KAMMAVARI SANGHAM (R) - 1952

K S GROUP OF INSTITUTIONS

K. S. INSTITUTE OF TECHNOLOGY

Accredited by NAAC

(Approved by AICTE & Affiliated to VTU)

#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru - 560109

KSIT MED

BLUE BOOK

Name of the student : Bhavan Kashyap K.

Class / Sem : VII 'A' Branch : Mechanical.

USN : 1 K S 1 9 M E 0 0 5

SUBJECT : Control engineering SUBJECT CODE : 18ME71.

MAXIMUM MARKS

Test	I	II	III	Average Marks Obtained
Date	27/10/22	28/11/22	22/11/22	Test
Marks Obtained	28/30	28/30	23/30	79/90 27/30
Signature of Student	Kashyap	Kashyap	Kashyap	Assignment 10
Initials of Faculty	Jthanky	Jthanky	Jthanky	Total 37

NAME OF FACULTY : Dr. M. Umashankar

SIGNATURE OF FACULTY : Jthanky

SIGNATURE OF H.O.D : Jthanky 3/1/23

K. S. INSTITUTE OF TECHNOLOGY

First Internal Test

Q. No	Marks	CO	Q. No	Marks	CO	CO	Total
1(a)	06	CO1	3(a)		CO2	CO1 -	16
1(b)	~~04~~ 06	CO1	3(b)		CO2		
1(c)	~~06~~ 04	CO1	3(c)			CO2 -	12
OR			OR				
2(a)		CO1	4(a)	06	CO2		
2(b)		CO1	4(b)	06	CO2		
2(c)		CO1	4(c)			Grand Total	28/30

Second Internal Test

Q. No	Marks	CO	Q. No	Marks	CO	CO	Total
1(a)	06	CO3	3(a)			CO3 -	18
1(b)	06	CO3	3(b)				
1(c)	06	CO3	3(c)			CO2 -	06
OR			OR			CO4 -	04
2(a)			4(a)	06	CO2		
2(b)			4(b)	CO4	04		
2(c)			4(c)			Grand Total	28/30

Third Internal Test

Q. No	Marks	CO	Q. No	Marks	CO	CO	Total
1(a)	06	CO5	3(a)			CO4 -	05
1(b)	06	CO5	3(b)				
1(c)	06	CO5	3(c)			CO5 -	18
OR			OR				
2(a)			4(a)	05	CO4		
2(b)			4(b)	00	CO4		
2(c)			4(c)			Grand Total	23/30

Signature of the Faculty

Part - A.

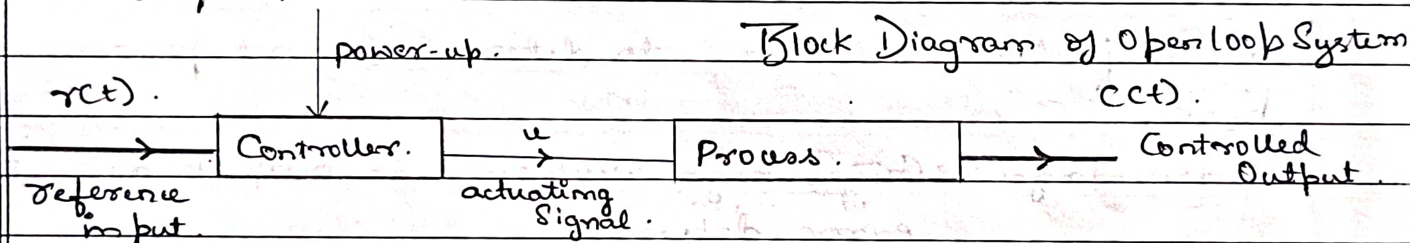
1a) Control system: Control means to regulate or direct or to command.

Hence control system is defined as arrangement of different physical components in such a way ~~that~~ / manner so as to regulate or to direct or to command itself to other systems.

→ Open loop Control system:

It is a type of control system where output of a system is dependent on the input but input is not dependent on output.

Block Diagram of Open loop System.



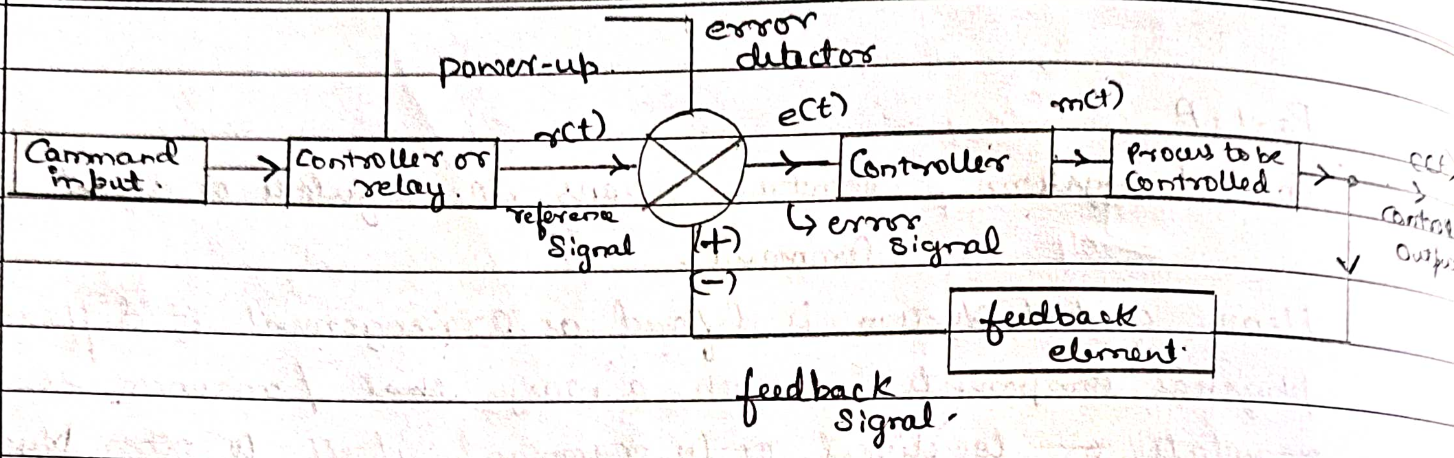
Example - Toaster.

In a toaster reference input is applied as time and the heating of bread is considered as process and the Controlled output is the Actual toast.

Advantages:
- Simple design
- Convient to use.
- Easy maintance.

Disadvantages:
- No accuracy in output.
- Variations in output due to enviroment changes.

→ Closed loop: It is a type of control system where input is dependent on output and changes in o/p.



Block Diagram of Closed loop Control System

Ex: Human beig.

In this case the output to be optained is picking the book up. where input is feed to the controller in this case the brain and the transmitted to the Hands where eye acts as a feedback element to determine exact position of the book.

Advantages: • Gives high accuracy in output due to error detector.

• Error detectors prevents the output to vary due to environment changes to obtain desired & appropriate output.

06

Disadvantages: • Complex design.

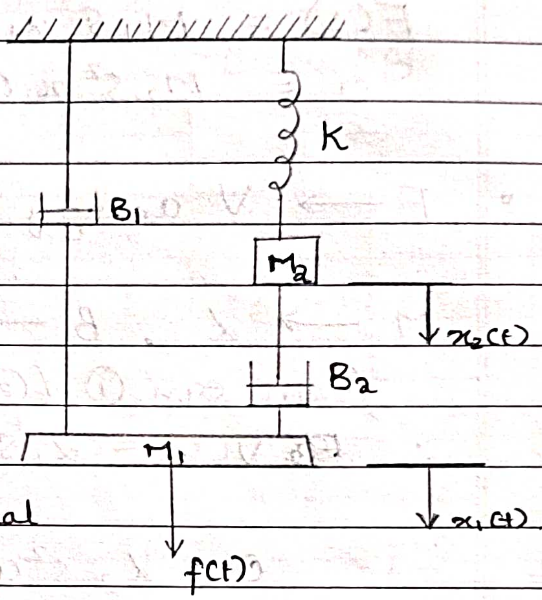
• requires Skilled worker.

• Comparitively difficult to maintane.

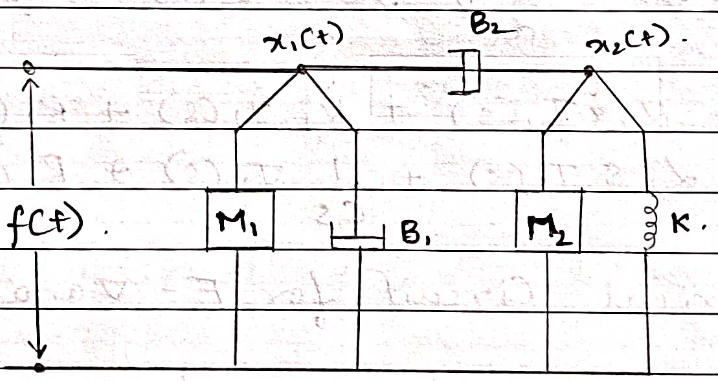
1b) To obtain:

- F - I } analogy.
- F - V
- and equilibrium equation.

Given:



for Given Mechanical Circuit.
the ~~Equilibr~~ Equivalent Mechanical Circuit is Given by.



Differential equation for Given Circuit (equivalent).

$$f(t) = M_1 \frac{d^2 x_1(t)}{dt^2} + B_1 \frac{d x_1(t)}{dt} + B_2 \left(\frac{d x_1(t)}{dt} - \frac{d x_2(t)}{dt} \right).$$

$$0 = M_2 \frac{d^2 x_2(t)}{dt^2} + K (x_2(t)) + B_2 \left(\frac{d x_2(t)}{dt} - \frac{d x_1(t)}{dt} \right)$$

Applying laplace transform.

$$F(s) = M_1 s^2 x_1(s) + B_1 s x_1(s) + B_2(s x_1(s) - s x_2(s)) \rightarrow (1)$$

$$0 = M_2 s^2 x_2(s) + K x_1(s) + B_2(s x_2(s) - s x_1(s)) \rightarrow (2)$$

- $F \longrightarrow V$ analogy (Loop analysis).

