University of Kurdistan
Department of Electrical Engineering

Linear Control Systems

Homework 5: The Root Locus Technique

Instructor: Dr. Q. Shafiee **Teaching Assistant:** N. Mohammadi

1. Root Locus Method

1.1 Sketch the root locus for the unity feedback system shown in Figure 1.1 for the following transfer functions.

a) $G(s) = \frac{K}{s^3+10s^2+7s-18}$

b) $G(s) = \frac{K}{(s+2)^3(s+5)}$

c) $G(s) = \frac{K(s+\frac{3}{2})}{s^2(s+10)}$

d) $G(s) = \frac{K(s+4)}{s^4+3s^3-8s^2+6s-20}$

(Hint: You can use MATLAB to find the denominator roots of above transfer functions)

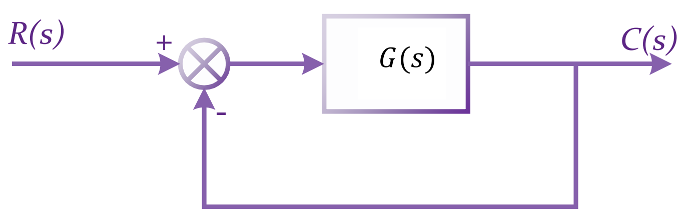

Figure 1. 1

1.2 The denominator of a closed-loop transfer function is given by

$$s^3 + 2s^2 + (5 + 15K)s + 60K$$

Sketch the root locus for this system.

1.3 Figure 1.2 shows open-loop poles and zeroes for a feedback control system. Sketch the root locus for this system.

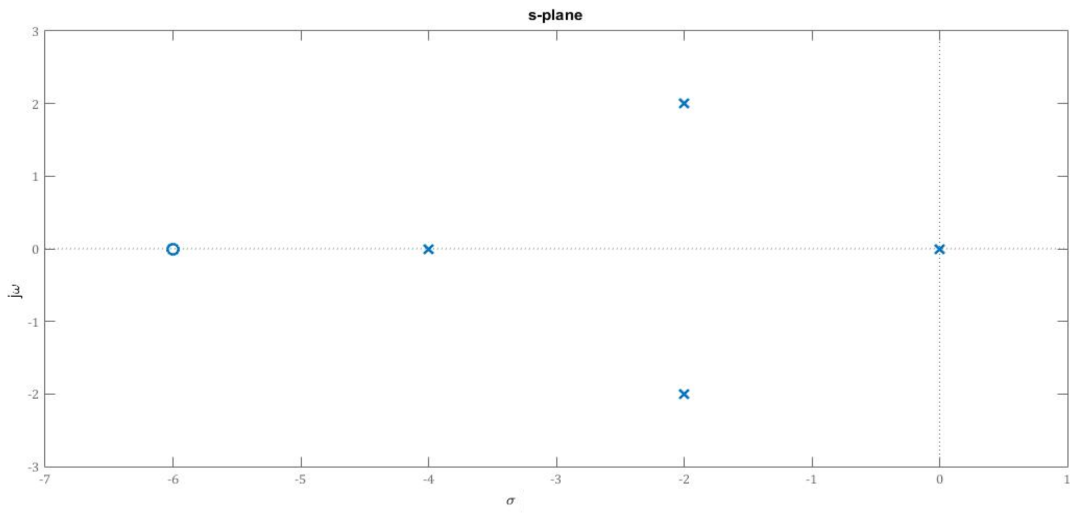

Figure 1. 2

1.4 Sketch the root locus for the system shown in Figure 1.3 as α is varied.

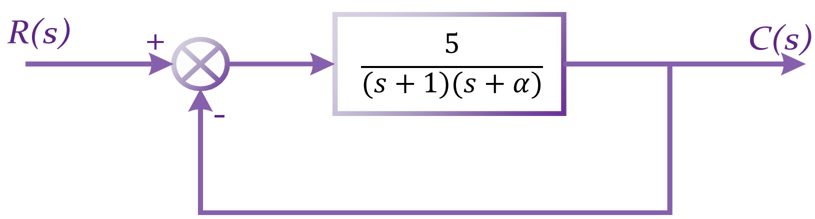

Figure 1. 3

1.5 Sketch the root locus for the control systems of Figure 1.4. (For both systems the gain k varies from 0 to $+\infty$.)

