2b	Wn=0.5,Td= 0.27sec, Θ=1.04rad,wd=4.33 rad/sec,Tr=0.485,Tp=0.72sec,Ts=1.6sec,Mp=16%,c(t)=1-1.5e$^{-2.5t}$sin(4.33t+1.04).
3a	$G(s)H(s) = \frac{K}{S(s+4)(s+6)}$ (i) Poles , $s=0$, $s=-4$, $s=-$ Zeroes $s=\infty$ (ii) Assymptotes : $x = \frac{\Sigma P_0 - \Sigma Z_0}{N_p - N_z} = \frac{-10}{3}$ $\alpha = \frac{\pm n \times 180}{N_p - N_z} = \pm n \times 60$ $= 60°, 180°,$ iii) Break-away point : Characteristic equation : $\frac{K_0}{S(s+4)(s+6)} + 1 = 0$

$K_0 + s(s+4)(s+6) = 0$

$\therefore K_0 = -s(s+4)(s+6)$

$K_0 = -s(s^2+10s+24)$

- break-away point $\frac{dK_0}{ds} = -s(2s+10) - 1(s^2+10s+24)$

$\frac{dK_0}{ds} = 0$

$\therefore -s(2s+10) - (s^2+10s+24) = 0$

$2s^2+10s+s^2+10s+24 = 0$

$3s^2+20s+24 = 0$

$s = -1.5695$ ✓ $s = -5.097$ ✗ → Not on root locus

K_0 at $s = -1.5695$ ~~[illegible]~~

$\therefore K_0 = 16.9$

Imaginary-axis intersection :

$3s^3+20s^2+24s+K_0 = 0$

Substitute $s = j\omega$.

$3(j\omega)^3 + 20(j\omega)^2 + 24(j\omega) + K_0 = 0$

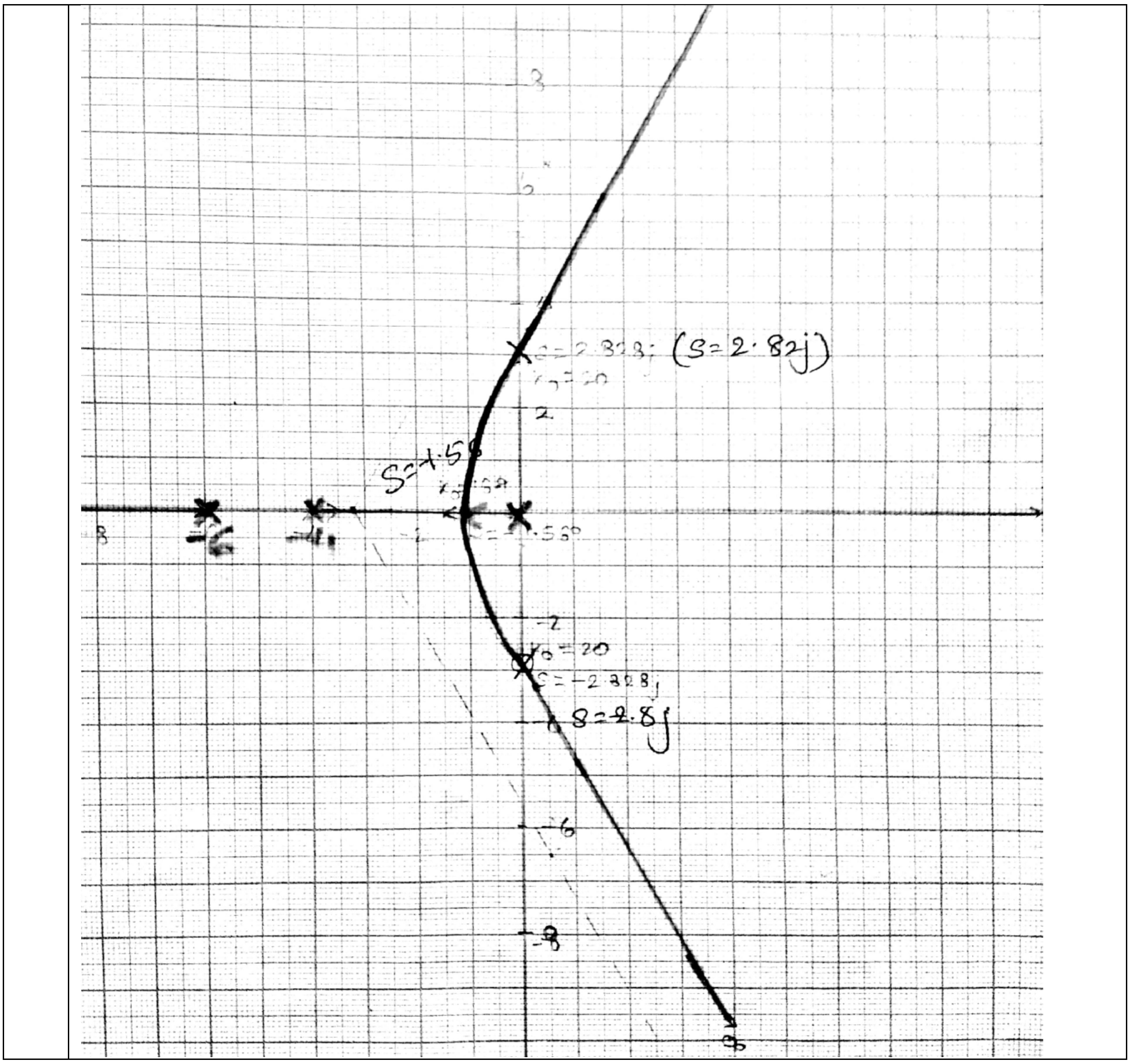
$-3j\omega^3 + 24j\omega - 20 + K_0 = 0$