$M \longrightarrow L$, $B \longrightarrow R$, $K \longrightarrow \frac{1}{C}$, $F \longrightarrow V$, $x \longrightarrow q$.

from eqn (1) & (2).

$$\therefore V(s) = L_1 s^2 q_1(s) + R_1 s q_1(s) + R_2(s q_1(s) - s q_2(s)).$$

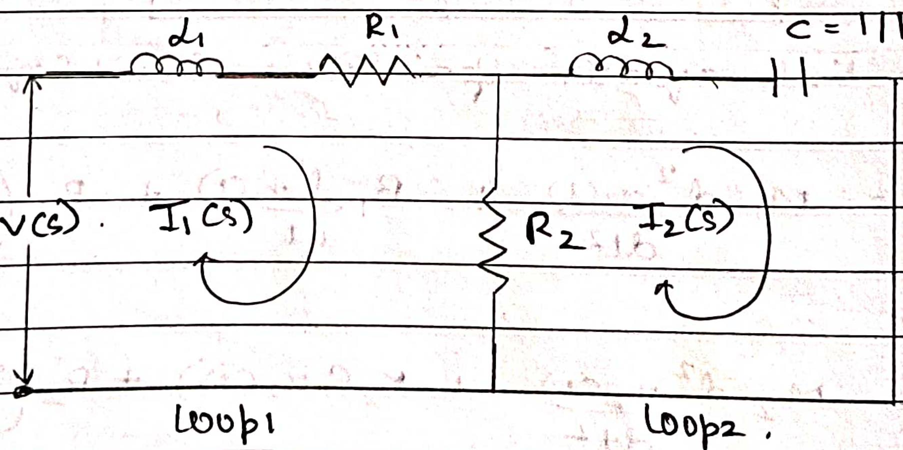
$$0 = L_2 s^2 q_2(s) + \frac{1}{C} q_2(s) + R_2(s q_2(s) - s q_1(s)).$$

$$V(s) = \frac{dq}{dt} \text{ i.e. } I(s) = s q(s).$$

$$\Rightarrow V(s) = L_1 s I_1(s) + R_1 I_1(s) + R_2(I_1(s) - I_2(s)) \rightarrow (3)$$

$$0 = L_2 s I_2(s) + \frac{1}{Cs} I_2(s) + R_2(I_2(s) - I_1(s)) \rightarrow (4)$$

$\therefore$ Electrical Circuit for F - V analogy.



- $F \longrightarrow I$ analogy (Node analysis).

$M \longrightarrow C$, $B \longrightarrow \frac{1}{R}$, $K \longrightarrow \frac{1}{L}$, $F \rightarrow I$, $x \rightarrow \phi$.

for eqn ① & ②.

$$I(s) = C_1 s^2 \phi_1(s) + \frac{1}{R_1} s\phi_1(s) + \frac{1}{R_2}(s\phi_1(s) - s\phi_2(s))$$

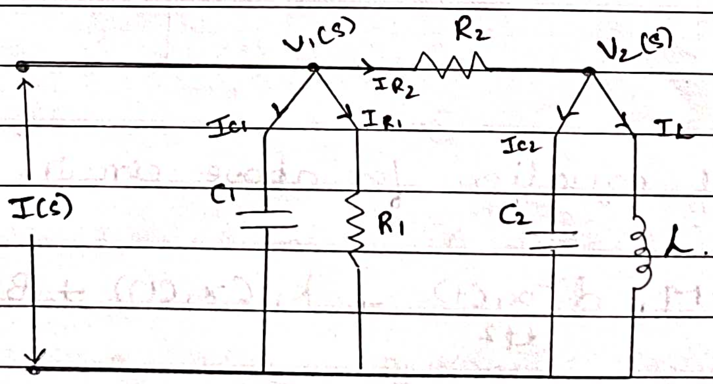
$$0 = C_2 s^2 \phi_2(s) + \frac{1}{L}\phi_2(s) + \frac{1}{R_2}(s\phi_2(s) - s\phi_1(s)).$$

$$I(s) = \frac{d\phi}{dt}, \text{ ie. } V(s) = s\phi(s).$$

$$I(s) = C_1 s V_1(s) + \frac{1}{R_1} V_1(s) + \frac{1}{R_2}(V_1(s) - V_2(s)) \quad \text{⑤}$$

$$0 = C_2 s V_2(s) + \frac{1}{Ls} V_2(s) + \frac{1}{R_2}(V_2(s) - V_1(s)) \quad \text{⑥}$$

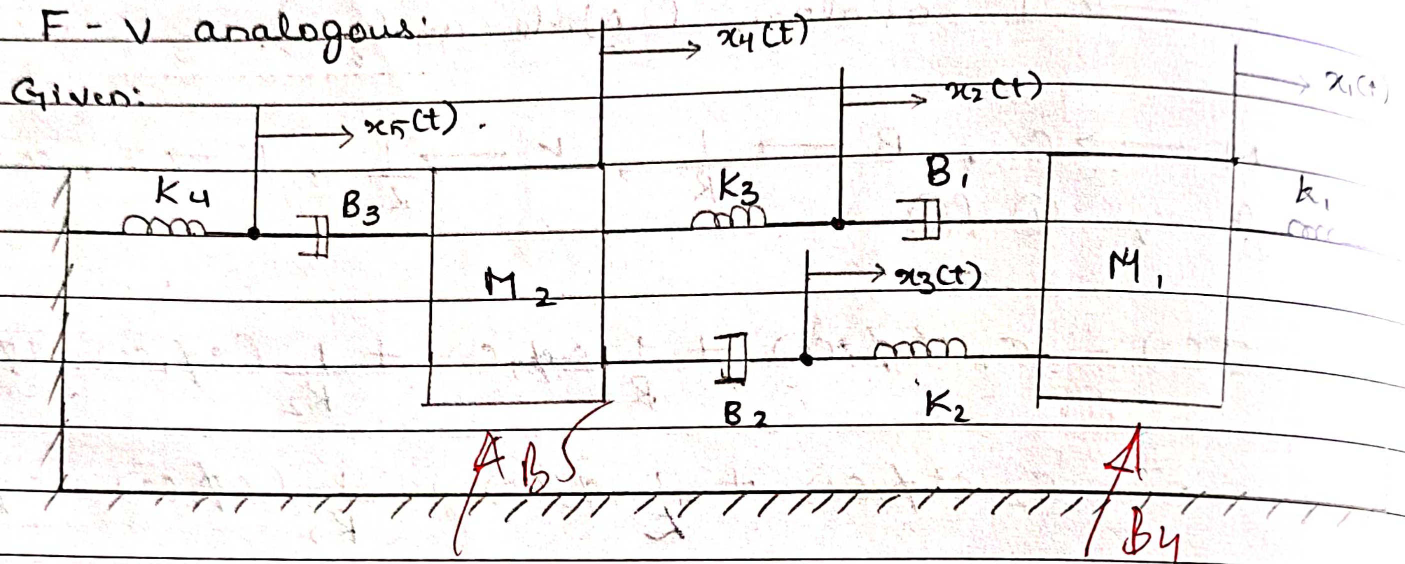
Electrical Circuit for $F \rightarrow I$ analogy.



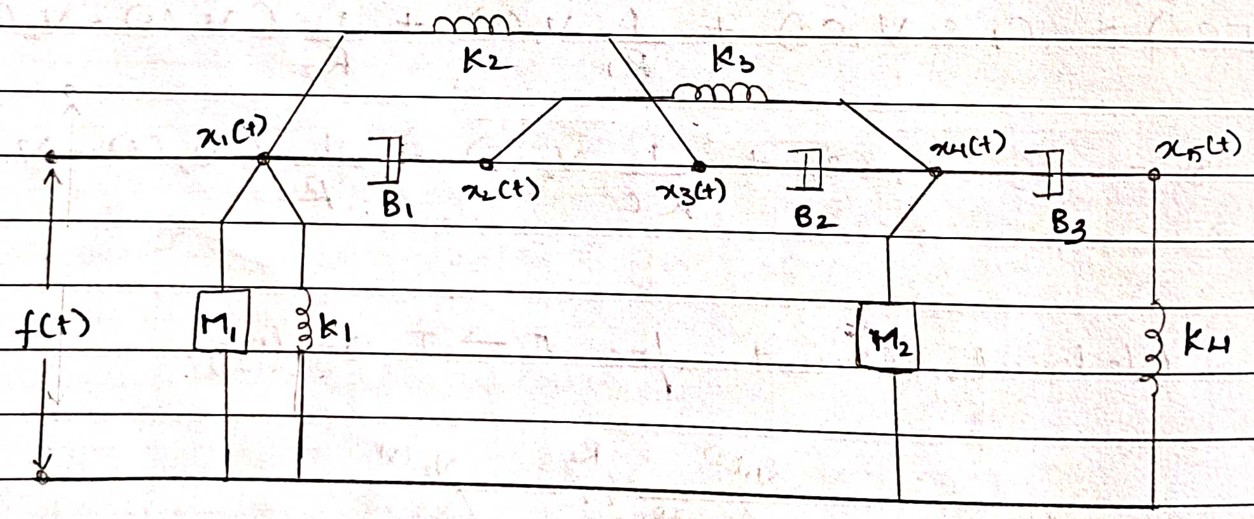
06

1c) F - V analogous:

Given:



for the Given Circuit Equivalent Mechanical Circuit is Given by.



Differential equation for above circuit.

$$f(t) = M_1 \frac{d^2 x_1(t)}{dt^2} + K_1 (x_1(t)) + B_1 \left(\frac{d}{dt} x_1(t) - \frac{d}{dt} x_2(t)\right) + K_2 (x_1(t) - x_2(t))$$

$$0 = B_1 \left(\frac{d}{dt} x_2(t) - \frac{d}{dt} x_1(t)\right) + K_3 (x_2(t) - x_4(t))$$

$$0 = K_2(x_3(t) - x_1(t)) + B_2\left(\frac{d}{dt}x_3(t) - \frac{d}{dt}x_4(t)\right).$$

$$0 = M_2\frac{d^2x_4(t)}{dt^2} + K_3(x_4(t) - x_2(t) + B_2\left(\frac{d}{dt}x_4(t) - \frac{d}{dt}x_3(t)\right)$$
$$+ B_3\left(\frac{d}{dt}x_4(t) - \frac{d}{dt}x_5(t)\right).$$

$$0 = K_4(x_5(t)) + B_3\left(\frac{d}{dt}x_5(t) - \frac{d}{dt}x_4(t)\right)$$

Applying laplace transform.

$$F(s) = M_1 s^2 x_1(s) + K_1 x_1(s) + B_1(s x_1(s) - s x_2(s))$$
$$+ K_2(x_1(s) - x_3(s)) \rightarrow (1)$$

$$0 = B_1(s x_2(s) - \cancel{s} x_1(s)) + K_3(x_2(s) - x_4(s) \rightarrow (2)$$

$$0 = K_2(x_3(s) - x_1(s)) + B_2(s x_3(s) - s x_4(s)) \rightarrow (3)$$

$$0 = M_2 s^2 x_4(s) + K_3(x_4(s) - x_2(s)) + B_2(x_4(s) - x_3(s))$$
$$+ B_3(s x_4(s) - s x_5(s)) \longrightarrow (4)$$

$$0 = K_4(x_5(s)) + B_3(s x_5(s) - s x_4(s)) \longrightarrow (5)$$

for the ~~of~~ above equation apply.

