Kammavari Sangham (R) 1952
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K.S. INSTITUTE OF TECHNOLOGY

Affiliated to VTU, Belagavi & Approved by AICTE, New Delhi, Accredited by NBA & NAAC
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To,
The Registrar Evaluation,
VTU, Belagavi
Respected Sir,

Date: 19-08-2022

Sub: Out of Syllabus questions in July 2022 BE Examination Question Paper – Request to give directions

As a faculty who taught this course in the current semester, I want to bring to your kind notice that 2 questions in the question paper are not there in the syllabus.

Sem: 6th
Branch: CSE
Course Code: 18CS645
Course Name: System Modelling and Simulation
Course type: Professional Elective Group 1
Prescribed text Book: Jerry Banks, John.S. Carson II, Barry L Nelson, Davis M Nicol: Discrete Event System Simulation, 5th Edition, Pearson Education 2010

Module – 3
Question No: 5 c) 9 Marks

c. Based on runs up and runs down, determine whether the following sequence of 40 numbers is such that the hypothesis of independence can be rejected where $\alpha = 0.05$, $z_{0.025} = 1.96$

0.41	0.68	0.89	0.94	0.74	0.91	0.55	0.62	0.36	0.27
0.19	0.72	0.75	0.08	0.54	0.02	0.01	0.36	0.16	0.28
0.18	0.01	0.95	0.69	0.18	0.47	0.23	0.32	0.82	0.53
0.31	0.42	0.73	0.04	0.83	0.45	0.13	0.57	0.63	0.29

(09 Marks)

OR

Runs Up and Down test is not in the 2018 Scheme Syllabus.
As per the syllabus and in the Text book only Kolmogorov Smirnov test and Chi-square test are available but not Runs test. **[The runs test was there in 2010 scheme syllabus and 3rd edition text book of the same Title and authors]**

Module -5
Question No. 9 c) ii) CPU Simulation 2 Marks

CPU simulation comes under the topic Simulation of Computer System which is replaced by a new topic Simulation of Networked Computer Systems in 5th edition book mentioned above. It should also be noted that Chapter 14 and its contents are not at all included any where in the new syllabus. Please give proper directions to valuation centers and see that the students who studied existing syllabus and wrote the examination will not be penalized.
Sir, As valuation will start soon, please do the needful as early as possible.

Enclosures: Syllabus and Question paper

Head of the Department
Dept. of Computer Science & Engg.
K.S. Institute of Technology
Bengaluru -560 109

PRINCIPAL
K.S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109.

CBCS SCHEME

USN | 18CS645

Sixth Semester B.E. Degree Examination, July/August 2022
System Modeling and Simulation

Time: 3 hrs. | Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Missing data may be suitably assumed.

Module-1

1 a. What is simulation? Explain with flowchart the steps involved in simulation study. **(08 Marks)**

b. A grocery store has one checkout counter. Customers arrive at this checkout counter at random from 1 to 8 min apart and each interval time has the same probability of occurrence. The service times vary from 1 to 6 minutes with probability given below:

Service (minutes)	1	2	3	4	5	6
Probability	0.10	0.20	0.30	0.25	0.10	0.05

Simulate the arrival of 6 customers and calculate:
(i) Average waiting time for a customer
(ii) Probability that a customer has to wait
(iii) Probability of a server being idle
(iv) Average service time

Use time between arrival and the following sequence of random numbers:

Random digits for arrival		913	727	015	948	309	922	753	235	302
Random digit for service time	84	10	74	53	17	79	91	67	89	38

Assume that the first customer arrives at time 0. Depict the simulation in a tabular form. **(12 Marks)**

OR

2 a. Define: (i) Discrete system (ii) Continuous system (iii) Stochastic system (iv) Deterministic system (v) Entity **(10 Marks)**

b. Consider the grocery store with one checkout counter. Prepare the simulation table for eight customers and find out average waiting time of customer in queue, idle time of server and average service time. The Inter Arrival Time (IAT) and Service Time (ST) are given in minutes.
IAT : 3, 2, 6, 4, 4, 5, 8
ST (min) : 3, 5, 5, 8, 4, 6, 2, 3
Assume first customer arrives at time t = 0. **(10 Marks)**

Module-2

3 a. Explain any two discrete distributions and give equations for probability mass function. Also calculate mean and variables of same. **(10 Marks)**

b. Hurricane hitting east cost of India follows Poisson with a mean of 0.8 per year. Determine:
(i) The probability of more than two hurricanes in one year.
(ii) The probability of exactly one hurricane in one year.
(iii) The probability of hurricane not hitting in a year. **(10 Marks)**

OR

4 a. Explain any two long run measures of performance of queuing systems. **(08 Marks)**

b. Explain Kendall's notation for parallel server queuing system A/B/C/N/K and also interpret meaning of M/M/2/∞/∞. **(07 Marks)**

c. List different queuing notations. **(05 Marks)**

SYSTEM MODELLING AND SIMULATION
(Effective from the academic year 2018 -2019)
SEMESTER – VI

Course Code	18CS645	CIE Marks	40
Number of Contact Hours/Week	3:0:0	SEE Marks	60
Total Number of Contact Hours	40	Exam Hours	03

CREDITS –3

Course Learning Objectives: This course (18CS645) will enable students to:

- Explain the basic system concept and definitions of system;
- Discuss techniques to model and to simulate various systems;
- Analyze a system and to make use of the information to improve the performance.

Module 1	Contact Hours
Introduction: When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation Simulation examples: Simulation of queuing systems. **General Principles.** **Textbook 1: Ch. 1, 2, 3.1.1, 3.1.3** **RBT: L1, L2, L3**	08
Module 2	
Statistical Models in Simulation :Review of terminology and concepts, Useful statistical models,Discrete distributions. Continuous distributions,Poisson process, Empirical distributions. **Queuing Models:**Characteristics of queuing systems,Queuing notation,Long-run measures of performance of queuing systems,Long-run measures of performance of queuing systems cont…,Steady-state behavior of M/G/1 queue, Networks of queues, **Textbook 1: Ch. 5,6.1 to 6.3, 6.4.1,6.6** **RBT: L1, L2, L3**	08
Module 3	
Random-NumberGeneration: Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers,Tests for Random Numbers, **Random-Variate Generation:** ,Inverse transform technique Acceptance-Rejection technique. **Textbook 1: Ch. 7,8.1, 8.2** **RBT: L1, L2, L3**	08
Module 4	
Input Modeling: Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models. **Estimation of Absolute Performance:** Types of simulations with respect to output analysis ,Stochastic nature of output data, Measures of performance and their estimation, **Contd..** **Textbook 1: Ch. 9, 11.1 to 11.3** **RBT: L1, L2, L3**	08
Module 5	
Measures of performance and their estimation,Output analysis for terminating simulations Continued..,Output analysis for steady-state simulations. **Verification, Calibration And Validation:** Optimization: Model building, verification and validation, Verification of simulation models, Verification of simulation models,Calibration and validation of models, Optimization via Simulation.	08

Textbook 1: Ch. 11.4, 11.5, 10
RBT: L1, L2, L3

Course Outcomes: The student will be able to :

- Explain the system concept and apply functional modeling method to model the activities of a static system
- Describe the behavior of a dynamic system and create an analogous model for a dynamic system;
- Simulate the operation of a dynamic system and make improvement according to the simulation results.

Question Paper Pattern:

- The question paper will have ten questions.
- Each full Question consisting of 20 marks
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Textbooks:

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5 th Edition, Pearson Education, 2010.

Reference Books:

1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.
2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw-Hill, 2007

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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	[signature]	[signature]	[signature]	**Total** 37

NAME OF FACULTY : Dr. M. Umashankar

SIGNATURE OF FACULTY : [signature]

SIGNATURE OF H.O.D : [signature] 3/1/23

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First Internal Test

Q. No	Marks	CO	Q. No	Marks	CO	CO	Total
1(a)	06	CO1	3(a)		CO2	CO1 -	16
1(b)	06	CO1	3(b)		CO2		
1(c)	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.

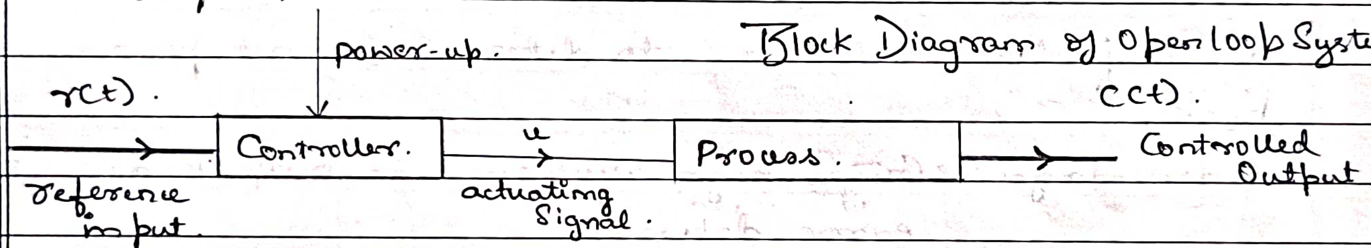
1a) Control system: Control means to regulate or direct or to command.