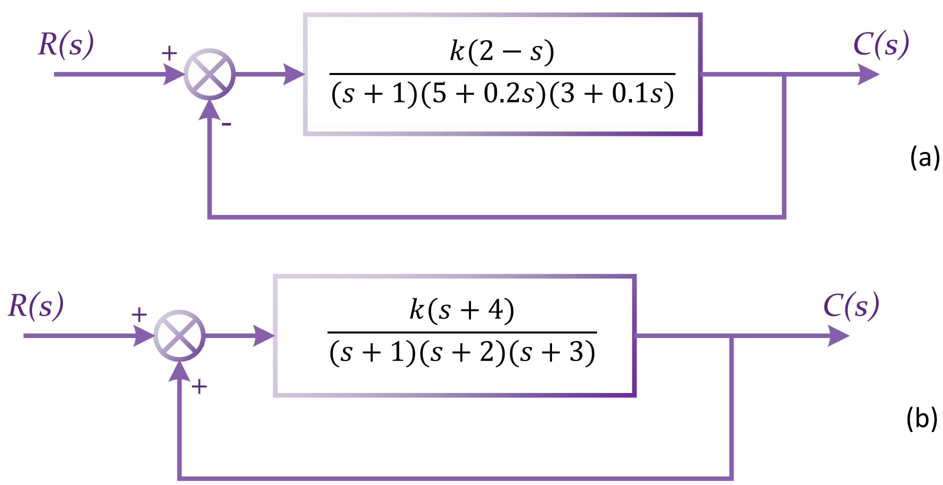

Figure 1. 4

2. MATLAB Simulation

2.1 Use MATLAB to sketch the root locus for the system of Figure 2.1 and find the following:

a) The exact point and gain where the locus crosses the 0.7 damping ratio line.

b) The exact point and gain where the locus crosses the $j\omega$-axis

c) The breakaway point on the real axis

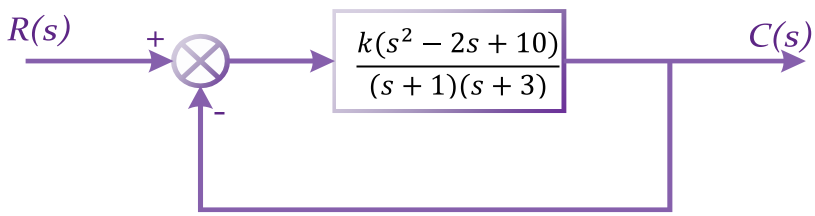

Figure 2. 1

2.2 Consider the unity feedback system of Figure 2.2, Use MATLAB to do the following for this system:

a) Display a root locus and pause.

b) Draw a close-up of the root locus where the axes go from -2 to 0 on the real axes and -2 to 2 on the imaginary axes.

c) Overlay the 10% overshoot line on the close-up root locus.

d) Select interactively the point where the root locus crosses the 10% overshoot line, and respond with the gain at that point as well as of the closed-loop poles at that gain.

e) Generate the step response at the gain for 10% overshoot.

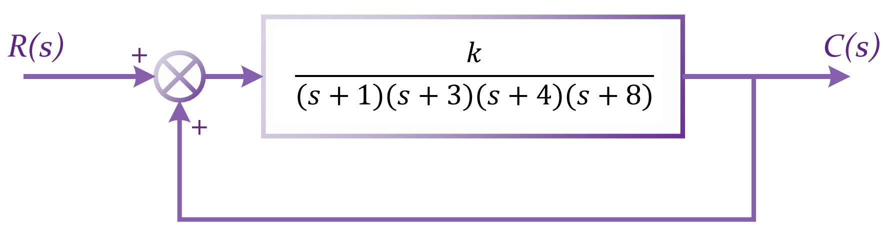

Figure 2. 2