

reject.

$$CS = -34.747$$

✓ reject.

2. there is no break points ✓ reject.

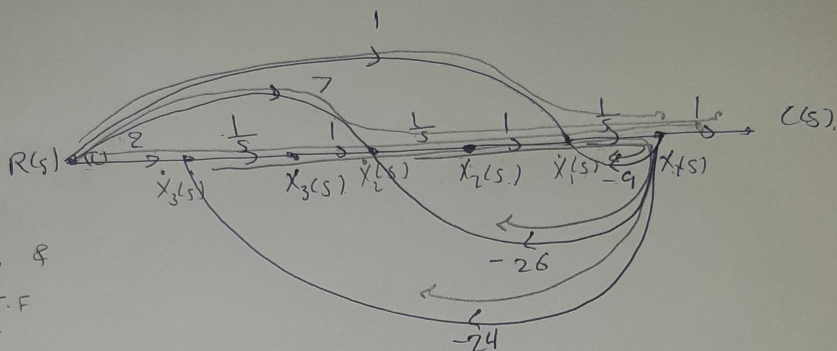
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Final 2021

السؤال توفيقه لمار

220 18 14 53

Q1



SS &

T. F

$$X_1 = -9X_1 + X_2 + r$$

$$x_2 = -26x_1 + x_3 + 7r$$

$$Y = X_1$$

$$x_3 = -24x_1 + 25$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -9 & 1 & 0 \\ -26 & 0 & 1 \\ -24 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 7 \\ 2 \end{bmatrix}$$

$$Y(t)_2 \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

2

Forward Path.

$$M_1 = \frac{2}{s^3}$$

$$M_2 = \frac{7}{s^2}$$

$$M_3 = \frac{1}{s}$$

Close Loop.

$$L_1 = -\frac{9}{s}$$

$$L_2 = -\frac{26}{s^2}$$

$$L_3 = -\frac{24}{s^3}$$

two non-touching loop. z_0

$$D = 1 - [L_1 + L_2 + L_3]$$

$$s + \frac{9}{s} + \frac{26}{s^2} + \frac{24}{s^3} \quad (A)$$

$$D_1 = 1, D_2 = 1, D_3 = 1$$

$$T.F = \frac{1}{D} [M_1 D_1 + M_2 D_2 + M_3 D_3] \quad (B)$$

$$\frac{1}{D} \left[\frac{2}{s^3} + \frac{7}{s^2} + \frac{1}{s} \right] = \frac{s^2 + 7s + 2}{s^3 + 9s^2 + 26s + 24}$$

to check.

$$\frac{C(s)}{R(s)} = C [SI - A]^{-1} B = \frac{s^2 + 7s + 2}{s^3 + 9s^2 + 26s + 24} \quad \#$$

$$s = -4.75 \pm j3.27$$

reject.

there is no Break Points

$$s = -34$$

reject

(3)

Charac eqn.

Q_2

$$Q(s) = s^5 + 10s^4 + 45s^3 + 90s^2 + 164s + 200 = 0$$

$$s^5 \quad 1 \quad 45 \quad 164$$

$$s^4 \quad 10 \quad 90 \quad 200$$

$$s^3 \quad 36 \quad 144 \quad 0$$

$$s^2 \quad 50 \quad 200 \quad 0$$

$$s^1 \quad \frac{100}{0} \quad 0 \quad 0$$

$$s^0 \quad 200$$

$$P(s) = 50s^2 + 200s^0$$

$$\dot{P}(s) = 100s + 0$$

the system not stable but

marginally stable

Even(2) , Rest(3)

↳ 2-jw axis ↳ 3 LHP.

14

$$P(s) = 50s^2 + 200 = 0$$

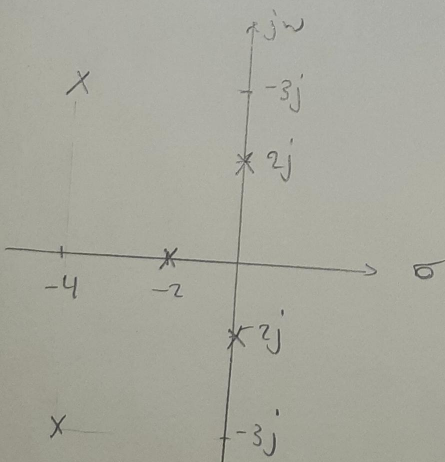
$$s = \pm 2j$$

∴ the total poles are.

