6.3 Tell how many roots of the following polynomial are in the RHP, in the LHP, and on the $j\omega$-axis

$$P(s) = s^5 + 3s^4 + 5s^3 + 4s^2 + s + 3$$

6.2 Tell how many roots of the following polynomial are in the RHP, in the LHP, and on the $j\omega$-axis

$$P(s) = s^5 + 6s^3 + 5s^2 + 8s + 20$$

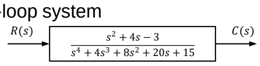
6.3 Using the Routh table, tell how many poles of the following function are in the RHP, in the LHP, and on the $j\omega$-axis

$$T(s) = (s + 8)/(s^5 - s^4 + 4s^3 - 4s^2 + 3s - 2)$$

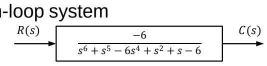
6.4 Determine how many closed-loop poles lie in the RHP, in the LHP, and on the $j\omega$-axis

$$T(s) = (s^3 + 2s^2 + 7s + 21)/(s^5 - 2s^4 + 3s^3 - 6s^2 + 2s - 4)$$

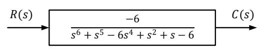
6.5 How many poles are in the RHP, in the LHP, and on the $j\omega$-axis for the open-loop system



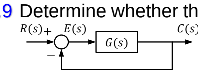
6.6 How many poles are in the RHP, in the LHP, and on the $j\omega$-axis for the open-loop system



6.7 Use matlab to find the pole locations for the system of



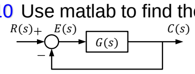
6.9 Determine whether the unity feedback system is stable if



$$G(s) = \frac{240}{(s+1)(s+2)(s+3)(s+4)}$$

$$T(s) = \frac{G(s)}{1+G(s)} = \frac{240}{s^4+10s^3+35s^2+50s+264}$$

6.10 Use matlab to find the pole locations for the system of

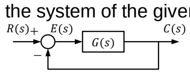


$$G(s) = \frac{240}{(s+1)(s+2)(s+3)(s+4)}$$

6.11 Consider the unity feedback system with $G(s) = 1/4s^2(s^2+1)$. Using the Routh-Hurwitz criterion, find the region of the s-plane where the poles of the closed-loop system are located

$$T(s) = \frac{G(s)}{1+G(s)} = \frac{1}{4s^4+4s^2+1}$$

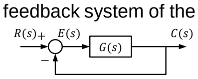
6.12 In the system of the given figure, let



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

Find the range of K for closed-loop stability

6.13 Given the unity feedback system of the given figure with

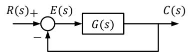


$$G(s) = \frac{84}{s(s^7+5s^6+12s^5+25s^4+45s^3+50s^2+82s+60)}$$

tell how many poles of the closed-loop TF lie in the RHP, in the LHP, and on the $j\omega$-axis

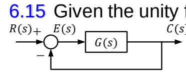
6.14 Using the Routh-Hurwitz criterion and the unity feedback system with

$$G(s) = \frac{1}{2s^4 + 5s^3 + s^2 + 2s}$$



tell whether or not the closed-loop system is stable

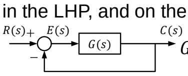
6.15 Given the unity feedback system with



$$G(s) = \frac{8}{s(s^6 - 2s^5 - s^4 + 2s^3 + 4s^2 - 8s - 4)}$$

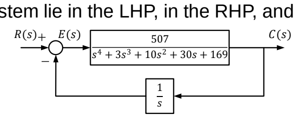
tell how many closed-loop poles are located in the RHP, in the LHP, and on the $j\omega$-axis

6.16 Using matlab find closed-loop poles are located in the RHP, in the LHP, and on the $j\omega$-axis

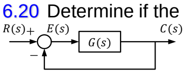


$$G(s) = \frac{8}{s(s^6 - 2s^5 - s^4 + 2s^3 + 4s^2 - 8s - 4)}$$

6.19 Using the Routh-Hurwitz criterion, tell how many closed-loop poles of the system lie in the LHP, in the RHP, and on the $j\omega$-axis