Hence control system is defined as arrangement of different physical components in such a way ~~that~~ / manner so is 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.

To 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

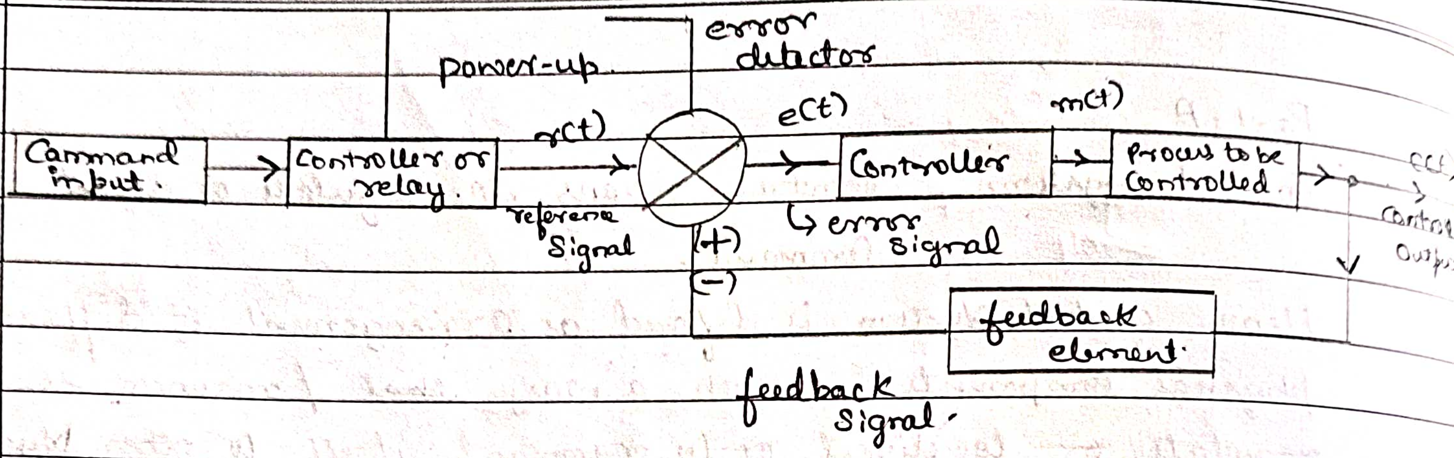
• Convient to use.

• 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 being

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.

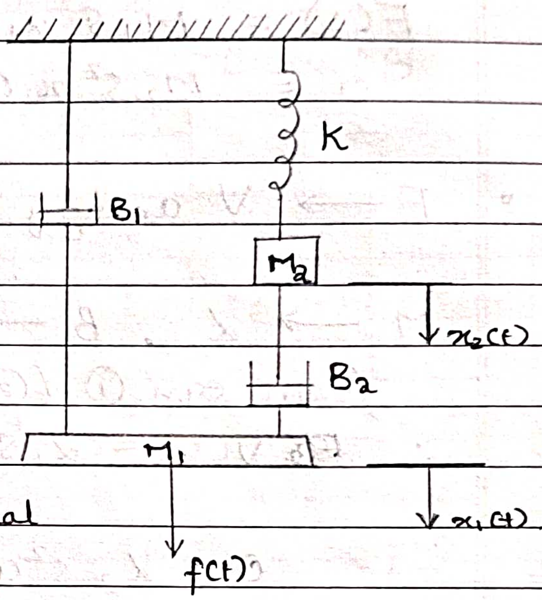
1b) To obtain:

• F - I } analogy.

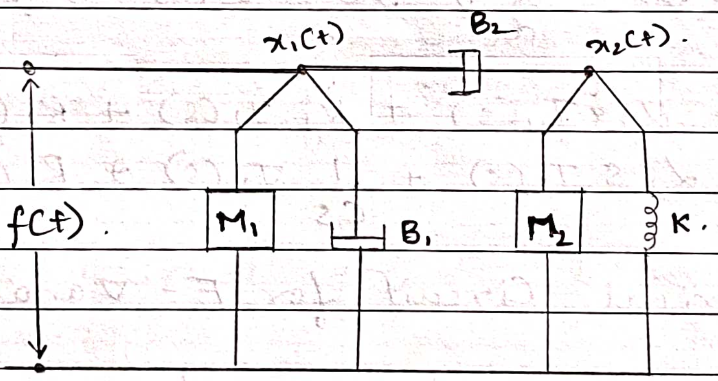
• F - V

• 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 ⟶ V analogy (Loop analysis).

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

from eqn (1) & (2).

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

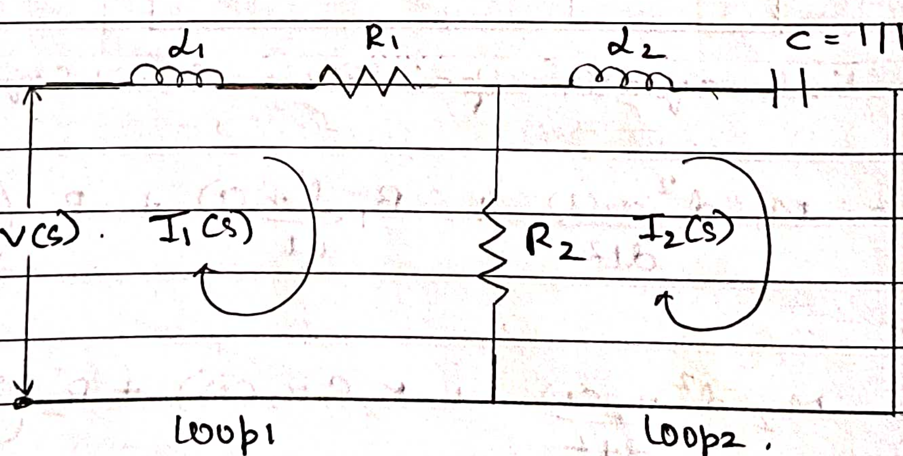
$$0 = L_2 s^2 q_2(s) + \frac{1}{C} q_2(s) + R_2(s q_2(s) - s q_1(s)).$$

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

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

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

∴ 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.

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

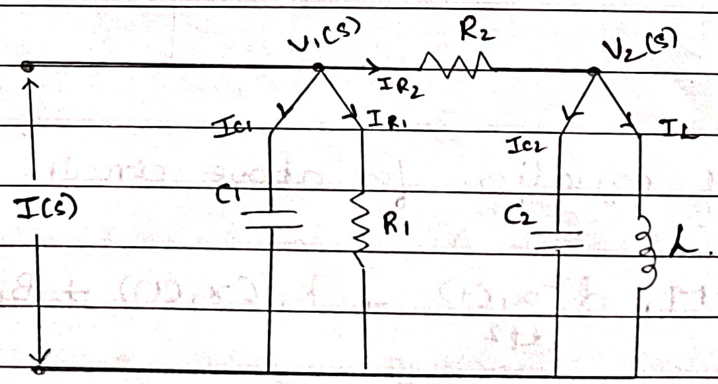
$$0 = C_2 s^2 \phi_2(s) + \frac{1}{L}\phi_2(s) + \frac{1}{R_2}(s\phi_2(s) - s\phi_1(s)).$$

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

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

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

Electrical Circuit for $F \rightarrow I$ analogy.