3 LHP $\rightarrow -4+3j, -4-3j, -2$

2 jw-axis $\rightarrow +2j, -2j$

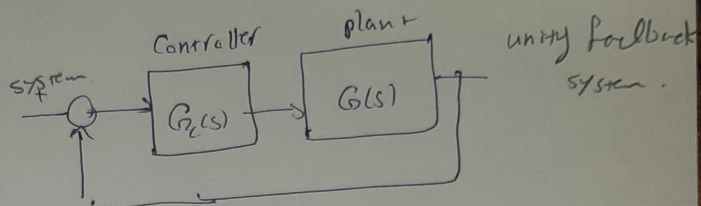
∴ marginal stable system.



s-plane

Q3

- * R-L
- * k for stable system
- * $\pm j$ on j-w axis



$$G_c(s) G(s) = \frac{k(s+2)(s+3)}{s^2(s+1)(s+10)(s+50)} \quad \leftarrow \text{the open loop gain.}$$

$$n = 5 \quad @ \quad 0, 0, -1, -10, -50$$

$$m = 2 \quad @ \quad -2, -3$$

$$\alpha = n - m = 5 - 2 = 3$$

$$\sigma_m = \frac{\sum \text{Poles} - \sum \text{zeros}}{\alpha} = \frac{(0+0-1-10-50) - (-2-3)}{3} = -18.66$$

$$\theta_m = r \frac{180^\circ}{\alpha} = (\pm 1, 3) \frac{180^\circ}{3} = +60^\circ, -60^\circ, 180^\circ$$

$$\text{B.P } \frac{d}{ds} G_c(s) G(s) = 0 \quad - (3s^5 + 142s^4 + 1505s^3 + 7064s^2 + 12580s + 6000)$$

$$\frac{- (3s^5 + 142s^4 + 1505s^3 + 7064s^2 + 12580s + 6000)}{s^3(s+1)^2(s+10)^2(s+50)^2} = 0$$

$$\therefore s = -0.737, s = -2.337 \rightarrow \text{reject}$$

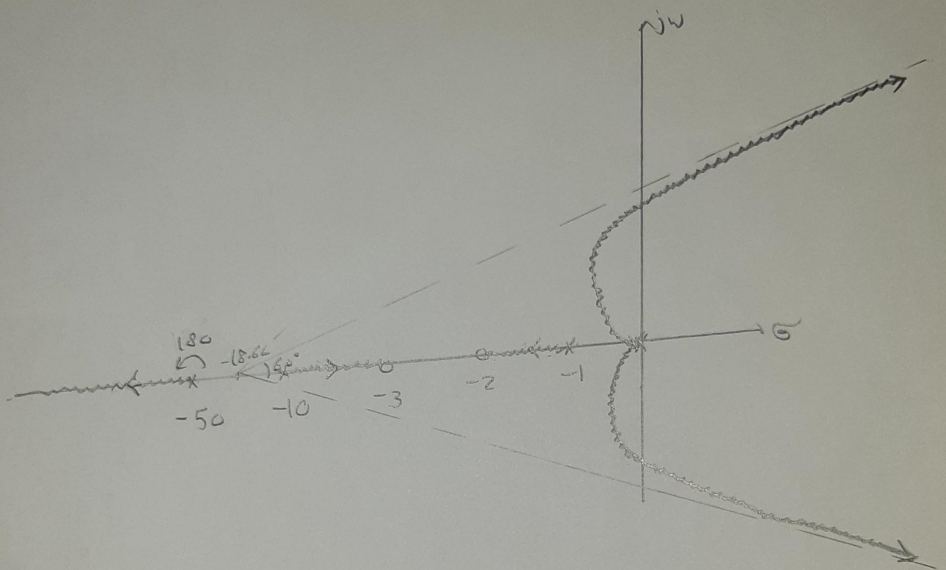
$$s = -4.75 \pm j3.27, s = -34.747$$

reject. reject.

\therefore there is no Break Points exist.



