Control Theory Assignment – Root Locus

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1 Sketch the root locus for the unity feedback systems that have an open-loop transfer function of:

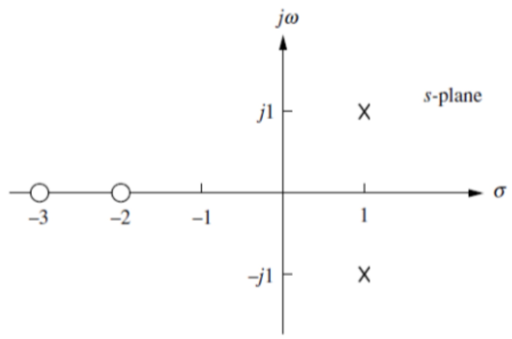
1. $$G(s) = \frac{k(s+2)(s+6)}{s^2+8s+25}$$
2. $$G(s) = \frac{k(s^2+4)}{(s^2+1)}$$
3. $$G(s) = \frac{k(s^2+1)}{s^2}$$
4. $$G(s) = \frac{k}{(s+1)^3(s+4)}$$
5. $$G(s) = \frac{k(s+3)(s+5)}{(s+1)(s-7)}$$
6. $$G(s) = \frac{k(s^2+1)}{(s-1)(s+2)(s+3)}$$
7. $$G(s) = \frac{k(s^2-2s+2)}{s(s+1)(s+2)}$$

For each sketch find the asymptotes, break-in and break-out points, $j\omega-$axis intersection, angles of arrival and departure, and ranges of k for stability.

2 Let
$$G(s) = \frac{-K(s+1)^2}{s^2+2s+2}$$
with $K > 0$.

1. Find the range of K for closed-loop stability.
2. Sketch the system's root locus.
3. Find the position of the closed-loop poles when $K = 1$ and $K = 2$.

3 For the open-loop pole-zero plot shown in the Figure, sketch the root locus and find the break-in point.

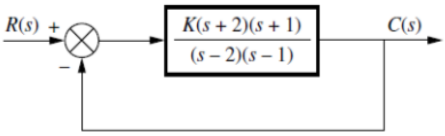


4 Plot the root locus for the unity feedback system that has an open loop transfer function of:
$$G(s) = \frac{K(s+2)(s^2+4)}{(s+5)(s-3)}$$
For what range of K will the poles be in the right half-plane?

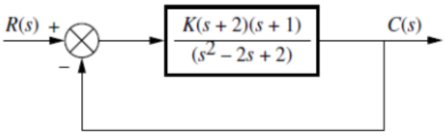
5 Sketch the root locus for the unity feedback system that has an open-loop transfer function of:
$$G(s) = \frac{K(s^2+2)}{(s+3)(s+4)}$$
Give the values for all critical points of interest. Is the system ever unstable? If so, for what range of K?

6 For each system shown in the Figure, make an accurate plot of the root locus and find the following:

1. The break-away and break-in points.
2. The range of K to keep the system stable.
3. The value of K that yields a stable system with critically damped second-order poles.

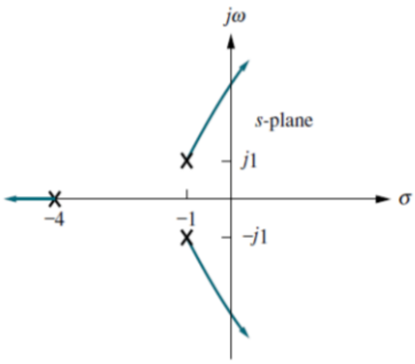


System 1



System 2

7 Given the root locus shown in the Figure:



1. Find the value of the gain that will make the system marginally stable.

2. Find the value of gain for which the closed-loop transfer function will have a pole on the real axis at -5.

8 For the unity feedback system that has an open-loop transfer function of:

$$G(s) = \frac{K(s-1)(s-2)}{s(s+1)}$$

Sketch the root locus and find the following:

1. The break-away and break-in points.

2. The $j\omega$-axis intersection.

3. The range of gain to keep the system stable.