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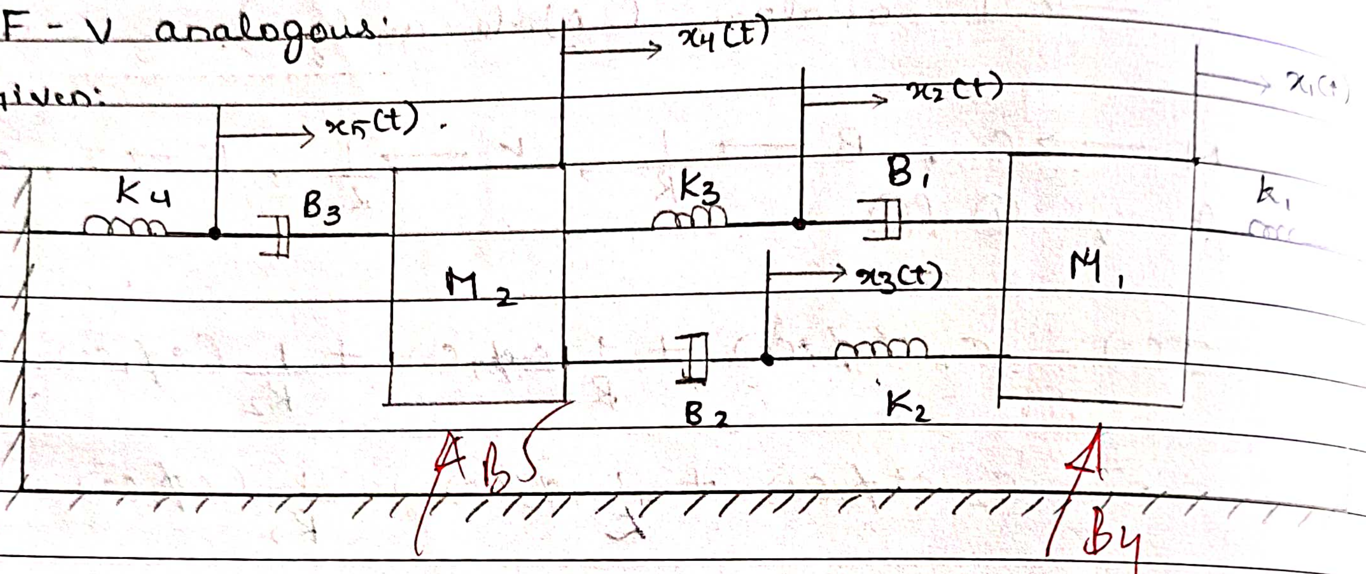
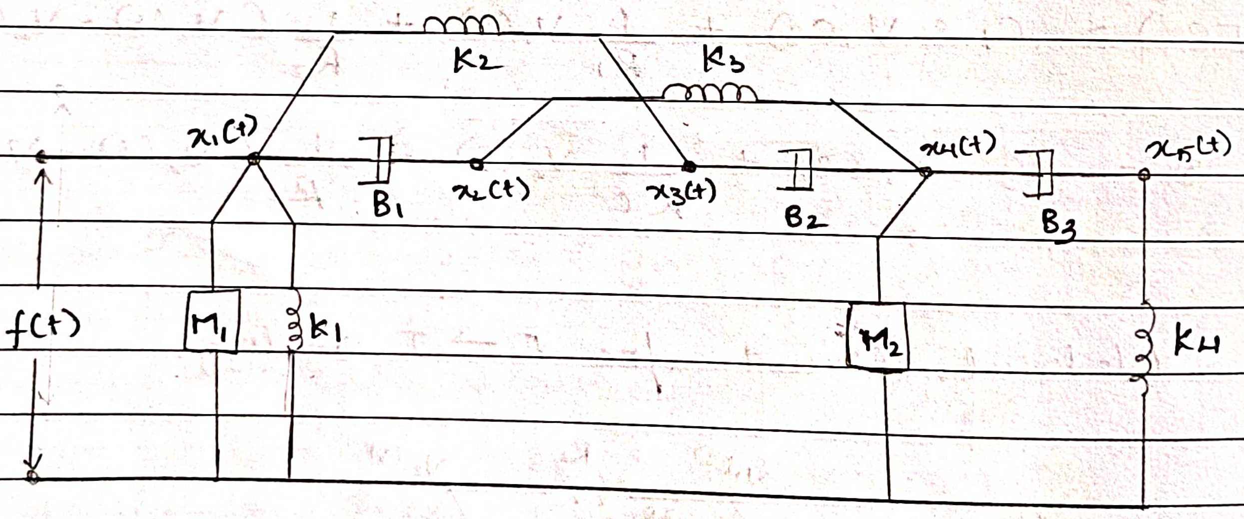
1c) F - V analogous:

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.

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

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

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

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

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

for the above equation apply.

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

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

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

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

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

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

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

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

~~Electrical Circuit for F-V analogy.~~

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

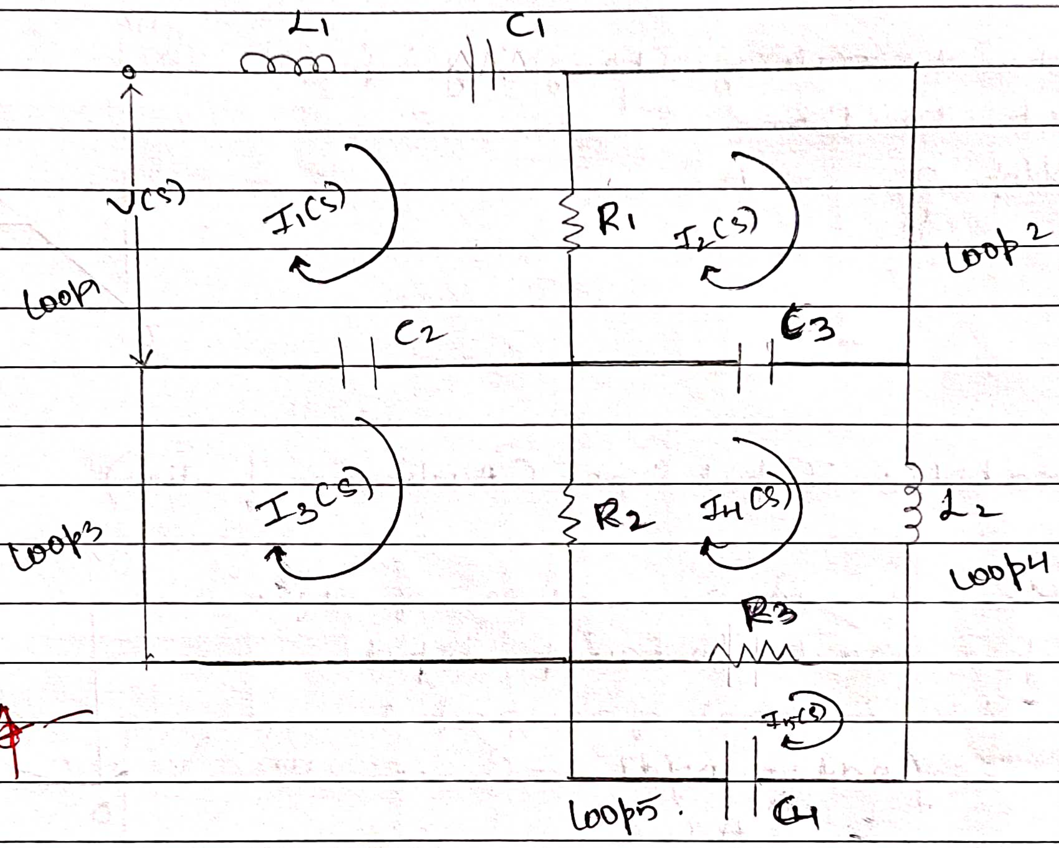
$$0 = R_1 (I_2(s) - I_1(s)) + \frac{1}{C_3 s}(I_2(s) - I_4(s)).$$

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

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

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

Electrical ~~equival~~ Circuit for F → V.



04

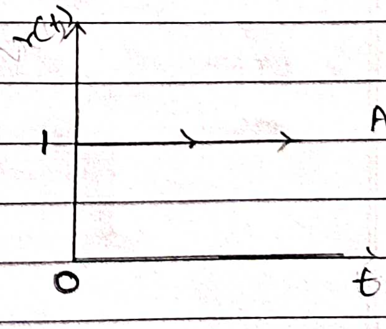
Part - B:

4a) Different input Signals are.

• Step input Signal (position function).

Where sudden application of input is Given

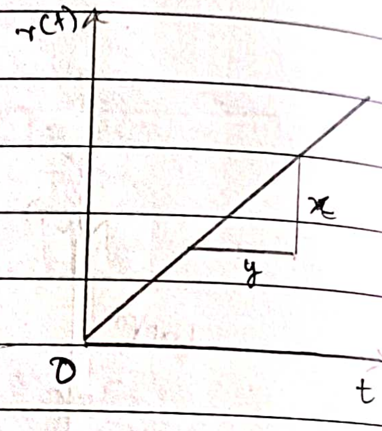
A dt = u(t) = 1 = A.



ii) Ramp Input Signal (Velocity function).

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

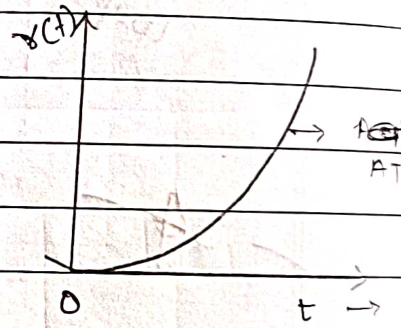
Slope $\frac{x}{y} = A$.



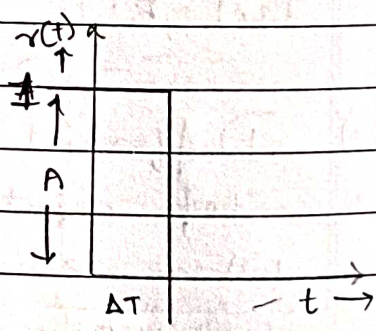
iii) Parabolic Input Signal. (Acceleration function)

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.
Instantaneous increase in amplitude at a given interval of time.