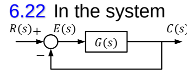
6.20 Determine if the unity feedback system



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

can be unstable

6.22 In the system

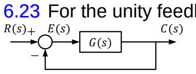


$$G(s) = \frac{K(s - a)}{s(s - b)}$$

Find the range of K for closed-loop stability when

a. $a < 0, b < 0$ b. $a < 0, b > 0$ c. $a > 0, b < 0$ b. $a > 0, b > 0$

6.23 For the unity feedback system with

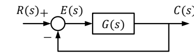


$$G(s)=\frac{K(s+3)(s+5)}{(s-2)(s-4)}$$

determine the range of K for stability

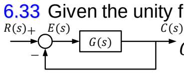
6.28 Find the range of gain K to ensure stability in the unity feedback system

$$G(s)=\frac{K(s-2)(s+4)(s+5)}{s^2+12}$$



$$T(s)=\frac{G(s)H(s)}{1+G(s)H(s)}=\frac{Ks^3+7Ks^2+2Ks-40K}{Ks^3+(7K+1)s^2+2Ks+(12-4K)}$$

6.33 Given the unity feedback system with



$$G(s)=\frac{K(s+4)}{s(s+1.2)(s+2)}$$

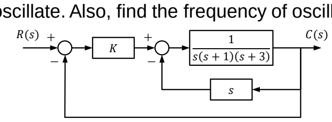
find the following

a. The range of K that keeps the system stable

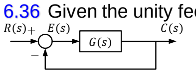
b. The value of K that makes the system oscillate

c. The frequency of oscillation when K is set to the value that makes the system oscillate

6.35 For the given system, find the value of gain K that will make the system oscillate. Also, find the frequency of oscillation



6.36 Given the unity feedback system with



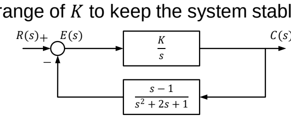
$$G(s)=\frac{Ks(s+2)}{(s^2-4s+8)(s+3)}$$

a. Find the range of K for stability

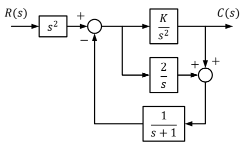
b. Find the frequency of oscillation when the system is marginally stable

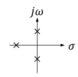
Solution

6.42 Find the range of K to keep the system stable



6.43 Find the value of K in the system that will place the closed loop poles as shown





6.44 The closed-loop TF of a system is

$$T(s) = \frac{s^2 + K_1 s + K_2}{s^4 + K_1 s^3 + K_2 s^2 + 5s + 1}$$

Determine the range of K_1 in order for the system to be stable. What is the relationship between K_1 and K_2 for stability?

6.50 A system is represented in state space as

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 0 & 1 & 3 \\ 2 & 2 & -4 \\ 1 & -4 & 3 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} u,\ y = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} \boldsymbol{x}$$

Determine how many eigenvalues are in RHP, in LHP, on $j\omega$-axis

6.51 Use matlab to find the eigenvalues of the following system

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & -4 \\ -1 & 1 & 8 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} u,\ y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \boldsymbol{x}$$

6.52 The following system in state space represents the forward path of a unity feedback system. Use the Routh-Hurwitz criterion to determine if the closed-loop system is stable

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 3 \\ -3 & -4 & -5 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u,\ y = \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \boldsymbol{x}$$

6.52 The following system in state space represents the forward path of a unity feedback system. Using matlab to determine if the closed-loop system is stable

$$\dot{\boldsymbol{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 3 \\ -3 & -4 & -5 \end{bmatrix} \boldsymbol{x} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u,\ y = \begin{bmatrix} 0 & 1 & 1 \end{bmatrix} \boldsymbol{x}$$