⑥



Charact eq :-

$$s^5 + 61s^4 + 560s^3 + (500+k)s^2 + 5ks + 6k = 0$$

$$s^5 \quad 1 \quad 560 \quad 5k$$

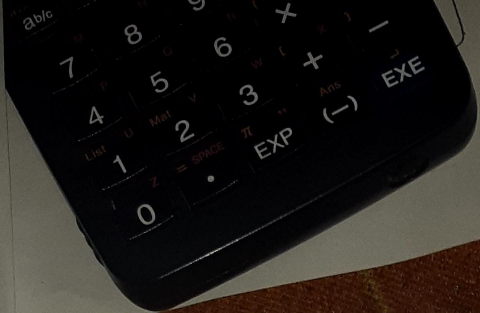
$$s^4 \quad 61 \quad 500+k \quad 6k \quad \text{--- (B)}$$

$$\textcircled{A} \leftarrow s^3 \quad \frac{-(k-33600)}{61} \quad \frac{2991.5}{61} \quad 0$$

$$\textcircled{D} \leftarrow s^2 \quad \frac{k^2 - 14921k - 16830,000}{k - 33600} \quad 6k \quad 0$$

$$s^1 \quad 5k^3 - 79759k^2 + 28947600k \quad 0 \quad 0$$

$$s^0 \quad 6k$$



7)

to be stable system.

$$51k^3 - 79759k^2 + 28947600k > 0$$

$$k = 15621.18$$

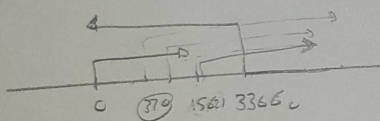
$$k = 370.61$$

$$k = 0 \quad \text{reject.}$$

f

$$61k > 0$$

$$k - 33600 < 0 \Rightarrow k < \underline{33600}$$



$$k^2 - 14921k - 168301000 > 0$$

$$k = 4915.71$$

$$k = -3423.71 \quad \text{reject.}$$

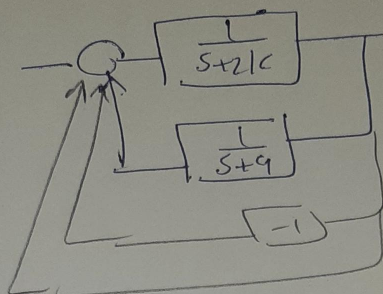
$$0 < k < 370.61 \quad \text{stable system.}$$

$$\text{marginal stable @ } k = 370.618$$

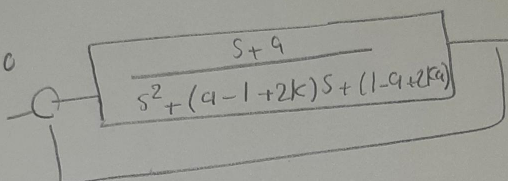
$$-60212.45s^2 + 6 \times 370.61 = 0$$

$$s = \pm j 3.23$$

Q4)



SYSTEM Type 0



$$e_{ss}(\omega) = 0$$

step

$$\lim_{s \rightarrow 0} G(s) = \frac{a}{1 - a + 2ka} = 0$$

can't determine k & a

$$\%OS < 5\%$$

$$T(s) = \frac{s + a}{s^2 + (a + 2k)s + (2ka + 1)}$$

$$\zeta = \frac{-\ln(0.05)}{\sqrt{\pi^2 + \ln^2(0.05)}} \leq 0.69$$

$$a + 2k = 2\zeta \omega_n \rightarrow (1)$$

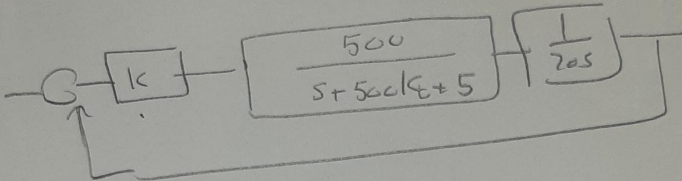
$$2ka + 1 = \omega_n^2 \rightarrow (2)$$

Q5

~~1.08~~

$$1.05 \leq 10^{-1}$$

$$T_s = 0.0625 \text{ s}$$



$$\frac{25K}{s^2 + (500s + 5) + 25K}$$

$$\delta = \frac{-\ln(0.1)}{\sqrt{\pi^2 + \ln^2(0.1)}} = 0.591$$

$$T_s = \frac{4}{\delta \omega_n} \Rightarrow \omega_n = 108.29$$

$$25K = \omega_n^2 \quad K = \frac{(108.29)^2}{25}$$

$$K = 469.1$$

$$500Kt + 5 = 2\delta \omega_n$$

$$\therefore Kt = 0.245$$