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4b) Steady state error.

Differential equation for 1st 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

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

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

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

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

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

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

for $(A+BT)s$

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

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

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

Substituting (2), (3) & (4) in (1).

06 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.

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

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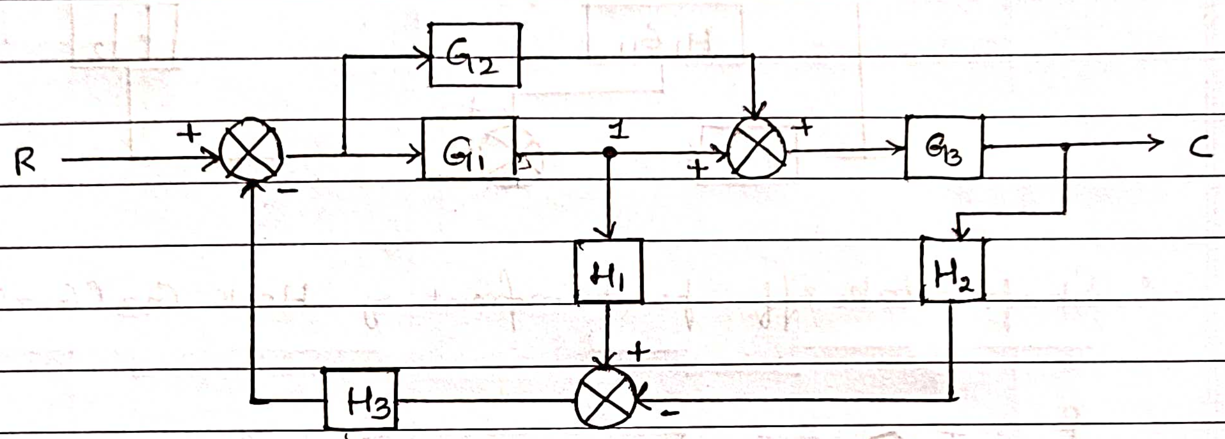
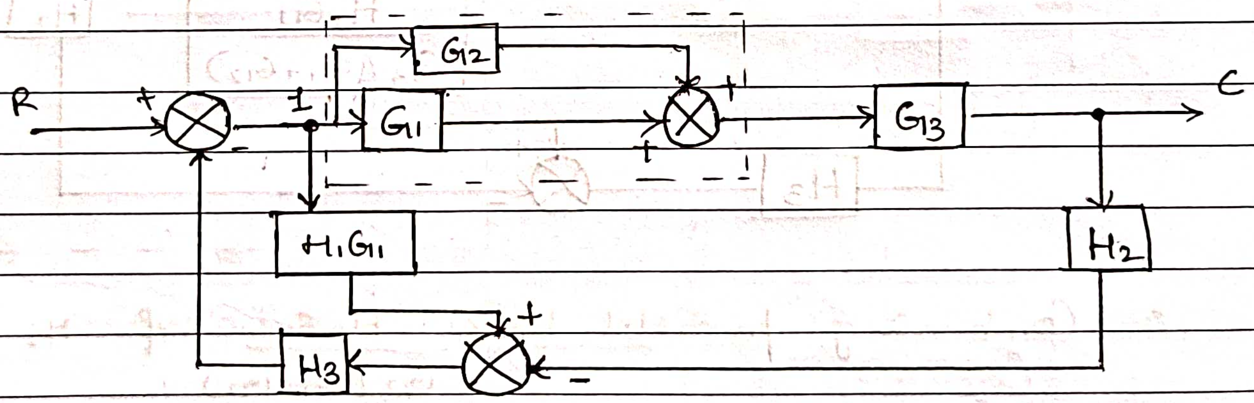
Internals - II.

Part - A.

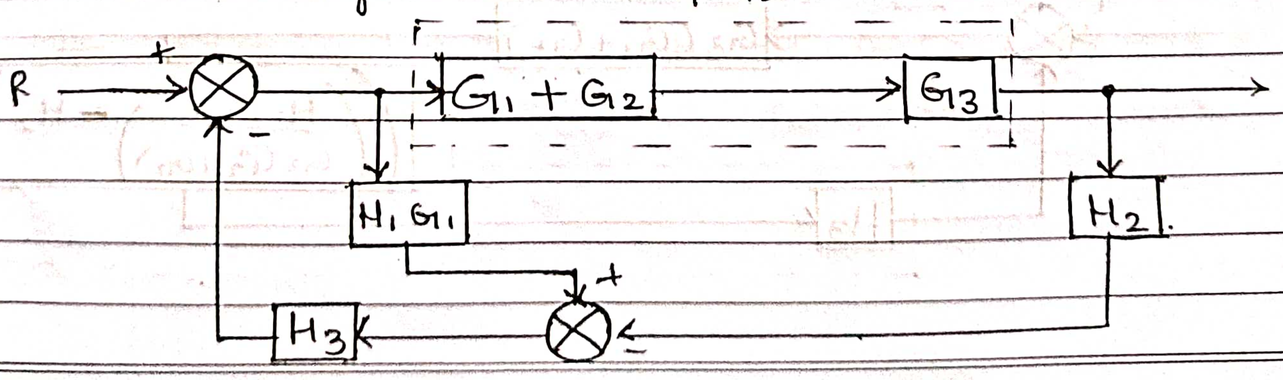
1a) Given.



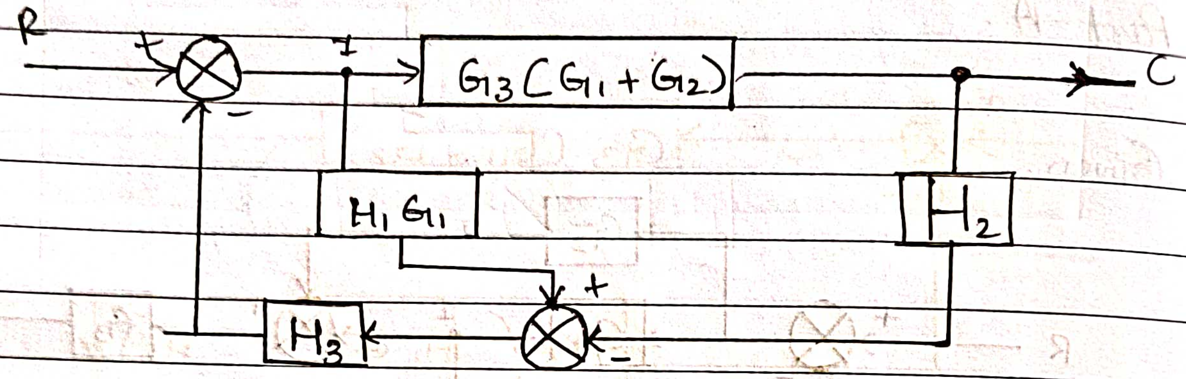
• Shifting take off point 1 Ahead of block G1.



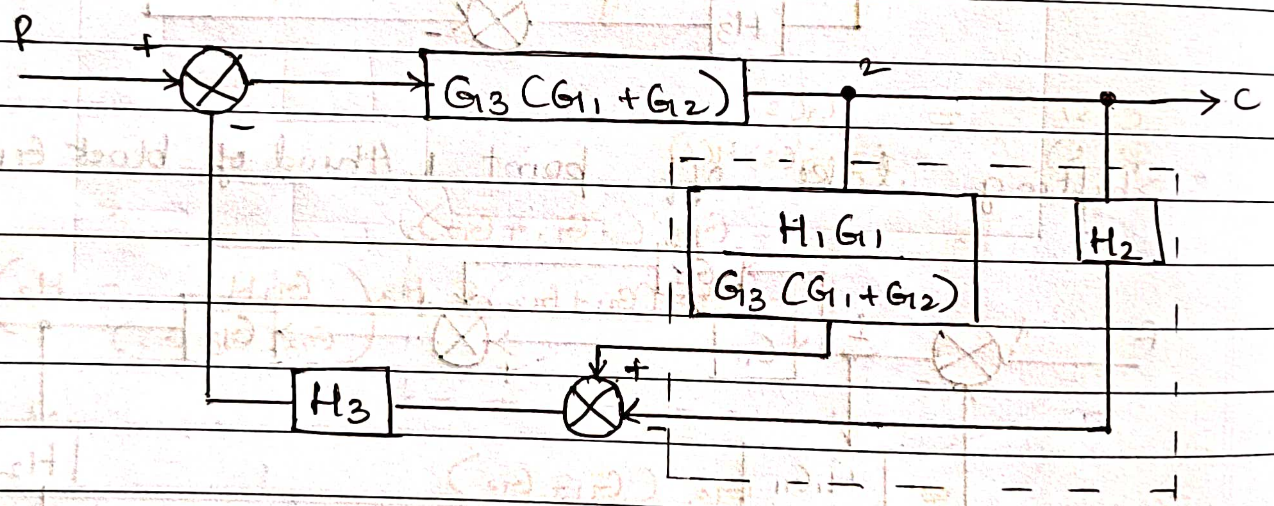
• Combining block G1 & G2.



