① $H(s) = \dfrac{10}{10s^3 + 17s^2 + 8s + k}$

| | | |
|---|---|---|
| $s^3$ | 10 | 8 |
| $s^2$ | 17 | $k$ |
| $s^1$ | $8 - \frac{10}{17}k$ | 0 |
| $s^0$ | $k$ | 0 |

$$8 - \frac{10}{17}k = 0$$

$$k = \frac{17(8)}{10} = \frac{68}{5} = 13.6$$

$$17s^2 + \frac{68}{5} = 0$$

$$s^2 + \frac{4}{5} = 0$$

$$s = \pm j\frac{2}{\sqrt{5}} \Rightarrow \omega_n = 0.8944$$

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② $T(s) = \dfrac{k(s+1)}{s(s-1)(s+6) + k(s+1)} = \dfrac{k(s+1)}{s^3 + 5s^2 + (k-6)s + k}$

| | | |
|---|---|---|
| $s^3$ | 1 | $k-6$ |
| $s^2$ | 5 | $k$ |
| $s^1$ | $\frac{4}{5}k - 6$ | 0 |
| $s^0$ | $k$ | 0 |

(i) $k > 6$

(ii) $\frac{4}{5}k - 6 > 0$

$$k > \frac{30}{4} = 7.5$$

(3) $$\frac{KS+K_I}{S(S+1)(S+2)+KS+K_1} = \frac{KS+K_1}{S^3+3S^2+(2+K)S+K_1}$$

| | | | |
|---|---|---|---|
| $S^3$ | 1 | $K+2$ | $K>0$ |
| $S^2$ | 3 | $K_1$ | $K_1>0$ |
| $S^1$ | $K+2-\frac{K_1}{3}$ | 0 | $K+2-\frac{K_1}{3}>0$ |
| $S^0$ | $K_1$ | | $3K+6>K_1$ |

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(4) $$\frac{K(S+4)}{S(S^2+0.4S+4)+K(S+4)} = \frac{K(S+4)}{S^3+0.4S^2+(4+K)S+4K}$$

| | | |
|---|---|---|
| $S^3$ | 1 | $4+K$ |
| $S^2$ | $0.4$ (4) | ~~$4K$~~ ($40K$) |
| $S^1$ | $4-9K$ | 0 |
| $S^0$ | $4K$ | 0 |

$4-9K>0$

$0<K<\frac{4}{9}$