$3j\omega^3 = 24j\omega$ $K_0 = 20$

$\omega^2 = 8$

$\omega = \pm 2\sqrt{2}$

$= \pm 2.828$

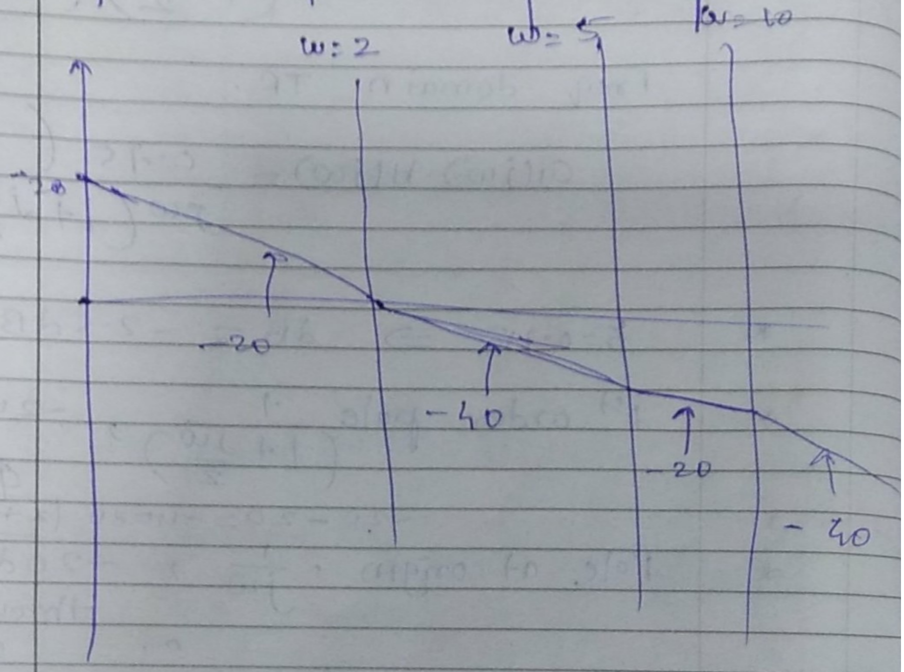


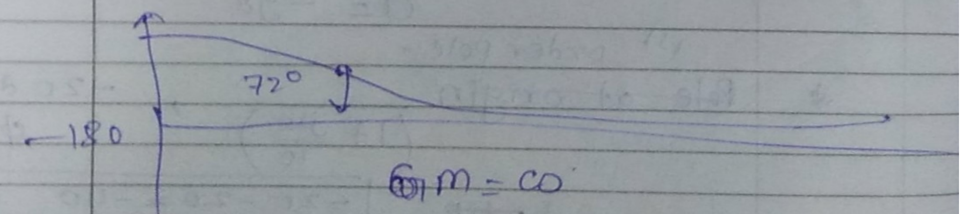
(S=2·82j)
S=-1·58
-2
S=-2·828j
S=-2·8j
-6
-8

3b

Phase angle

ω	$\frac{1}{j\omega}$	$-\tan^{-1}(\frac{\omega}{2})$	$-\tan^{-1}(\frac{\omega}{10})$	$\tan^{-1}(\frac{\omega}{5})$	φ
0.1	-90	-2.86	-0.57	1.15	-92.28
1		-26.5	-5.71	11.30	-110.91
2		-45	-11.31	21.8	-124.51
5		-68.2	-26.56	45	-139.76
10		-78.6	-45	63.43	-150.26
50		-87.7	-78.69	84.3	-172.1
100		-88.8	-84.3	87.13	-176.02
1000		-89.8	-89.42	89.71	-179.85





GM = ∞

PM 72°　　ωgc = 0.78 rad

ωpc = ∞

system is stable.