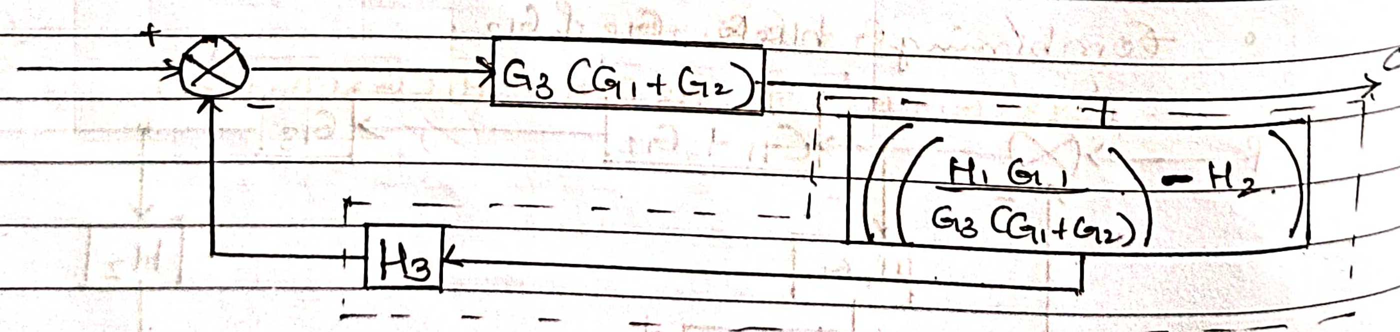
- Combining block $[G_1+G_2]$ & $[G_3]$



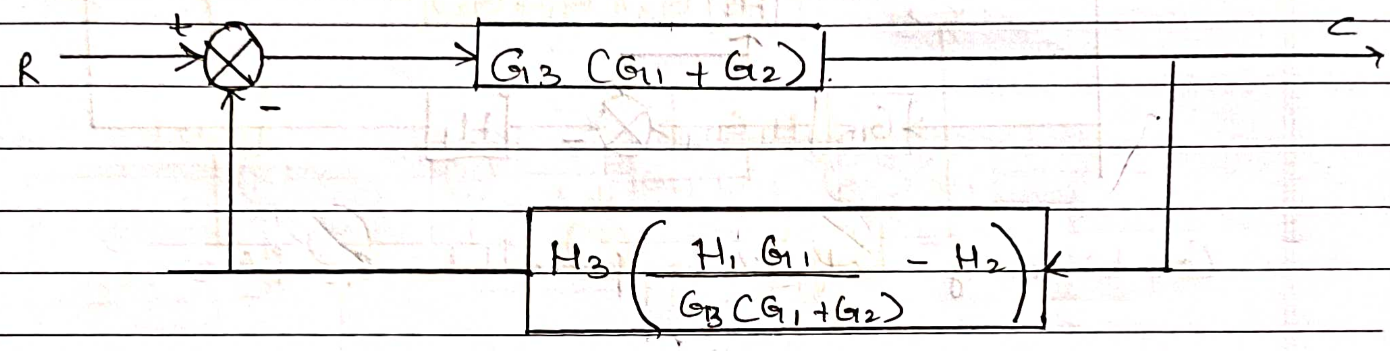
- Shaft take off point infront of block $G_3(G_1+G_2)$.



- Combining parallel blocks $\frac{H_1G_1}{G_3(G_1+G_2)}$ & H_2.



- Combining two blocks in Series $\frac{H_1G_1}{G_1(G_2+G_3)} - H_2$ & H_3



Now solving Minor feedback loop, we get.

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

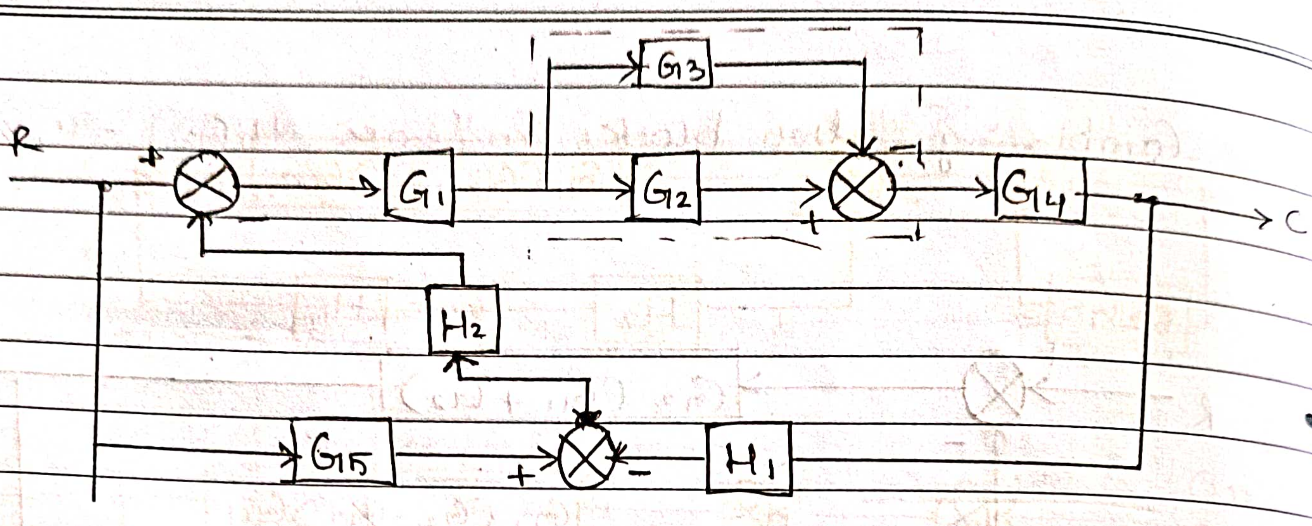
$$= \frac{G_3(G_1+G_2)}{1 + G_3(G_1+G_2)\cdot H_3\left(\frac{G_1H_1}{G_3(G_1+G_2)} - H_2\right)}$$

$$\Rightarrow \frac{G_3(G_1+G_2)}{G_3(G_1+G_2) + G_3(G_1+G_2)\cdot \frac{H_3G_1H_1}{G_3(G_1+G_2)} - H_2(G_3(G_1+G_2))}$$

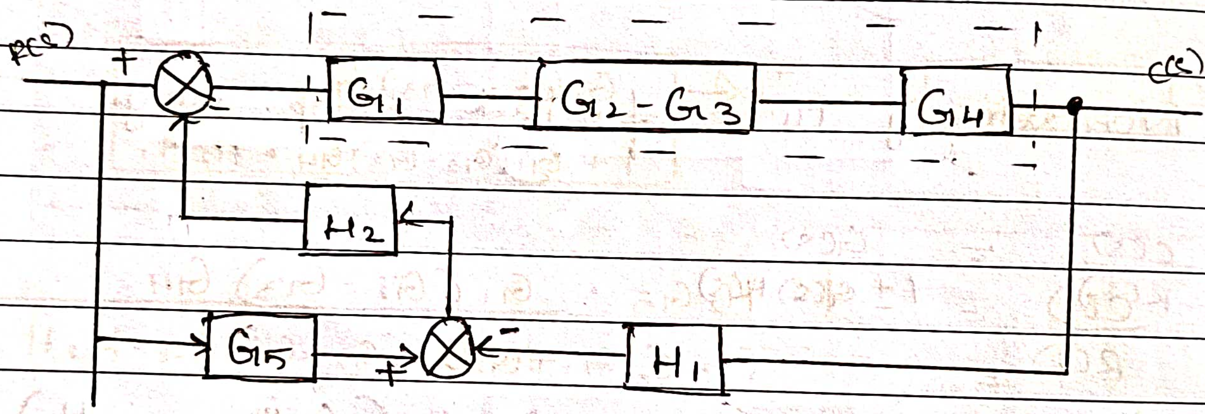
$$\Rightarrow \frac{G_3(G_1+G_2)}{G_3(G_1+G_2) + H_3G_1H_1 - H_2(G_3(G_1+G_2))} = \frac{C(s)}{R(s)}.$$

