

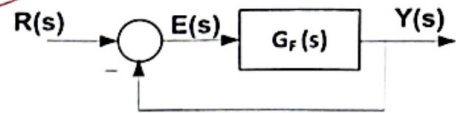
**Be neat and clear, and show all the details.**For the system shown in Fig. 1, let $G_F(s) = \frac{16K}{s^2 + 3s - 4}$: (10 points)

Fig. 1

- i) Find the range of K for stability (2 points)
 ii) Find the value of K the best overall response (4 points) $\zeta = \frac{1}{\sqrt{2}}$
 iii) Find the value of K so that the steady state error to the input $r(t) = 5u_s(t)$ is $e_{ss} = 0.1$ (4 points)

$$i) \Delta(s) = 1 + G_F(s) = 1 + \frac{16K}{s^2 + 3s - 4} = \frac{s^2 + 3s - 4 + 16K}{s^2 + 3s - 4}$$

$$s^2 + 3s - 4 + 16K = 0$$

$$\omega_n^2 = -4 + 16K \quad \zeta > 0$$

$$2\zeta\omega_n = 3 \Rightarrow 2 \cdot \sqrt{-4 + 16K} \zeta = 3 \Rightarrow \sqrt{-4 + 16K} \zeta = 1.5$$

$$\zeta = \frac{1.5}{\sqrt{16K - 4}}$$

$$16K - 4 > 0 \Rightarrow 16K > 4 \Rightarrow K > 0.25$$

$$ii) \zeta = \frac{1}{\sqrt{2}} \Rightarrow \frac{1}{\sqrt{2}} = \frac{1.5}{\sqrt{16K - 4}} \quad K = 0.531$$

$$iii) e_{ss} = \frac{A}{1 + K_p} \quad A = 5, \quad K_p = \lim_{s \rightarrow 0} \frac{16K}{s^2 + 3s - 4} = \frac{16K}{-4} = -4K$$

$$e_{ss} = \frac{5}{1 - 4K} = 0.1 \quad K =$$

$$-12.25$$

unstable