$F \longrightarrow V$ analogous (Loop analysis).

$M \longrightarrow L$, $B \longrightarrow R$, $K \longrightarrow \frac{1}{C}$, $F \rightarrow V$, $x \rightarrow q$.

$$V(s) = L_1 s^2 q_1(s) + \frac{1}{C_1} q_1(s) + R_1 (s q_1(s) - s q_2(s)) + \frac{1}{C_2}(q_1(s) - q_3(s))$$

$$0 = R_1 (s q_2(s) - s q_1(s)) + \frac{1}{C_3}(q_2(s) - q_4(s))$$

$$0 = \frac{1}{C_2}(q_3(s) - q_1(s)) + B_2 (s q_3(s) - s q_4(s))$$

$$0 = L_2 s^2 q_4(s) + B_2 (s q_4(s) - s q_3(s)) + \frac{1}{C_3}(q_4(s) - q_2(s)) + B_3 (s q_4(s) - s q_5(s))$$

$$0 = \frac{1}{C_4} q_5(s) + B_3 (s q_5(s) - s q_4(s)).$$

$V(s) = \frac{dq}{dt}$, ie $I(s) = s q(s)$.

~~Electrical Circuit for F-V analogy~~

$$V(s) = L_1 s I_1(s) + \frac{1}{C_1 s} I_1(s) + R_1 (I_1(s) - I_2(s)) + \frac{1}{C_2 s}(I_1(s) - I_3(s))$$

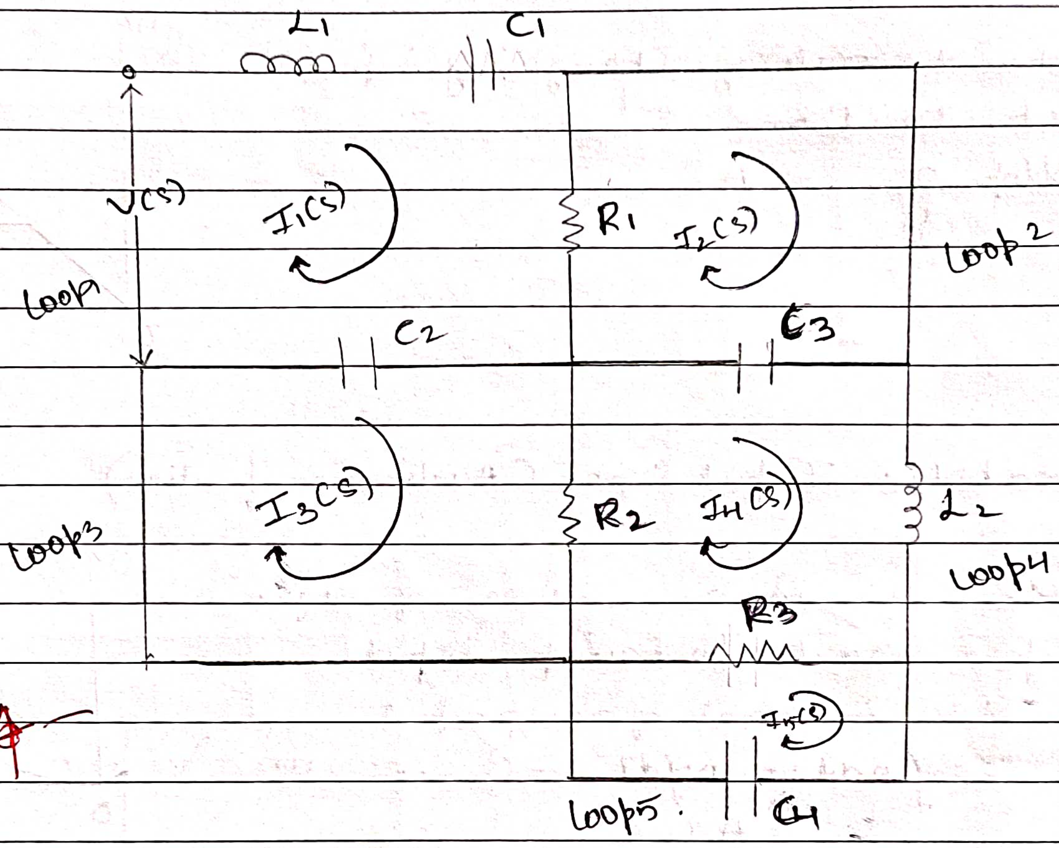
$$0 = R_1 (I_2(s) - I_1(s)) + \frac{1}{C_3 s}(I_2(s) - I_4(s)).$$

$$0 = \frac{1}{C_2 s}(I_3(s) - I_1(s)) + B_2 (I_3(s) - I_4(s)).$$

$$0 = L_2 s I_4(s) + B_2 (I_4(s) - I_3(s)) + \frac{1}{C_3 s}(I_4(s) - I_2(s)) + B_3 (I_4(s) - I_5(s)).$$

$$0 = \frac{1}{C_4 s}(I_5(s)) + B_3 (I_5(s) - I_4(s)).$$

Electrical ~~equival~~ Circuit for $F \rightarrow V$.



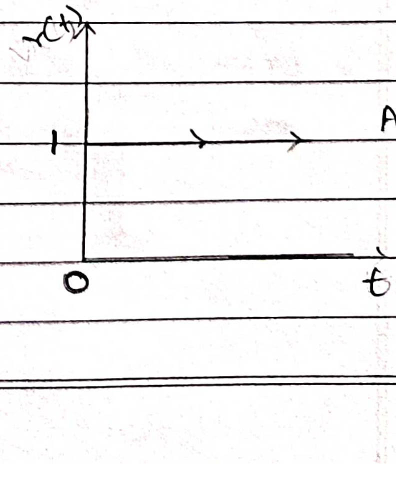
04

Part - B:

4a) Different input Signals are

- Step input Signal (position function). Where sudden application of input is Given

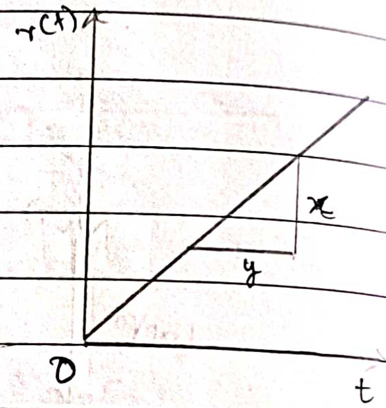
$A\,dt = u(t) = 1 = A.$



ii) Ramp Input Signal (Velocity function)

Constant rate of change of input w.r.t to time.

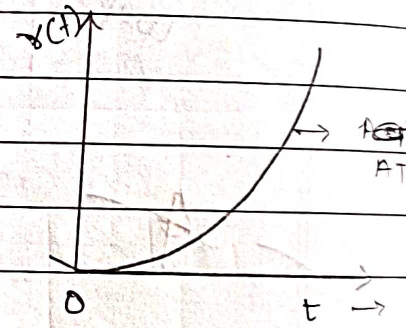
Slope $\frac{x}{y} = A$.



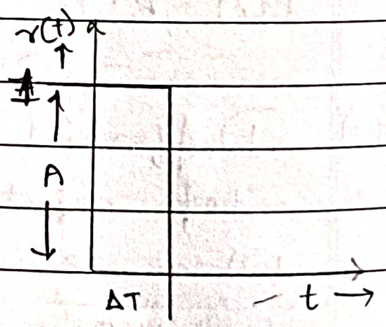
iii) Parabolic Input Signal (Acceleration function)

Where there is an increase of one degree of input w.r.t to ramp input.
or it is integral of ramp input

$\int A dt = A \int dt$
$= AT$



iv) Impulse input signal.
Instantenous increase in amplitude at a given interval of time.



06

4b) Steady state error.

Differential equation for 1^{st} order time ~~eq~~ response is Given

$$\frac{C(s)}{R(s)} = \frac{1}{(s+T)}$$

w.k.t ~~the~~ ramp input $R(s) = \frac{1}{s^2}$

$$\therefore C(s) = \frac{1}{s^2(s+T)}$$

on further ~~diff~~ D.E

$$C(s) = \frac{1}{s^2(s+T)} = \frac{A}{s^2} + \frac{B}{s} + \frac{C}{(s+T)} \longrightarrow (1)$$

$$\therefore \frac{A(\cancel{s^2}(s+T))}{\cancel{s^2}} + \frac{B(s^2(s+T))}{\cancel{s}} + \frac{C(s^2(s\cancel{+T}))}{(s\cancel{+T})} = 1$$

$$A(s+T) + Bs(s+T) + Cs^2 = 1$$

$$\Rightarrow As + AT + Bs^2 + BTs + Cs^2 = 1.$$

$$(A+BT)s + (B+C)s^2 + AT = 1.$$

$$\therefore AT = 1 \Rightarrow A = \frac{1}{T} \longrightarrow (2)$$

for $(A+BT)s$

$$\Rightarrow \frac{1}{T} + BT = 0 \Rightarrow B = -\frac{1}{T^2} \longrightarrow (3)$$

///ly for $(B+C)s = 0$

$$C = \frac{1}{T^2} \longrightarrow (4)$$

Substituting ②, ③ & ④ in ①.