06

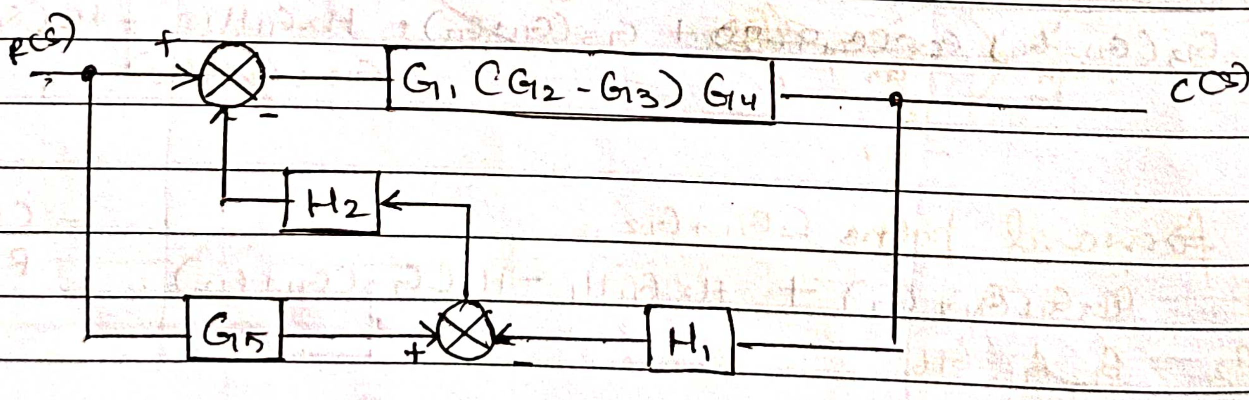
b)



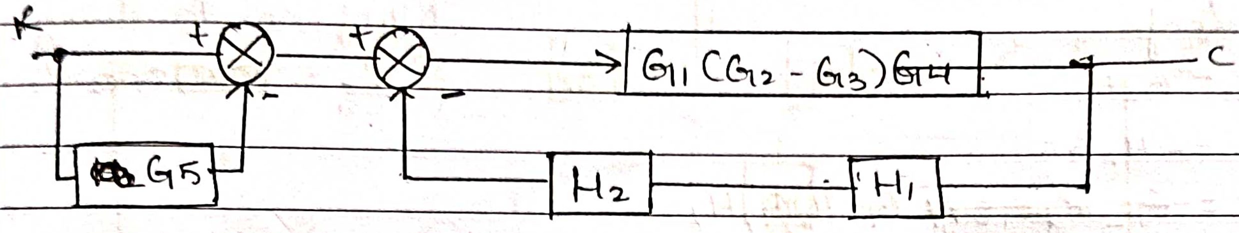
Combining blocks in parallel. G_2 & G_3

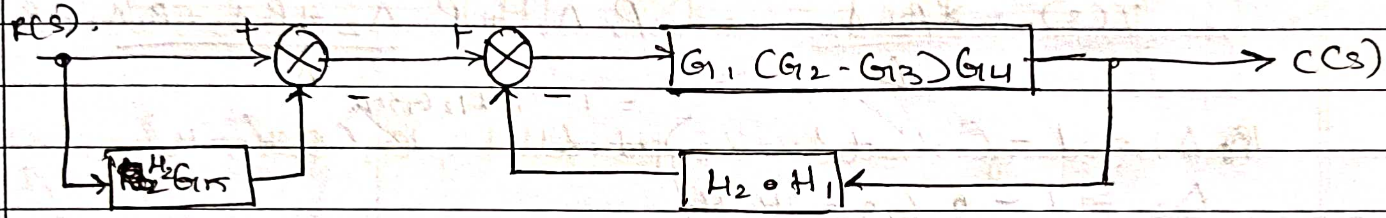


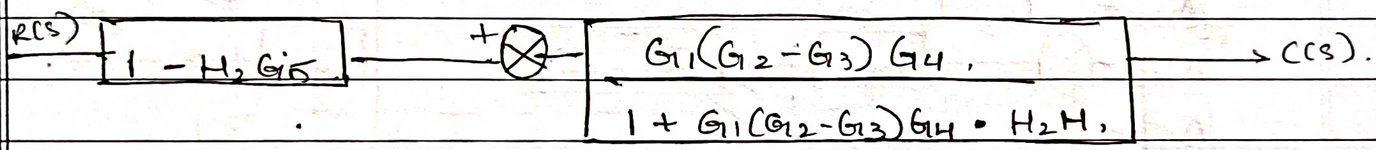
Combining blocks G_1, $G_2 - G_3$ & G_4 in Series.



- Splitting Summing point.



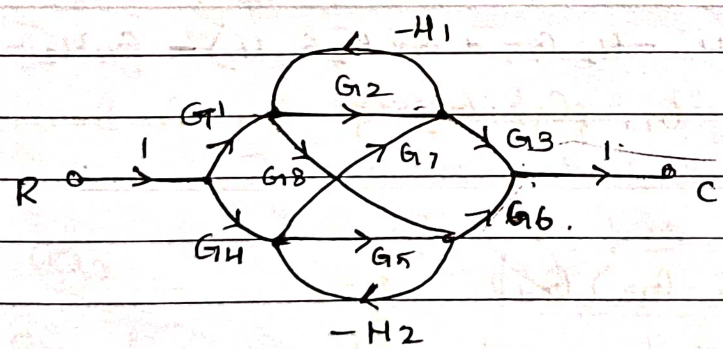




06

$$\frac{C(s)}{R(s)} = 1 - H_2 G_5 \cdot \frac{G_1(G_2-G_3)G_4}{1+G_1(G_2-G_3)G_4 \cdot H_2 H_1} \quad //$$

c)



forward paths.

$P_1 = G_1 G_2 G_3$

$P_2 = G_2 G_5 G_6$

$P_3 = G_1 G_8 G_6$.

$P_4 = G_4 G_7 G_3$.

$P_5 = -G_1 G_2 H_1 G_8 G_6$

$P_6 = -G_4 G_5 H_2 G_7 G_3$

Loops

$L_1 = -G_2H_1$

$L_2 = -H_2G_5$.

$L_3 = -~~G_{12}H_1G_8H_1~~ G_8H_2G_7H_1$

No of non touching loops =

$L_0 = ~~G_2H_1G_5H_2~~ L_1 \cdot L_2$

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

$= 1 - G_8H_2G_7H_6$.

$\Delta_1 = 1 - (L_1 + L_2 + L_3) + L$. $= 1 - (G_2H_1 - H_2G_5 - G_8H_2G_7H_1) + L_1L_3$

$\Delta_2 = 1 - G_8G_7H_2H_6$.

$\Delta_3 = 1$

$\Delta_4 = 1$

$\Delta_5 = 1$

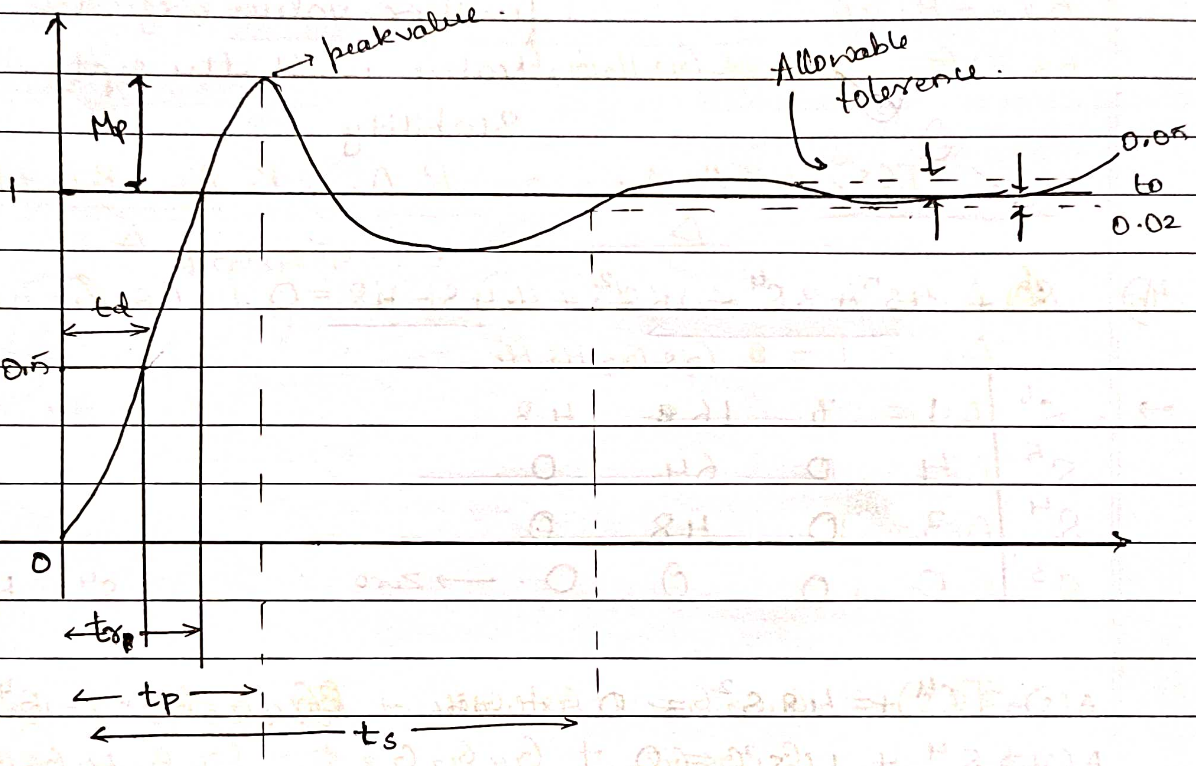
$\Delta_6 = 1$

$$T(s) = \frac{G_1G_2G_3 \cdot 1 - G_8H_2G_7H_6 + G_4G_5G_6 \cdot 1 - G_8G_7H_2H_6 + G_1G_8G_6 + G_4G_7G_3 - G_1G_2H_1G_8G_6 - G_4G_5H_2G_6}{1 - (-G_2H_1 - H_2G_5 + G_8H_2G_7H_1) - G_2H_2 - H_2G_5}$$

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

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.