4a ii)	

4a) ii)

Using Routh stability c
stability of the system w
eqn is

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2$$

s^6	1	8	20	16
s^5	2	12	16	0
s^4	2	12	16	0
s^3	0	0	0	0

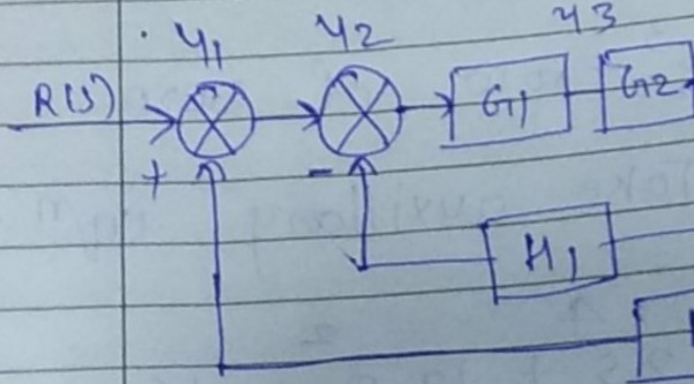
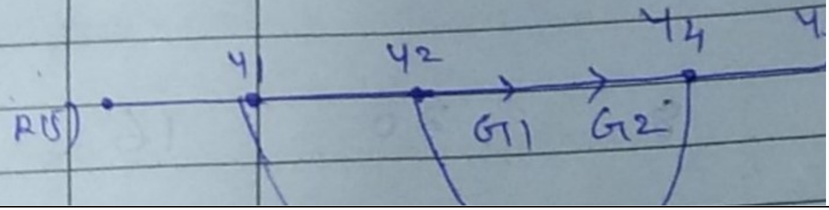
s^3 row of zero

Take auxillary e

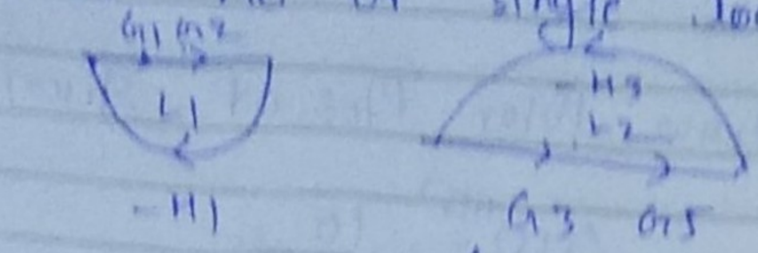
$$A(s) = 2s^4 + 12s^2 + 16$$

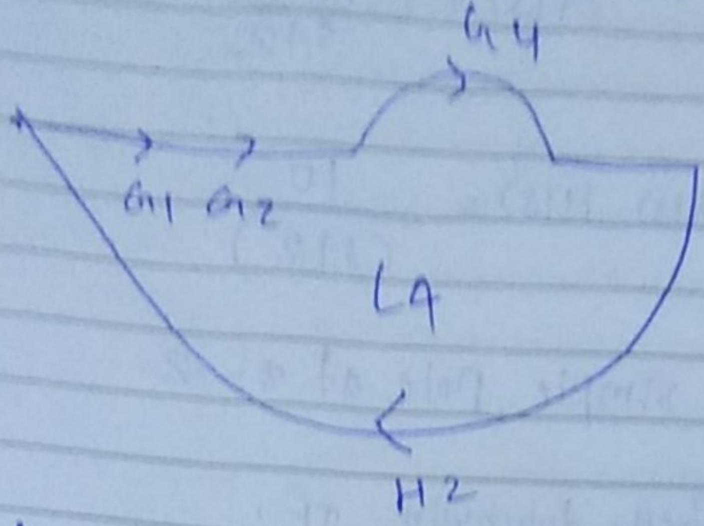
$$\frac{d\,A(s)}{ds} = 8s^3 + 24s$$

s^6	1	8	20

	for Marks / Question No. Aux. eqn. $2s^4 + 12s^2 + 16 = 0$ $s = \pm\sqrt{2}$
5a	 

Total No of single loop





$L_{11} = -G_1G_2H_1$

$L_{21} = -G_3G_5H_3$

$L_{31} = G_1G_2G_3H_2$

$L_{41} = G_1G_2G_4H_2$

* No of two non touchin

L_1 & L_2 are two n

$\therefore L_{21}^{12} = L_{11} \times L_{21} =$

$= (-G_1G_2H_1)(-G_3G$

Question No.

6 b)

II) Draw Polar Plot of giv

$$G(s)^{H(s)} = \frac{10}{s+2}$$

$$\Rightarrow \quad G(s) \cdot H(s) = \frac{10}{(s+2)}$$

simple pole at $s = -2$

freq. dowmain TF.

$$G(j\omega) \cdot H(j\omega) = \frac{10+0j}{j\omega +}$$

$$|G(j\omega) H(j\omega)| = \frac{}{\sqrt{\omega}}$$

$$\angle G(j\omega) \cdot H(j\omega) = \frac{\tan}{\tan}$$

$$= -\tan^{-1}($$

at $\omega = 0$