We get

$$V_o(s) = \frac{1/T^2}{s^2} + \frac{(-1/T^2)}{s} + \frac{1/T^2}{(s+T)}.$$

Applying inverse transform.

$$V_o(s) = \frac{1}{T^2}(t) + \left(-\frac{1}{T^2}\right) + \frac{1}{T^2} e^{-T(t)} //.$$

6

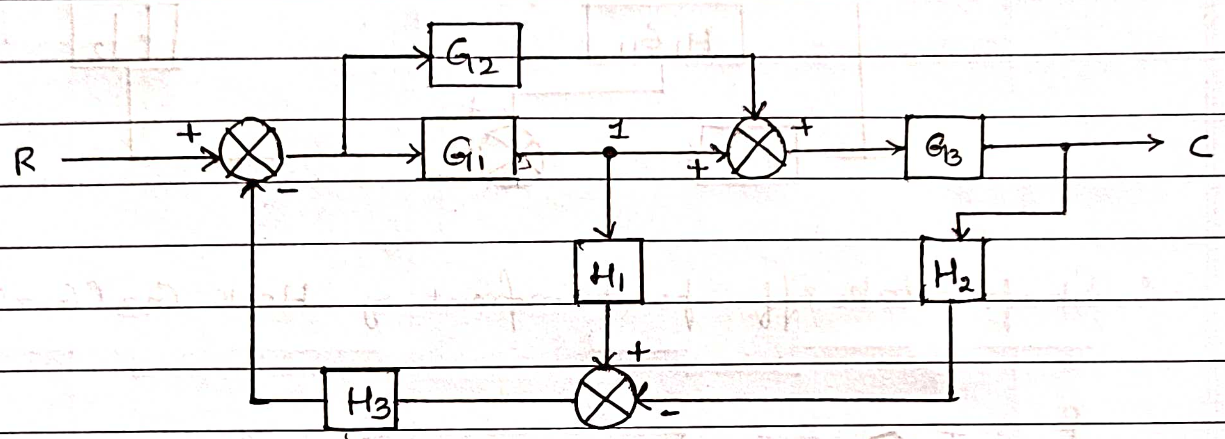
28/30

4/11/22

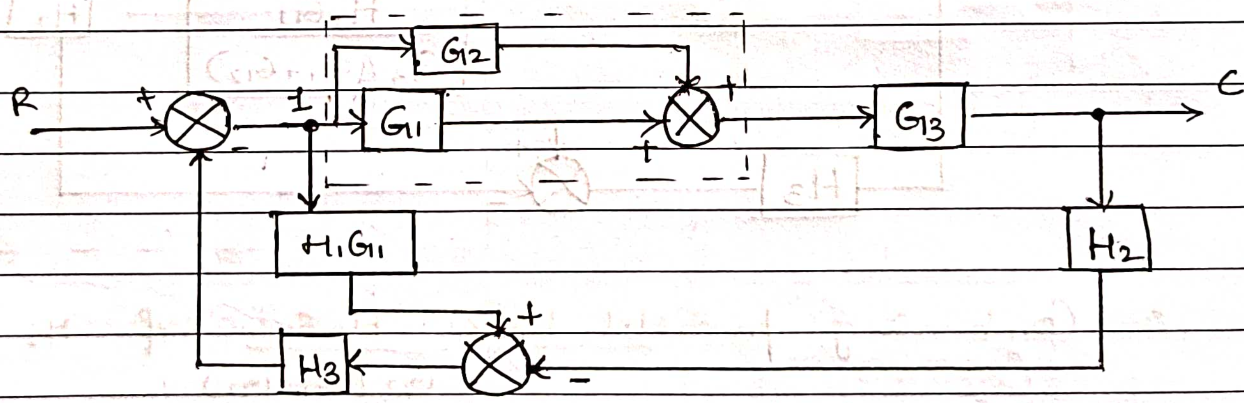
Internals - II.

Part - A.

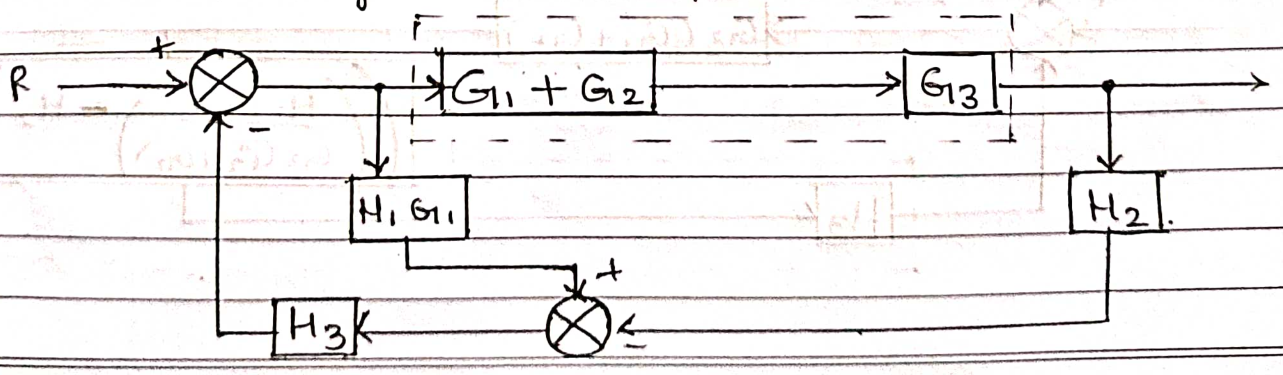
1a) Given.



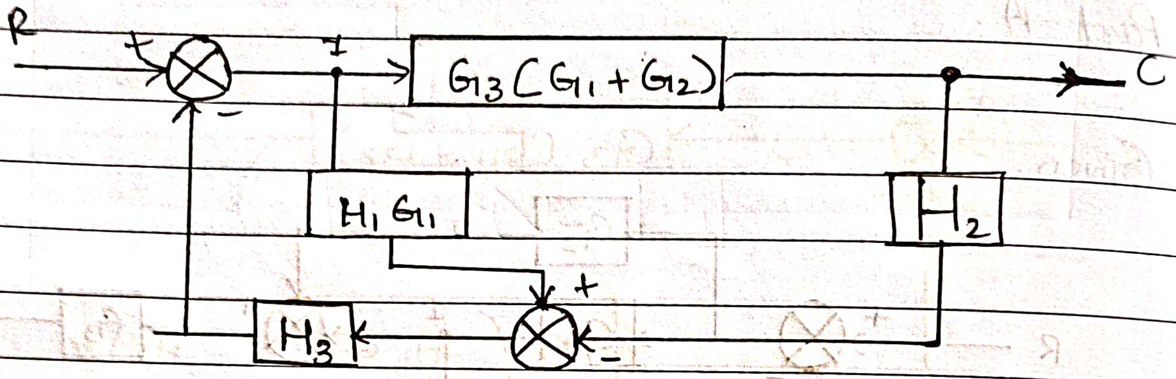
• Shifting take off point 1 Ahead of block G1.



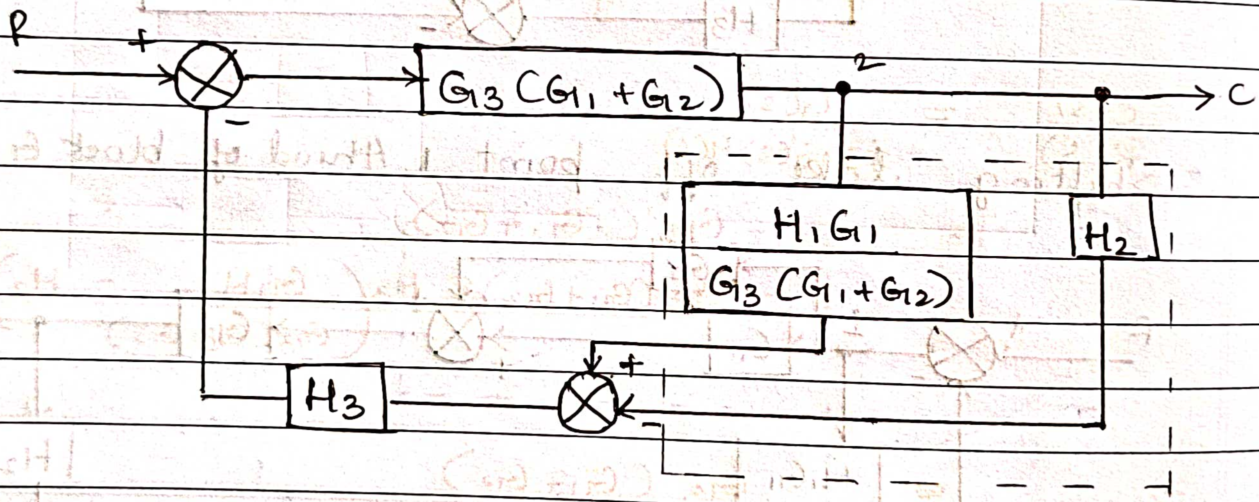
• Combining block G_1 & G_2.



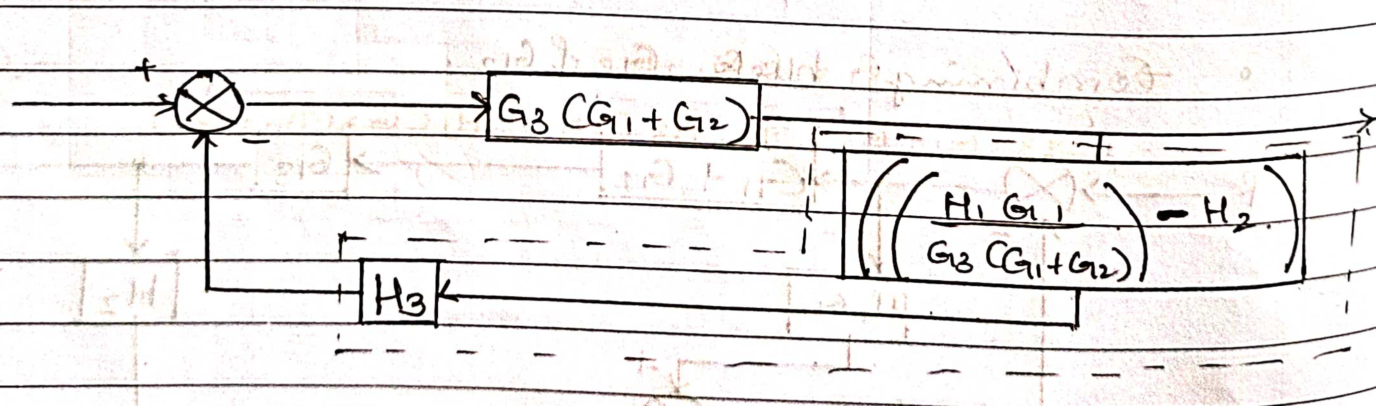
- Combining block $\boxed{G_1+G_2}$ & $\boxed{G_3}$



