Problem4.23(a) : System is Type I.

$$\begin{aligned} E(s) &= [1 - T(s)]R(s) \\ &= [\frac{1}{1+G(s)}]R(s) \\ &= \frac{s(\tau s+1)}{s(\tau s+1)+K}\frac{A}{s^2} \end{aligned}$$

The steady-state tracking error using the FVT (assuming stability) is

$$e_{ss} = \lim_{s\to 0} sE(s) = \frac{A}{K}$$

Problem4.24 :

$$\begin{aligned} K_p &= \lim_{s\to 0} G(s) = \infty \\ e_{ss} &= \frac{1}{1+K_p} = 0 \\ K_\nu &= \lim_{s\to 0} sG(s) = \infty \\ e_{ss} &= \frac{1}{K_\nu} = 0 \\ K_a &= \lim_{s\to 0} s^2G(s) = 1 \\ e_{ss} &= \frac{1}{K_a} = 1 \end{aligned}$$

Problem4.43(b) : $1 + KG = s^3 + s^2 + 2s + 8 = 0$ and the Routh's array is,

$$\begin{array}{lcll} s^3 & : & 1 & 2 \\ s^2 & : & 1 & 8 \\ s^1 & : & -6 & \\ s^0 & : & 8 & \end{array}$$

There are two sign changes in the first column of the Routh array. Therefore, there are two roots not in the LHP.

Problem4.46 : $1 + G(s) = s^5 + 1.9s^4 + 5.1s^3 + 6.2s^2 + (2+K)s + 4K = 0$

$$\begin{array}{lclll} s^5 & : & 1 & 5.1 & 2+K \\ s^4 & : & 1.9 & 6.2 & 4K \\ s^3 & : & a_1 & a_2 & \\ s^2 & : & b_1 & 4K & \\ s^1 & : & c_1 & & \\ s^0 & : & 4K & & \end{array}$$

where

$$
\begin{aligned}
a_1 &= \frac{(1.9)(5.1)-(1)(6.2)}{1.9} = 1.837 \\
a_2 &= \frac{(1.9)(2+K)-(1)(4K)}{1.9} = 2-1.1K \\
b_1 &= \frac{(a_1)(6.2)-(a_2)(1.9)}{a_1} = 1.138(K+3.63) \\
c_1 &= \frac{(b_1)(a_2)-(4K)(a_1)}{b_1} = \frac{-(1.25K^2+9.61K-8.26)}{1.138(K+3.63)} = \frac{-(K+8.47)(K_0.78)}{0.91(K+3.63)}
\end{aligned}
$$

For stability:
(1) $b_1 = K+3.63 > 0 \Rightarrow K > -3.63$

(2) $c_1 > 0 \Rightarrow -8.43 < K < 0.78$

(3) $d_1 > 0 \Rightarrow K > 0$

Intersection of (1), (2) and (3)$\Rightarrow 0 < K < 0.78$.