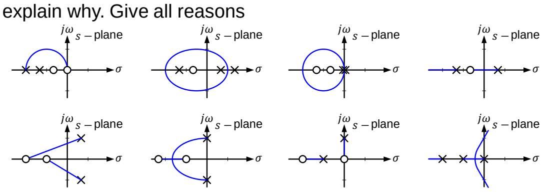
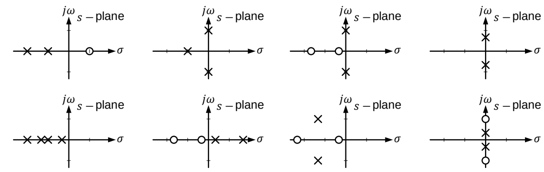
8.1 For each of the root loci as shown, tell whether or not the sketch can be a root locus. If the sketch cannot be a root locus, explain why. Give all reasons



8.2 Sketch the general shape of the root locus for each of the open-loop pole-zero plots shown

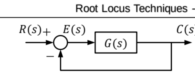


8.3 Sketch the root locus for the unity feedback system for

a. $G(s)=\dfrac{K(s+2)(s+6)}{s^2+8s+25}$ c. $G(s)=\dfrac{K(s^2+1)}{s^2}$

b. $G(s)=\dfrac{K(s^2+4)}{s^2+1}$ d. $G(s)=\dfrac{K}{(s+1)^3(s+4)}$

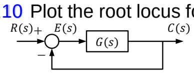
8.4 Let $G(s)=K(s+2/3)/s^2(s+6)$



a. Plot the root locus

b. Write an expression for the closed-loop TF at the point where the three closed-loop poles meet

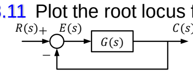
8.10 Plot the root locus for the unity feedback system



$$G(s)=\frac{K(s+2)(s^2+4)}{(s+5)(s-3)}$$

For what range of K will the poles be in the right half-plane?

8.11 Plot the root locus for the unity feedback system

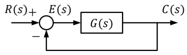


$$G(s)=\frac{K(s^2-9)}{s^2+4}$$

sketch the root locus and tell for what values of K the system is stable and unstable

Solution

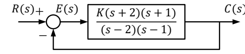
8.12 Sketch the root locus for the unity feedback system

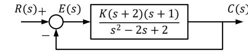


$$G(s)=\frac{K(s^2+2)}{(s+3)(s+4)}$$

Give the values for all critical points of interest. Is the system ever unstable? If so, for what range of K?

8.13 For each following system





make an accurate plot of the root locus and find the following

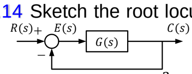
a. The breakaway and break-in points

b. The range of K to keep the system stable

c. The value of K that yields a stable system with critically damped second-order poles

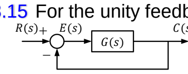
d. The value of K that yields a stable system with a pair of second-order poles that have a damping ratio of 0.707

8.14 Sketch the root locus and find the range of K for stability for the unity feedback system for the following conditions



a. $G(s)=\dfrac{K(s^2+1)}{(s+1)(s+2)(s+3)}$ b. $G(s)=\dfrac{K(s^2-2s+2)}{s(s+1)(s+2)}$

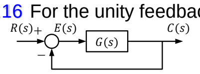
8.15 For the unity feedback system, where



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

sketch the root locus and find the range of K such that there will be only two right-half-plane poles for the closed-loop system

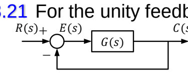
8.16 For the unity feedback system, where



$$G(s)=\frac{K}{s(s+6)(s+9)}$$

plot the root locus and calibrate your plot for gain. Find all the critical points, such as breakaways, asymptotes, $j\omega$-axis crossing, and so forth

8.21 For the unity feedback system



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

sketch the root locus and find the following

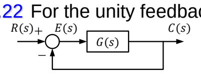
a. The breakaway and break-in points

b. The $j\omega$-axis crossing

c. The range of gain to keep the system stable

d. The value of K to yield a stable system with second-order complex poles, with a damping ratio of 0.5

8.22 For the unity feedback system



$$G(s)=\frac{K(s+10)(s+20)}{(s+30)(s^2-20s+200)}$$

do the following

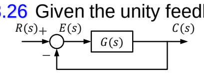
a. Sketch the root locus

b. Find the range of gain, K, that makes the system stable

c. Find the value of K that yields a damping ratio of 0.707 for the system's closed-loop dominant poles

d. Find the value of K that yields closed-loop critically damped dominant poles

8.26 Given the unity feedback system



$$G(s)=\frac{K}{(s+1)(s+2)(s+3)}$$

do the following problem parts by first making a second-order approximation. After you are finished with all of the parts, justify your second-order approximation

a. Sketch the root locus

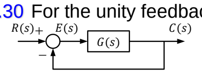
b. Find K for 20% overshoot

c. For K found in Part b, what is the settling time, and what is the peak time?

d. Find the locations of higher-order poles for K found in Part b

e. Find the range of K for stability

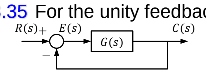
8.30 For the unity feedback system



$$G(s)=\frac{K(s+\alpha)}{s(s+1)(s+10)}$$

find the value of α so that the system will have a settling time of 4 seconds for large values of K. Sketch the resulting root locus

8.35 For the unity feedback system



$$G(s)=\frac{K(s+2)(s+3)}{(s^2+2s+2)(s+4)(s+5)(s+6)}$$

do the following

a. Sketch the root locus

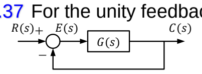
b. Find the $j\omega$-axis crossing and the gain, K, at the crossing

c. Find all breakaway and break-in points

d. Find angles of departure from the complex poles

e. Find the gain, K, to yield a damping ratio of 0.3 for the closed-loop dominant poles

8.37 For the unity feedback system



$$G(s)=\frac{K}{(s+3)(s^2+4s+5)}$$

do the following

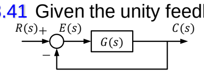
a. Find the location of the closed-loop dominant poles if the system is operating with 15% overshoot

b. Find the gain for Part a

c. Find all other closed-loop poles

d. Evaluate the accuracy of your second-order approximation

8.41 Given the unity feedback system



$$G(s)=\frac{K(s+z)}{s^2(s+20)}$$

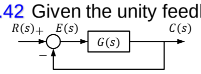
do the following

a. If $z=6$, find K so that the damped frequency of oscillation of the transient response is $10rad/s$

b. For the system of Part a, what static error constant (finite) can be specified? What is its value?

c. The system is to be redesigned by changing the values of z and K. If the new specifications are $\%OS=4.32\%$ and $T_s=0.4s$, find the new values of z and K

8.42 Given the unity feedback system



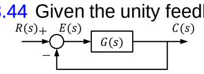
$$G(s) = \frac{K}{(s+1)(s+3)(s+6)^2}$$

find the value of gain, K, that will yield

a. a settling time of $T_s = 4s$

b. a critically damped system

8.44 Given the unity feedback system



$$G(s) = \frac{K}{(s+1)(s+5)}$$

evaluate the pole sensitivity of the closed-loop system if the second-order, underdamped closed loop poles are set for

a. $\zeta = 0.591$

b. $\zeta = 0.456$

c. Which of the two previous cases has more desirable sensitivity?