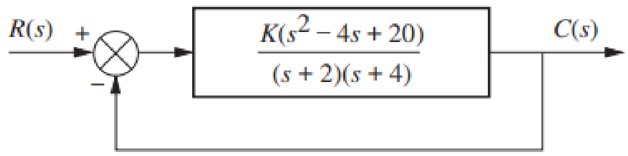
6. Given the unity feedback system with complex poles of the following figure, perform the following tasks.




a. Find the angle of departure from the complex poles and sketch the root locus. [8 marks]

b. Simulate the root locus diagram of the system in MATLAB. Comment on the results obtained from the simulation. [6 marks]

7. For the system shown in the following figure, perform the following tasks:




a. Sketch the root locus for the system. [10 marks]

b. Determine the exact point and gain where the locus crosses the 0.45 damping ratio line. [6 marks]

c. Determine the exact point and gain where the locus crosses the $j\omega$-axis. [6 marks]

d. Determine the breakaway point on the real axis. [12 marks]

e. Determine the range of $K$ within which the system is stable. [2 marks]