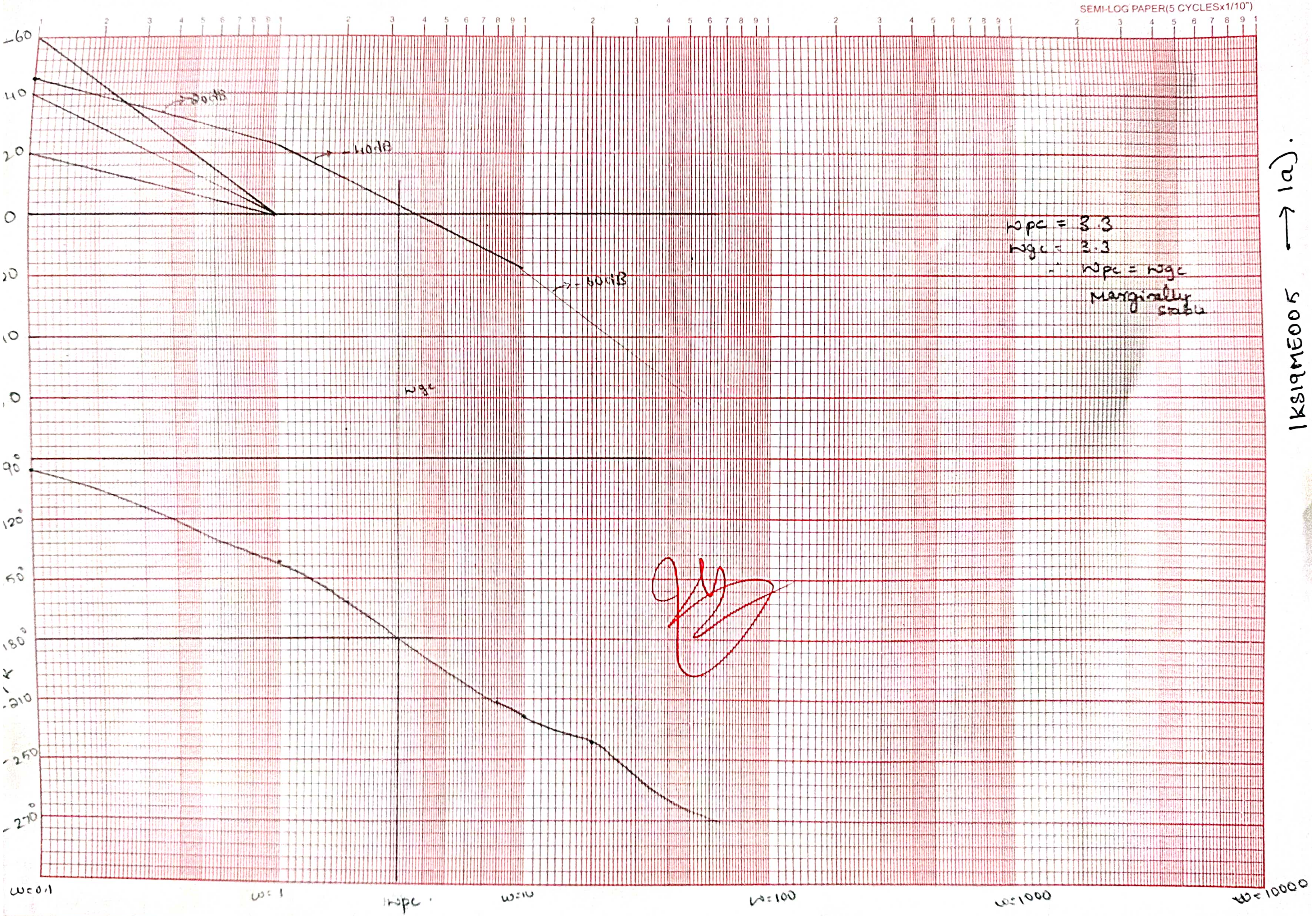
1) $K = 20 \Rightarrow 20\log_{10} K = 20\log_{10}(20) = 26.020$ dB/decade

2) No of poles at origin = 1.
3) Simple pole; $\frac{1}{S}$ = -20dB/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.	-20dB	-40dB	-60dB



1KS19ME005 → 1a).

Step4: Phase angle.

ω	1/jω	−tan⁻¹ 0.5ω	−tan⁻¹ 0.1ω	ϕR
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

ω_{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.

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

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

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

Step2: Identify factor's.

1) K = 2. 20 log k => 20 log 2 = 6.02 ≈ 6 dB/decade

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

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

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

4) Simple pole, $\frac{1}{1+0.05s} \Rightarrow T_2 = 0.05 \Rightarrow \omega_{c_2} = \frac{1}{0.05}$ = 20rad/sec.

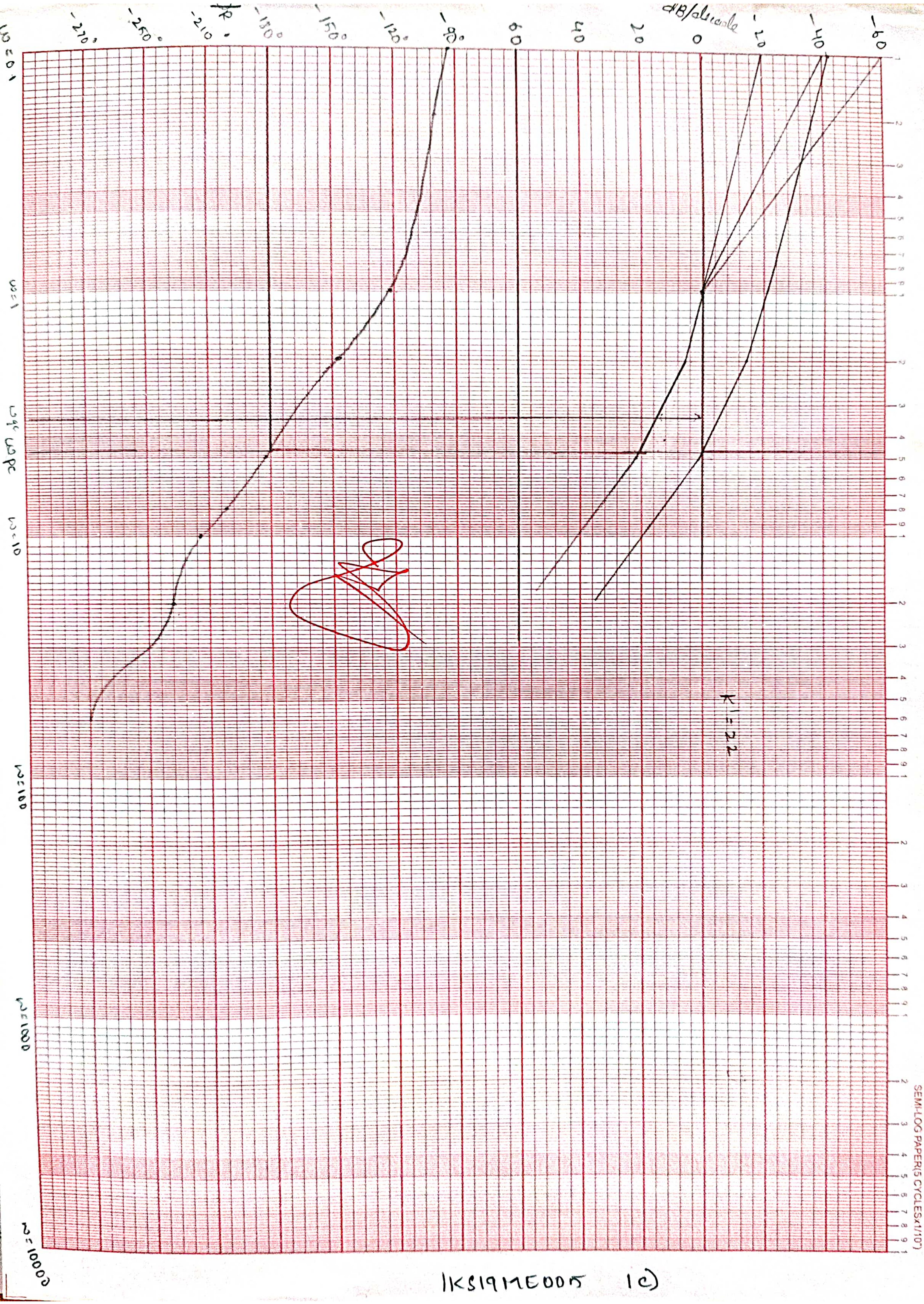
-40 - 20dB/sec = -60dB/sec.