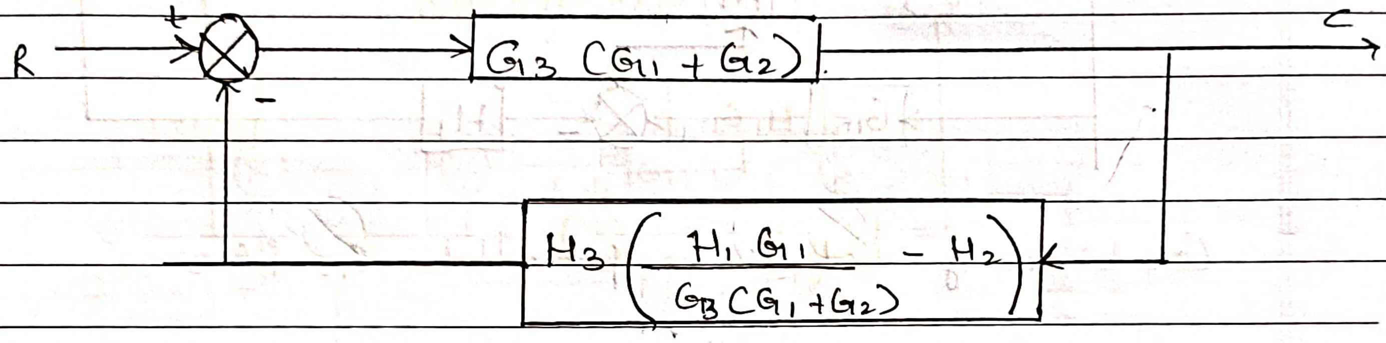
- Shaft take off point infront of block $G_3(G_1+G_2)$.



- Combining parallel blocks $\frac{H_1 G_1}{G_3(G_1+G_2)}$ & H_2.



- Combining two blocks in Series $\frac{H_1 G_1}{G_1(G_2+G_3)} - H_2$ & H_3



Now solving Minor feedback loop, we get.

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1 \pm G(s)H(s)}$$

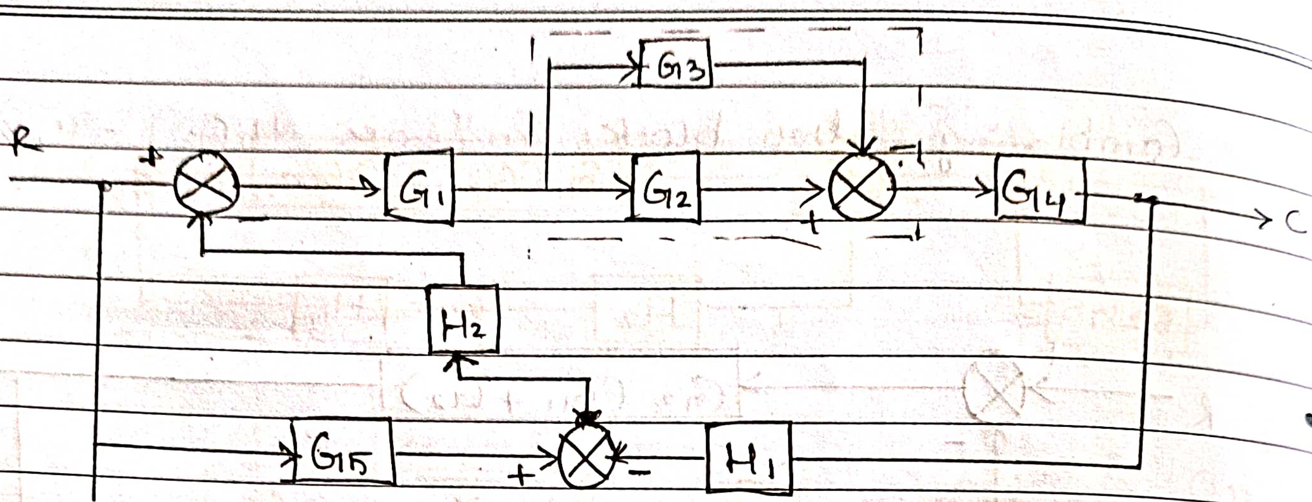
$$= \frac{G_3(G_1+G_2)}{1 + G_3(G_1+G_2) \cdot H_3\left(\frac{G_1 H_1}{G_3(G_1+G_2)} - H_2\right)}$$

$$\Rightarrow \frac{G_3(G_1+G_2)}{G_3(G_1+G_2)\ \cancel{G_3(G_1+G_2)} + G_3(\cancel{G_1+G_2}) \cdot \frac{H_3 G_1 H_1}{G_3(\cancel{G_1}+G_2)} - H_2(G_3(G_1+G_2))}$$

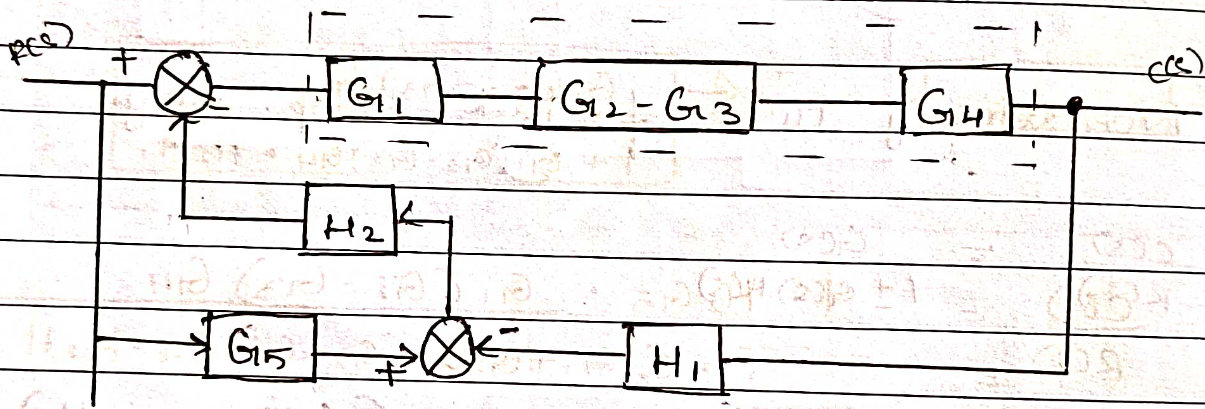
$$\Rightarrow \frac{G_3(G_1+G_2}{G_3(G_1+G_2) + H_3 G_1 H_1 - H_2(G_3(G_1+G_2)} = \frac{C(s)}{R(s)}.$$

06

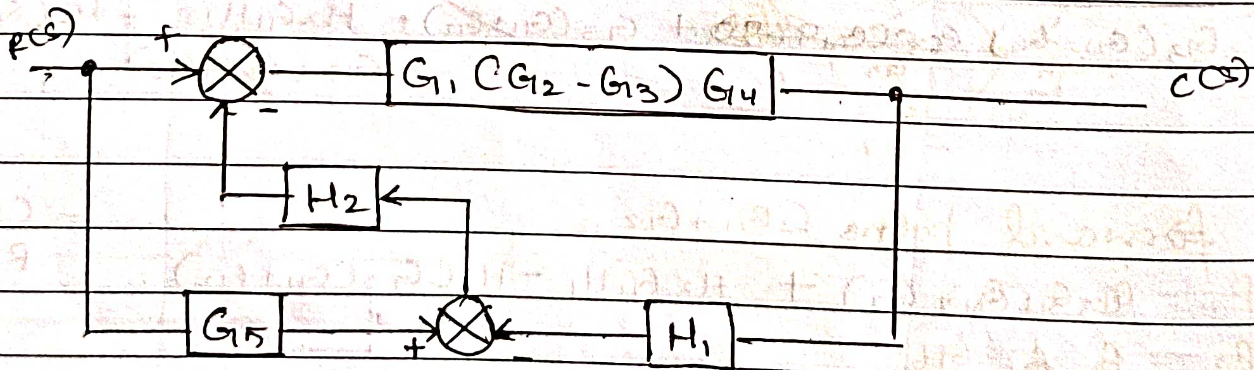
b)



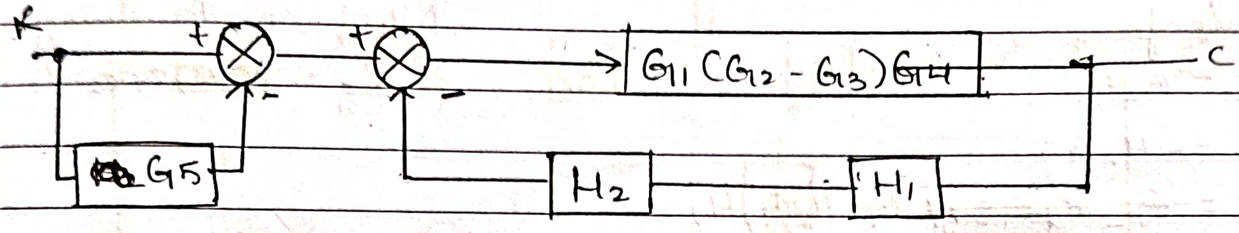
Combining blocks in parallel. G_2 & G_3

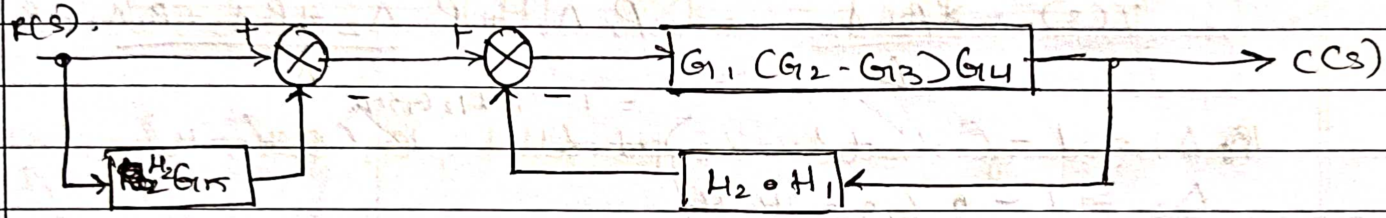


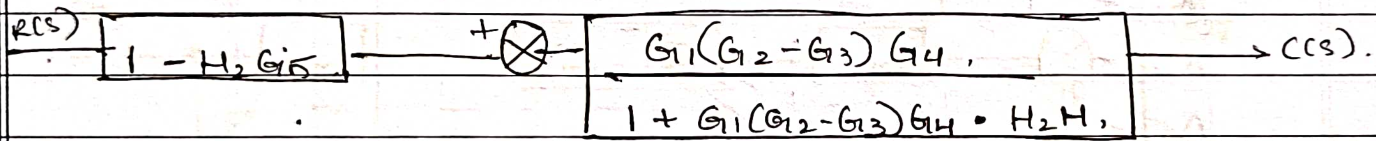
Combining blocks G_1, $G_2 - G_3$ & G_4 in Series.



