72857

Control System Solution

Q. 2 A]

$$G(S)H(S) = \frac{10}{S(0.1S+1)}$$

dynamic error Coefficients are

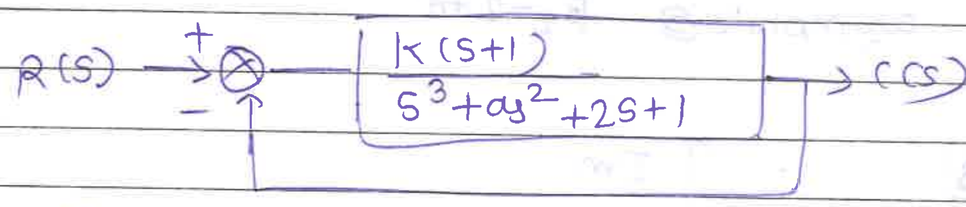
$$K_0 = \lim_{S\to 0}\left[\frac{0.1S^2+S}{0.1S^2+S+10}\right] = 0$$

$$K_1 = \lim_{S\to 0}\frac{d}{ds}\left[\frac{0.1S^2+S}{0.1S^2+S+10}\right] = 0.1$$

$$K_2 = \lim_{S\to 0}\frac{d^2}{ds^2}\left[\frac{0.1S^2+S}{0.1S^2+S+10}\right] = 0$$

Q. 2. B]

$K_{max} = 2$ & $a = 0.75$



$S^3 + aS^2 + (K+2)S + (K+1) = 0$ - - char. eq^n

from routh's array we get $a > \frac{K+1}{K+2}$

So s/m will marginally stable,

$K_{max} = 2$ & $a = 0.75$

Q. 3 A] $G(S)H(S) = \frac{C}{S(S+C)}$

i] $M_p = 40\%$

$$0.4 = e^{\frac{-\pi\xi}{\sqrt{1-\xi^2}}}$$

$\xi^2 = 0.078$ $\therefore$ $\xi = \pm 0.28$

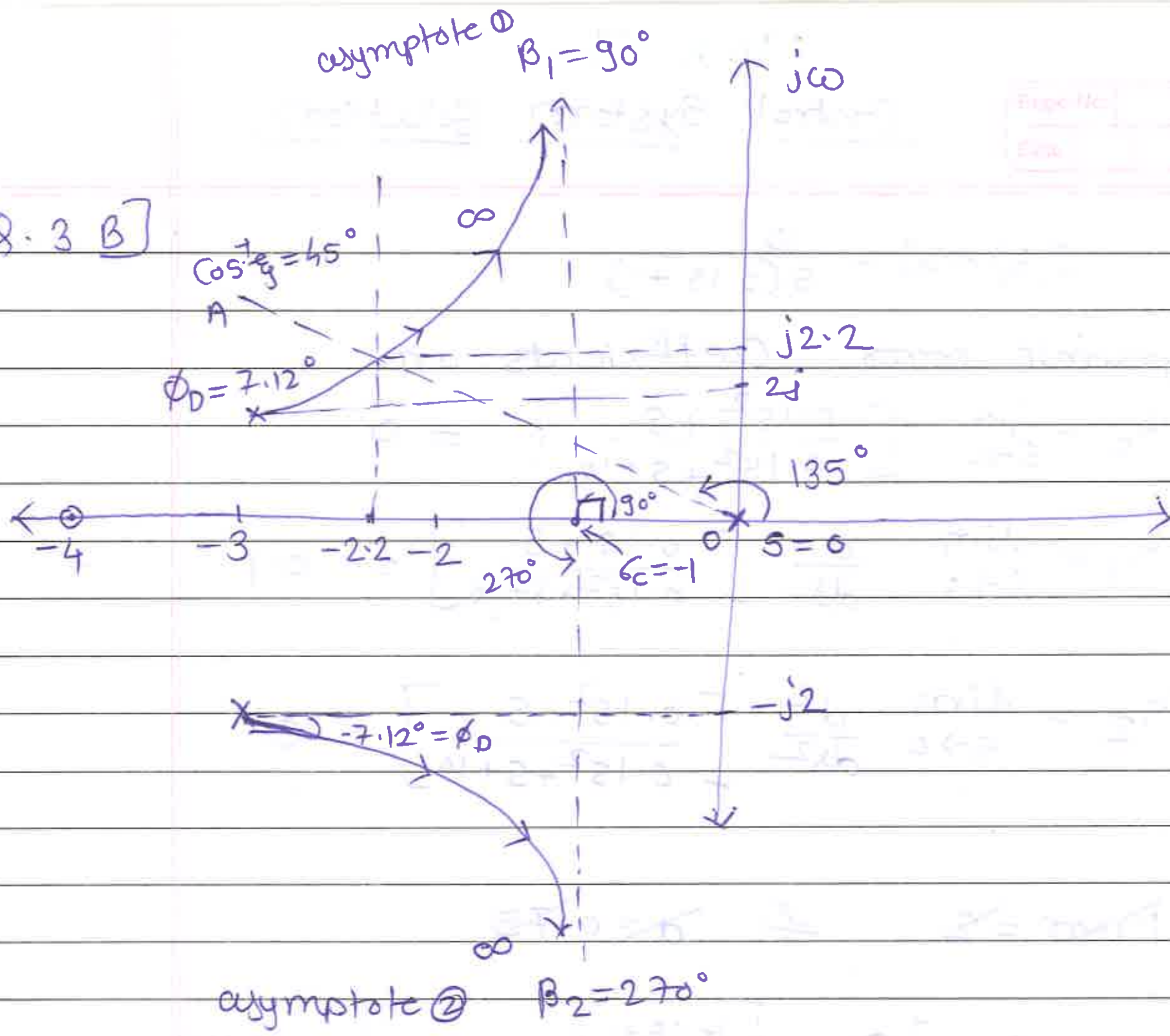
Since $\xi \geq 0$ $\therefore$ $\xi = 0.28$