Step3 = Magnitude of ω.

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

Step4: Phase angles.

ω	1/jω	$-\tan^{-1} 0.5\omega$	$-\tan^{-1} 0.05\omega$.	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.

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

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

12.53

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

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

2). No of poles at origin = $\frac{1}{s}$ ⇒ −20dB/decade at ω = 0.1.

3) Simple poles = $\frac{1}{1+0.5S}$ = $T_1 = 0.5 \Rightarrow \omega c_1 = \frac{1}{T_1}$ ∴ $\omega c_1 = \frac{1}{0.5}$
ωc_1 = 2 rad/sec.
→ ω ⇒ −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
⇒ −40dB − 20dB = −60dB.

Step 3: Magnitude of ω.

Range of ω	$0 < \omega < 2$	$2 < \omega < 10$	$10 < \omega < \infty$
Resultant.	-20	-40	-60.

Step 4: Phase angles

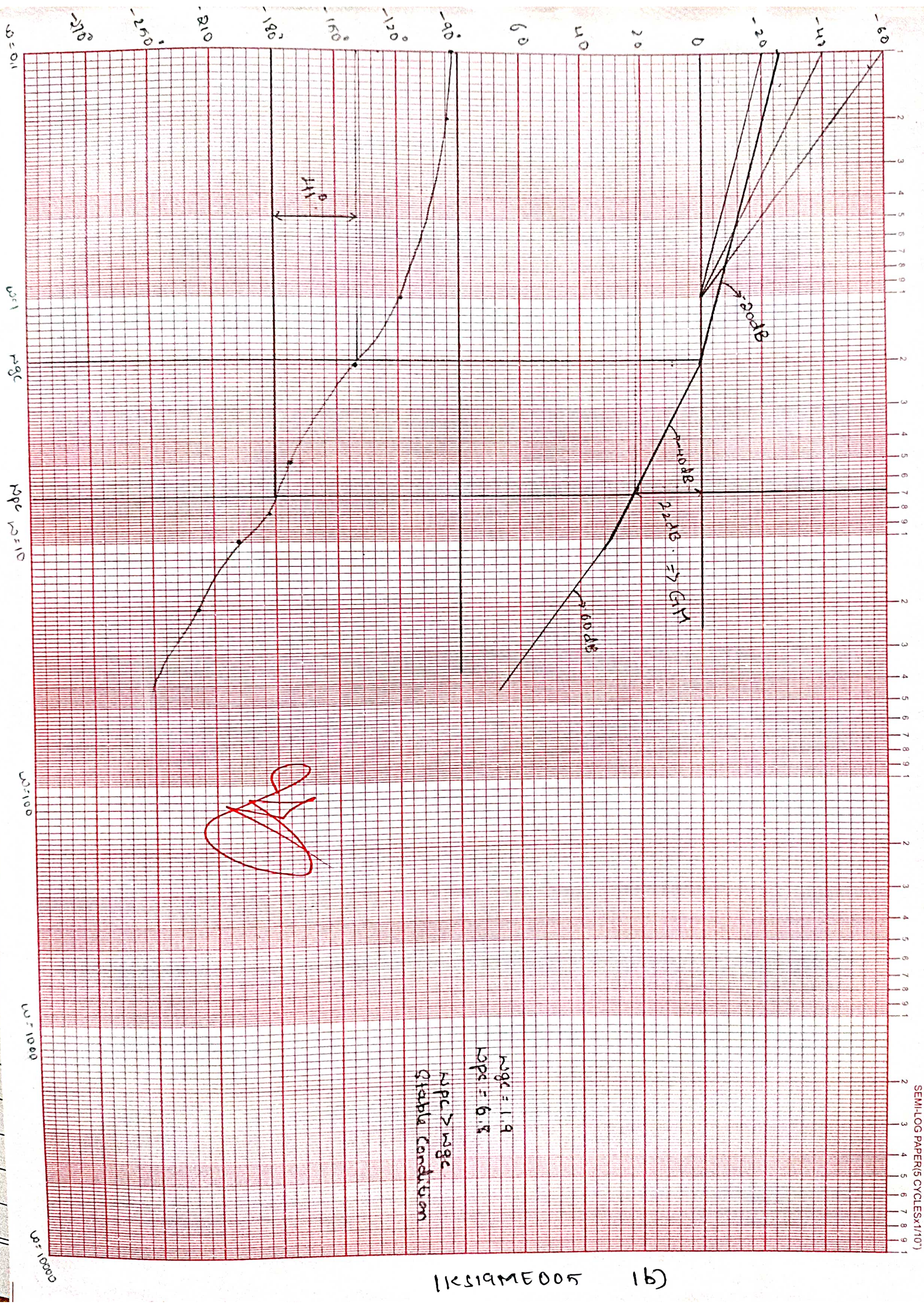
ω	$1/j\omega$	$-\tan^{-1}0.5\omega$	$-\tan^{-1}0.1\omega$	ϕ_R
0.1	-90°	-2.86	-0.572	-93.48
0.2	-90°	-5.71	-1.145	-96.85
1	-90°	-26.56	-5.71	-122.27
2	-90°	-45.	-11.30.	-146.3
5	-90°	-68.19	-26.56.	-184.75
8	-90°	-75.96	-38.65	-204.11
10	-90°	-78.69	-45	-213.69
20	-90°	-84.28	-63.43	-237.71
∞	-90°	-90°	-90°	-270°

$20 \log k' = 22.$

$k' = 12.58$

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

06



1KS19ME005 1b)

Part - B

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

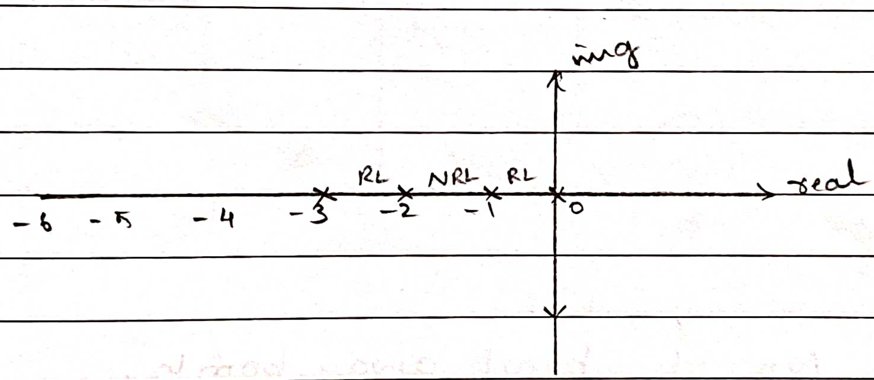
→ No of poles = 4

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.

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

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

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

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

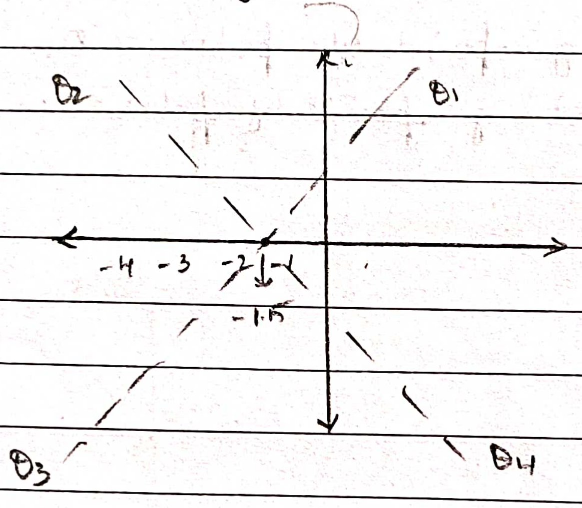
$q_4 = 2 \quad \theta_4 = \dfrac{(2(3)+1) \times 180}{4} = 315^0$

Step 4: Position of Centroid.

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

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

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



Step 5: No of break away points.

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

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

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

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

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

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

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

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

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

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

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

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

$S_3 = -4.72$

: 05

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26/12/22