- Splitting Summing point.



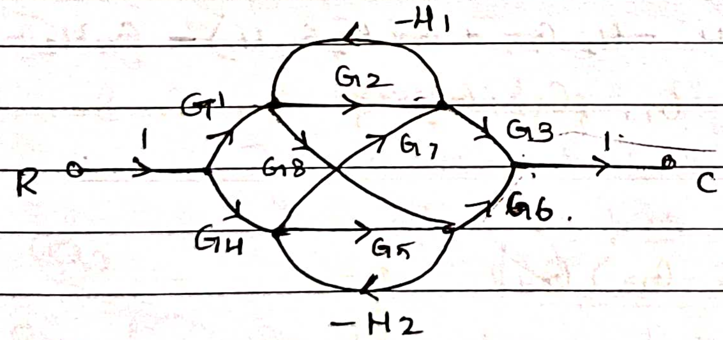




06

$$\frac{C(s)}{R(s)} = 1-H_2G_5 \cdot \frac{G_1(G_2-G_3)G_4}{1+G_1(G_2-G_3)G_4\cdot H_2H_1}$$ //

c)



forward paths.

$P_1 = G_1G_2G_3$

$P_2 = G_2G_5G_6$

$P_3 = G_1G_8G_6$.

$P_4 = G_4G_7G_3$.

$P_5 = -G_1G_2H_1G_8G_6$

$P_6 = -G_4G_5H_2G_7G_3$

Loops

$L_1 = -G_2 H_1$

$L_2 = -H_2 G_5$.

$L_3 = -\cancel{G_{12} H_1 G_8 H_1}\ G_8 H_2 G_7 H_1$

No of non touching loops =

$L_0 = \cancel{(G_2H_1)(G_5H_2)}\ L_1 \cdot L_2$

$$T(s) = \frac{\Sigma P_k \Delta_k}{\Delta} = \frac{P_1 \Delta_1 + P_2 \Delta_2 + P_3 \Delta_3 + P_4 \Delta_4 + P_5 \Delta_5 + P_6 \Delta_6}{\Delta}$$

$= 1 - G_8 H_2 G_7 H_6$.

$\Delta_1 = 1 - (L_1 + L_2 + L_3) + L$. $= 1 - (G_2 H_1 - H_2 G_5 - G_8 H_2 G_7 H_1 + L_1 L_3$

$\Delta_2 = 1 - \cancel{0}\ G_8 G_7 H_2 H_6$.

$\Delta_3 = 1$

$\Delta_4 = 1$

$\Delta_5 = 1$

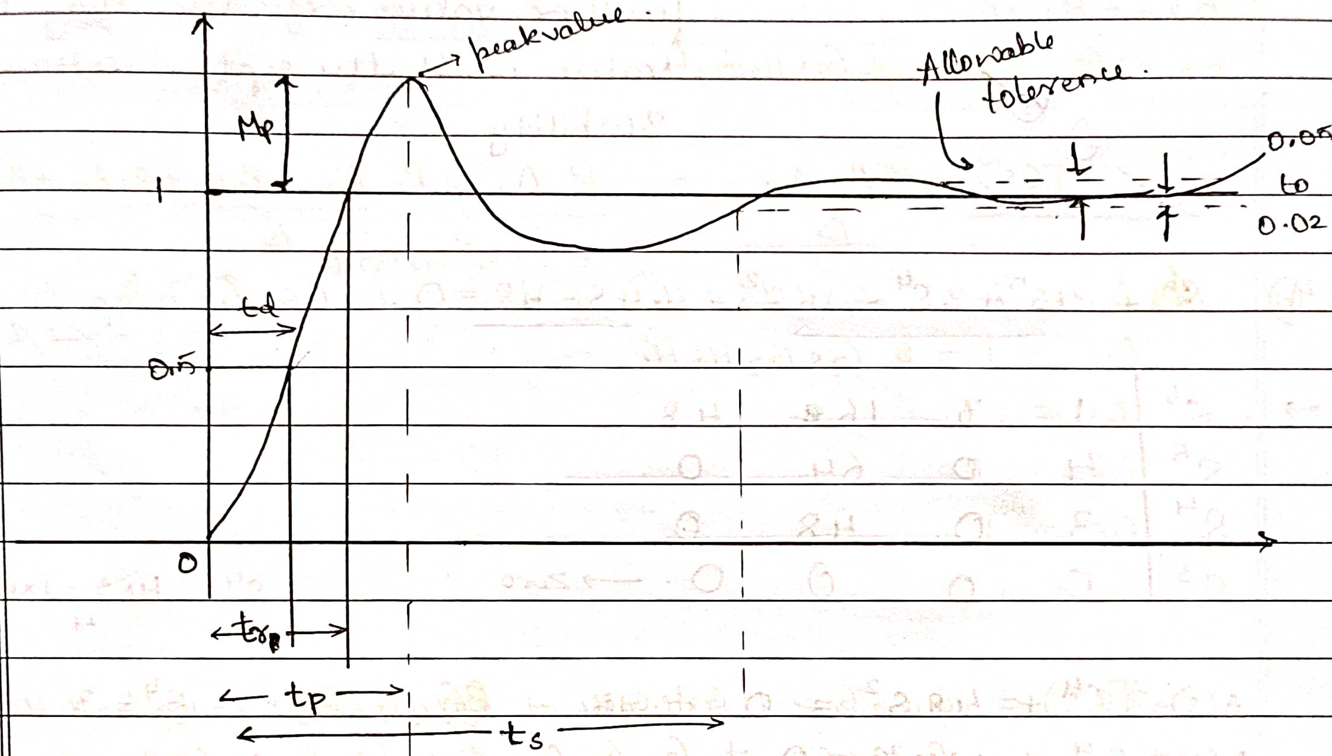
$\Delta_6 = 1$

$$T(s) = \frac{G_1 G_2 G_3 \cdot 1 - G_8 H_2 G_7 H_6 + G_4 G_5 G_6 \cdot 1 - G_8 G_7 H_2 H_6 + G_1 G_8 G_6 + G_4 G_7 G_3 - G_1 G_2 H_1 G_8 G_6 - G_4 G_5 H_2 G_3}{1 - (-G_2 H_1 - H_2 G_5 + G_8 H_2 G_7 H_1) - G_2 H_2 - H_2 G_5}$$

06

Part-B.

4a)



a) Delay time: It is a time take for the system to respond or time take for response to attain half of the value of ~~respon~~ rise time of or Complete value.

b) Rise time: It is time taken for response of time to reach unity. 0-90% for Overdamped and 0-100% for underdamped.

c) Peak time: It is time taken for response of time to to reach maximum Overshoot of highest peak value ~~after~~ ~~wavdeg~~. from the begining.

d) Maximum Overshoot : It is the maximum value obtained after reaching unity and all the further values are less than maximum value until the system attains stability.

0 6

4b) $s^6 + 4s^5 + 3s^4 - 16s^2 - 64s - 48 = 0.$

→

s^6	1	3	16	48
s^5	4	0	64	0.
s^4	3	0.	48	0.
s^3	0	0	0	0. → zero.

$s^4 = \frac{4 \times 3 - 1 \times 0}{4}.$

$s^4 = 3$

$A(s) \Rightarrow 3s^4 + 48s^2 = 0. \div 16.$

$A(s) \Rightarrow s^4 + 16s^2 = 0.$

$\frac{dA(s)}{ds} = 4s^3 + 32s^2 = 0.$

s^6	1	3	16	48
s^5	4	0	64	0
s^4	3	0	48	0.
s^3	4	0	32	0.
s^2	0	24	0	0.
s^1		0	0	0

→

s^6	1	3	16	48.
s^5	4	0	64	0
s^4	3	0	48	0
s^3	4	0	32	0
s^2	0	24	0	0
s^1	24	0	0	0
s^0	24	0	0	0

$A'(s) = 24s = 0.$

$s = 24.$

∴ As all the Values in the System is positive ~~the~~ and the value of $s = 24$
The System is Stable.

-04-

$\frac{28}{30}$

2/12/22

III rd Internals.

Part- A.

1a). $G(S) \cdot H(S) = \dfrac{20}{S(1+0.1S}$.

Step: Arrange $G(S) \cdot H(S)$ in time form.

$$G(S) \cdot H(S) = \frac{20}{S(1+0.1S)}.$$

Step2: Identify the factors.