$\xi = \frac{\sqrt{C}}{2}$ $C = 0.3136$, $\omega_n = \sqrt{C} = 0.56$

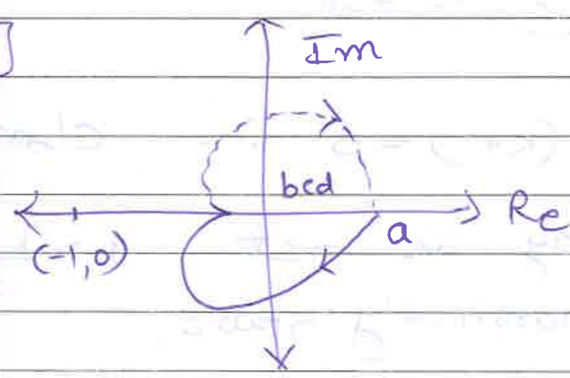
ii] $\omega_r = \omega_n\sqrt{1-2\xi^2} = 0.514$ rad/sec

$$M_r = \frac{1}{2\xi\sqrt{1-\xi^2}} = 1.86$$

Q. 3 B]



Q. 4. B]



S/m is stable

$(N = P - Z \quad \therefore Z = P - N$

$Z = 0)$

→ Nyquist paths are path a-b = $S = j\omega$

path b-c-d $S = \lim_{R \to \infty} Re^{j\theta}$

Path d-e $S = -j\omega$

→ path a-b

at $\omega = 0$ $|G(j\omega)H(j\omega)| = 25$

$\angle G(j\omega)H(j\omega) = 0$

at $\omega = \infty$; $|G(j\omega)H(j\omega)| = 0$

$\angle G(j\omega)H(j\omega) = -180°$

→ path b-c-d maps on origin.

→ path d-e (mirror image of path a-b)

Q. 6. A] $G(S)H(S) = \frac{K}{S(S+2)(S+4)}$

→ magnitude plot table :

	Factor	Slope	Start pt.	Endpt.
1.	$1/j\omega$	-20 dB/sec	0.1	2
2.	$\frac{1}{\left(1+\frac{j\omega}{2}\right)}$	-40 dB/sec	2	4
3.	$\frac{1}{\left(1+\frac{j\omega}{4}\right)}$	-60 dB/sec	4	∞

→ Phase angle table

$$\phi_{Resultant}(\omega) = -90^\circ - \tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}\left(\frac{\omega}{4}\right)$$

1) to get gain margin of 20dB, we need to shift the mag. curve by 8 dB in downward direaction

$20 \log K_1 = -8$ dB $K_1 = 0.398$

but $K_1 = \frac{K}{8}$ $K = 3.18$

2) to get phase margin of 60° we need to shift the mag. curve by 4 dB in downward direaction

$20 \log K_1 = -4$ dB $K_1 = 0.6$

$K_1 = \frac{K}{8}$ $K = 5.04$.