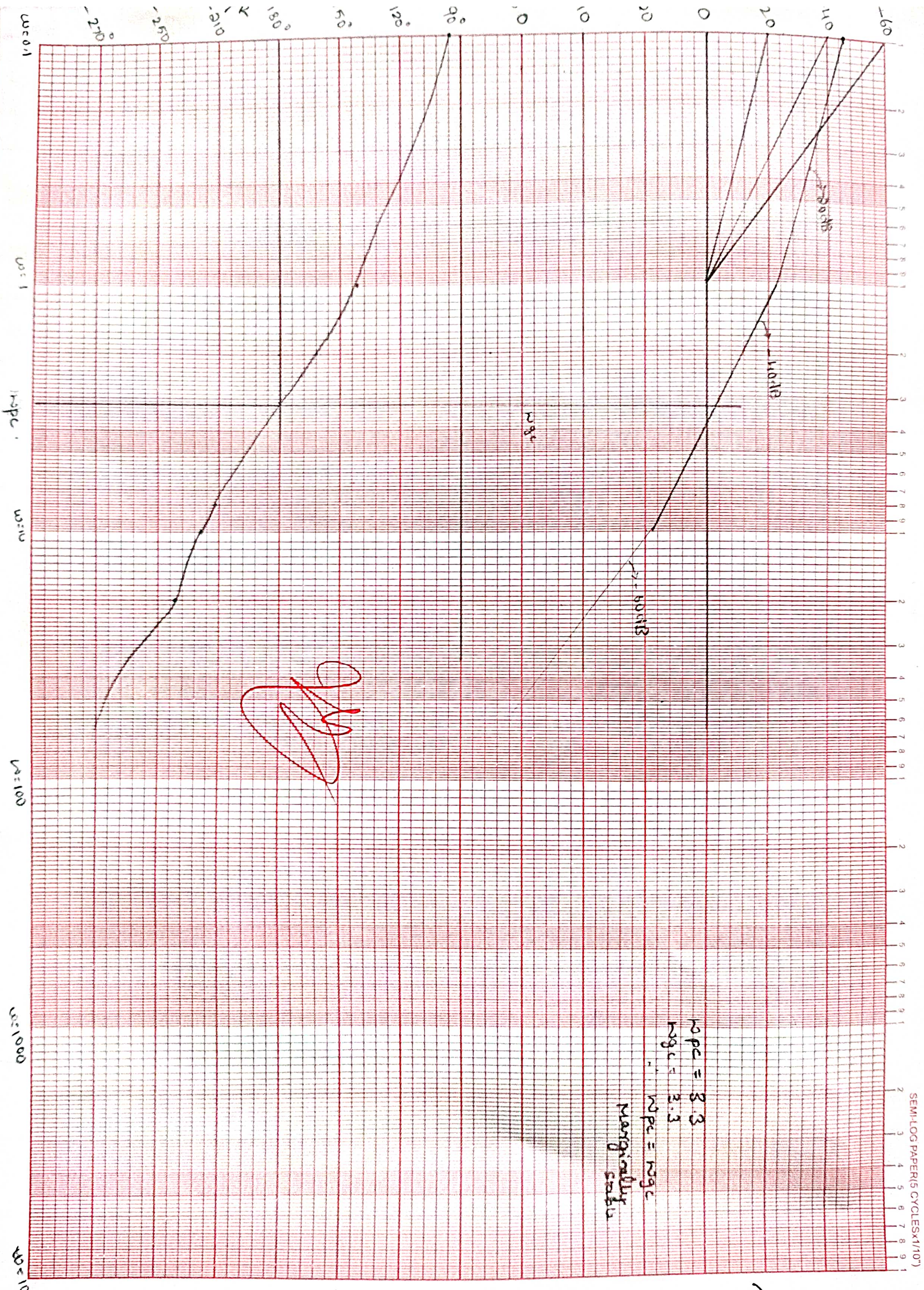
1) $K = 20 \Rightarrow 20 \log_{10} K = 20 \log_{10}(20) = 26.020$ dB/decade

2) No of poles at origin = 1.
3) Simple pole, $\frac{1}{S}$ = -20 dB/decade $\omega = 0.1$.

4) simple pole, $\frac{1}{1+0.1S} = T_1 = 0.1$, $\omega c_2 = \frac{1}{0.1} = 10$ dB/decade
$-20-20 = -40$ dB/decade.

Step 3: Magnitude of poles.

Range of ω.	$0.1 < \omega < 10$	$1 < \omega < 10$	$10 < \omega < \infty$
Resultant.	-20 dB	-40 dB	-60 dB



1KS19ME005 → 1a).

Step4: Phase angle.

ω	$1/j\omega$	$-\tan^{-1}\omega$	$-\tan^{-1}0.1\omega$	ϕ_R
0.1	-90°	-5.71°	-0.572	-96.282
1	-90°	-45°	-5.71	-140.71
2	-90°	-63.43°	-11.30	-164.73
8	-90°	-82.87°	-38.65	-211.52
10	-90°	-84.28°	-45	-219.28
20	-90°	-87.13°	-63.43	-240.56
∞	-90°	-90°	-90°	-270°

06

$\omega_{gc} = 3.3$ rad/sec

1b) $$G(s) = \frac{80}{s(s+2)(s+20)}.$$

GM = ?

ω_{gc} = ? , ω_{pc} = ? comment on stability.

Step1: Arrange $G(s).H(s)$ in time form.

$$G.(s).H(s) = \frac{80}{s(2)(1+\frac{s}{2}).(20)(1+\frac{s}{20})}.$$

$$= \frac{\cancel{80}^{2}/\cancel{40}}{s(1+0.5s).(1+0.05s)}.$$

$$G(s).H(s) = \frac{2}{s(1+0.5s).(1+0.05s)}.$$

Step2 : Identify factor's.

1) $K = 2$. $20 \log K \Rightarrow 20 \log 2 = 6.02 \approx 6\,dB/decade$

2). No of poles at origin $= \frac{1}{s} = -20 dB/decade$.

3) Simple poles, $\frac{1}{1+0.5s} = T_1 = 0.5 \Rightarrow \omega_{c1} = \frac{1}{0.5} = 2 rad/sec$

$\Rightarrow -20 - 20 dB/sec \Rightarrow -40 dB/sec$.

4) Simple pole, $\frac{1}{1+0.05s} \Rightarrow T_2 = 0.05 \Rightarrow \omega_{c2} = \frac{1}{0.05} = 20 rad/sec$.

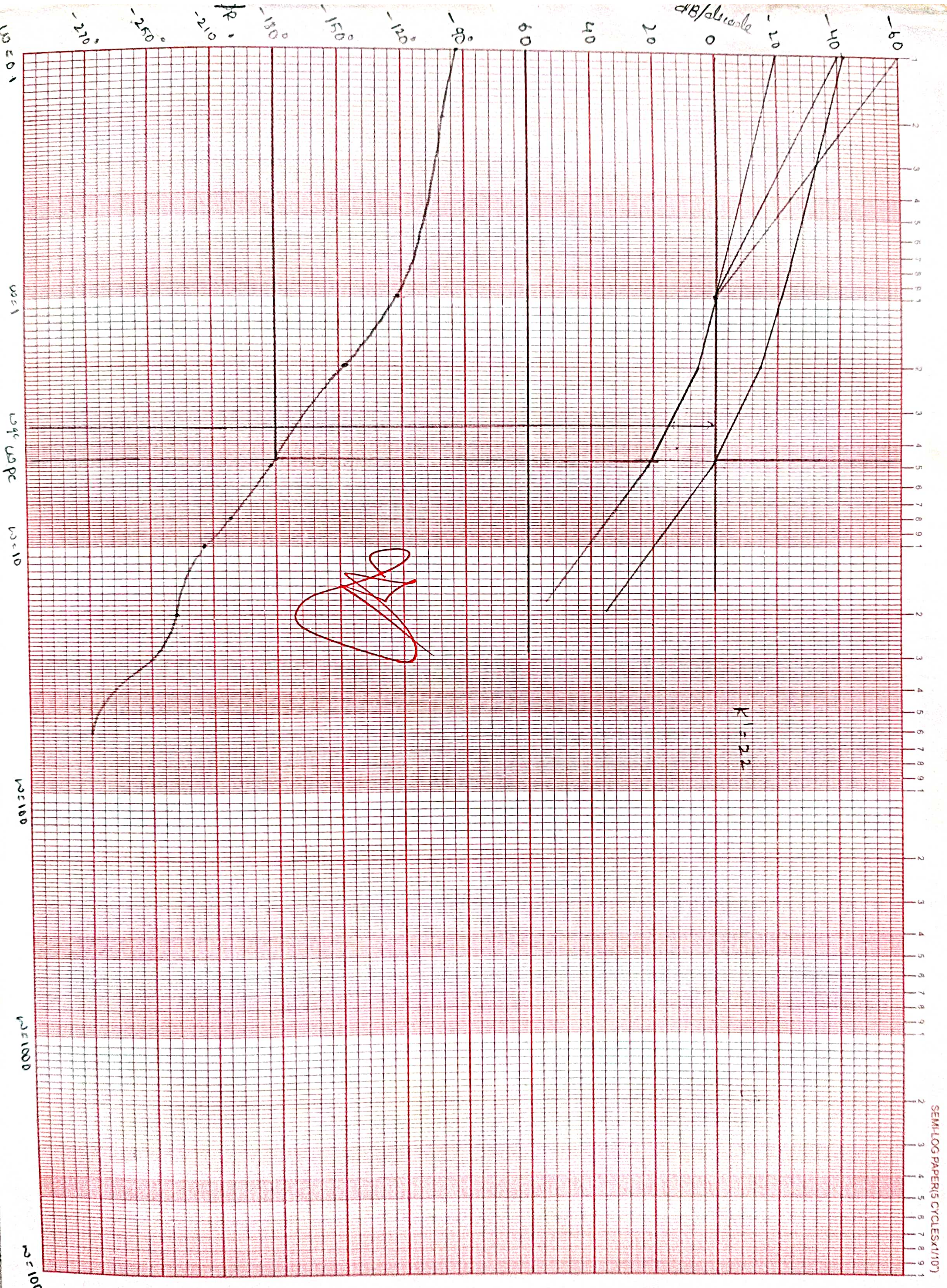
$-40 - 20 dB/sec = -60 dB/sec$.

Step3 = Magnitude of ω.

Range of ω	$0 < \omega < 2$	$2 < \omega < 20$	$20 < \omega < \infty$
Resultant.	-20	-40	-60.

Step4 : Phase angles.

ω	$1/j\omega$	$-\tan^{-1} 0.5\omega$	$-\tan^{-1} 0.05\omega$.	ϕ_R.
0.1	$-90°$	-2.86.	-0.28	-93.14
0.2	$-90°$	-5.71	-0.57.	-96.28.
1	$-90°$	-26.56	-2.86	-119.42
2.	$-90°$	-45	-5.71	-140.71
5	$-90°$	-68.19	-14.03	-172.22
8	$-90°$	-75.96.	-21.80	-187.76.
10	$-90°$	-78.69	-26.56	-195.25
20	$-90°$	-84.28	-45	-219.28
∞	$-90°$	$-90°$.	-90	$-270°$.



1KS19ME005 1c)

Gain Margin = 22dB / decade.
phase Margin = 41°
ω_{pc} = 6.8 rad/sec
ω_{gc} = 1.9 rad/sec.
as $\omega_{gc} > \omega_{pc}$.
The ~~Style~~ System is stable.

06

1c) $\frac{K}{S(S+2)(S+10)} = G(S)$.

Step: Arrange G(S).H(S) in time form.

$$G(S).H(S) = \frac{K}{S(2)(1+0.5S)\,10(1+0.1S)}.$$

$$G(S).H(S) = \frac{K/20}{S(1+0.5S).(1+0.1S)}.$$

12.53

Step2: ~~As~~ ~~Idefi~~ Identify factors.

1). $K' = \frac{K}{20} \Rightarrow 20\log_{10} K' = ?$

2). No of poles at origin = $\frac{1}{s} \Rightarrow -20$dB/decade at $\omega = 0.1$.

3) Simple poles = $\frac{1}{1+0.5s}$ = $T_1 = 0.5 \Rightarrow \omega_{c_1} = \frac{1}{T_1}$ ∴ $\omega_{c_1} = \frac{1}{0.5}$
ω_{c_1} = 2 rad/sec.

$\rightarrow \omega \Rightarrow -20dB - 20dB = -40dB$.

4) Simple poles = $\frac{1}{1+0.1s}$ = $T_2 = 0.5$ $\omega_{c_2} = \frac{1}{T_2} \Rightarrow \frac{1}{0.1}$ = 10 rad/sec

$\Rightarrow -40dB - 20dB = -60dB$.

Step3 : Magnitude of ω.

Range of ω	0 < ω < 2	2 < ω < 10	10 < ω < ∞
Resultant.	−20	−40	−60.

Step4 : Phase angles

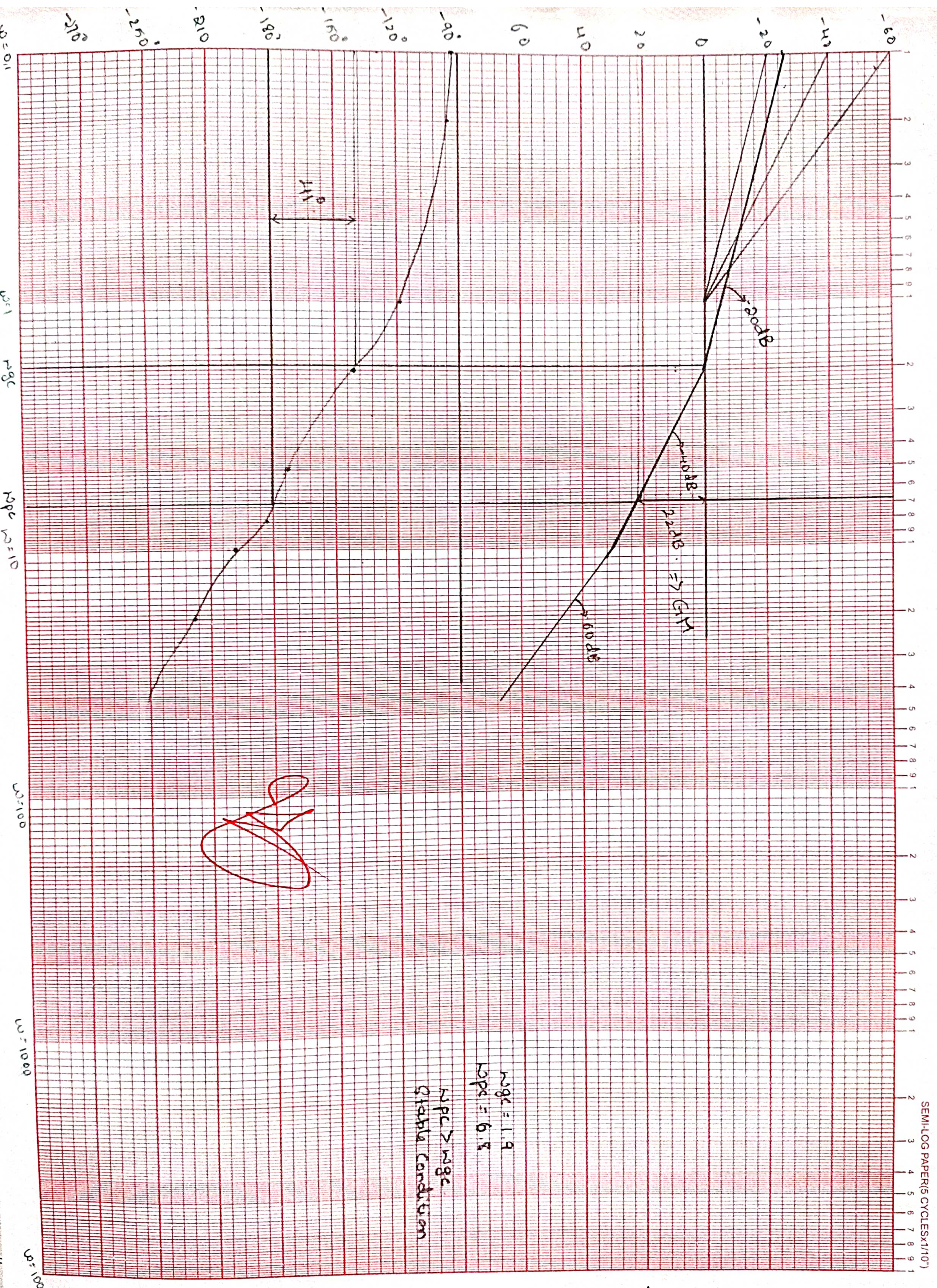
ω	$1/j\omega$	$-\tan^{-1}0.5\omega$	$-\tan^{-1}0.1\omega$	ϕ_R.
0.1	$-90°$	−2.86	−0.0572	−93.48
0.2	$-90°$	−5.71	−1.145	−96.85
1	$-90°$	−26.56	−5.71	−122.27
2	$-90°$	−45.	−11.30.	−146.3
5	$-90°$	−68.19	−26.56.	−184.75
8	$-90°$	−75.96	−38.65	−204.11
10	$-90°$	−78.69	−45	−213.69
20	$-90°$	−84.28	−63.43	−237.71
∞	$-90°$	$-90°$	$-90°$	$-270°$

$20 \log k' = 22.$

$k' = 12.58$

$\frac{K}{20} = 12.58 \quad K = 251.6.$

06



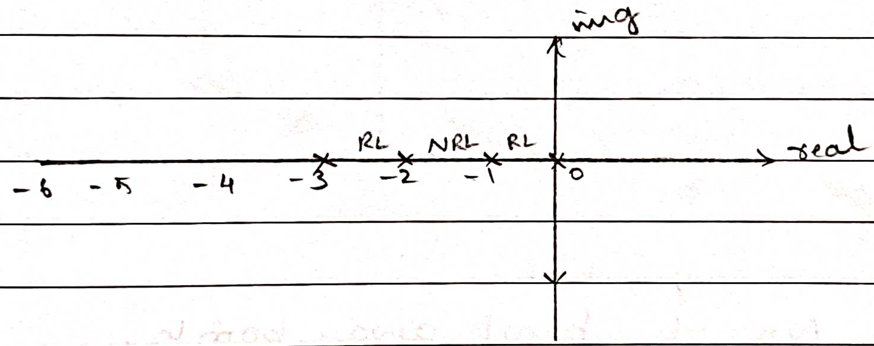
1KS19ME005 1b)

Part - B

4a) $G(s) \cdot H(s) = \dfrac{K}{s(s+2)(s+4)(s+6)}$.

→ No of poles = 4
No of zero's = 0.
~~Ini~~ Starting point of poles = 0, -1, -2, -3.
terminating points of poles = ∞, ∞, ∞, ∞.

Step 2:



Step 3: Angles of Assymtotes.

$$\theta = \frac{(2q+1) \times 180}{P-Z}.$$

$q_1 = 0 \quad \theta_1 \Rightarrow \dfrac{(2(0)+1) \times 180}{4-0} = 45^0.$

$q_2 = 1 \quad \theta_2 = \dfrac{(2(1)+1) \times 180}{4} = 135^0.$

$q_3 = 2 \quad \theta_3 = \dfrac{(2(2)+1) \times 180}{4} = 225^0$

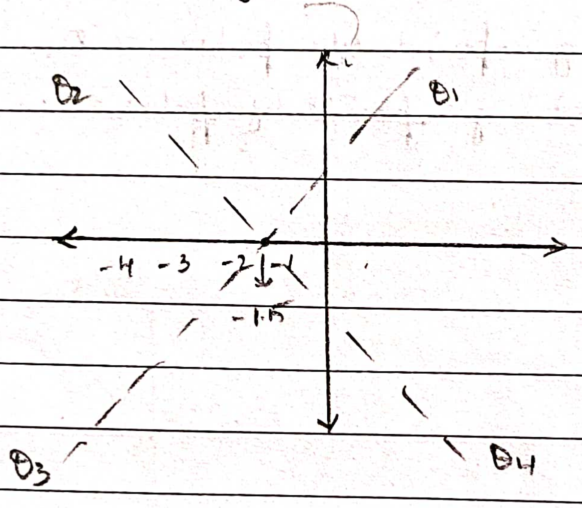
$q_4 = 2 \quad \theta_4 = \dfrac{(2(3)+1) \times 180}{4} = 315^0$

Step 4: Position of Centroid.

centroid = $\dfrac{\text{Sum of poles} - \text{Sum of zero}}{P-Z}$

$\Rightarrow \dfrac{0-1-2-3-0}{4} = \dfrac{-6\,3}{4\,2} = -1.5$

$\therefore$ The position of centroid $= -1.5$.



Step 5: No of break away points.

$1 + G(s)\cdot H(s) = 0.$

$1 + \dfrac{K}{s(s+2)(s+4)(s+6)} = 0$

$s(s+2)(s+4)(s+6) + K = 0.$

$(s^2+2s)(s+4)(s+6) + K = 0.$

$(s^3+2s^2+8s+4s^2)(s+6) + K = 0.$

$s^4+6s^3+2s^3+12s^2+8s^2+48s+4s^3+24s^2+K = 0.$

$s^4+12s^3+44s^2+48s+K = 0.$

$\dfrac{dK}{ds} = 4s^3+36s^2+88s+48+K = 0. \div 4.$

$\dfrac{dK}{ds} = s^3+9s^2+22s+12+K = 0.$

$K = -s^3 - 9s^2 - 22s + 12 = 0.$

~~$x' = 0$~~. $S_1 = 0.45$ $K = 0.18.$

$S_2 = -4.72$ $K = 421.49.$

$S_3 = -4.72$

: 05

23/30

26/12/22