Alva's Institute of Engineering & Technology

Shobhavana Campus, Mijar, Moodbidri, D.K – 574225

Phone: 08258-262725, Fax: 08258-262726

DEPARTMENT OF MECHANCAL ENGINEERING

Course File

Course Name	:	**Control Engineering**
Course Code	:	**18ME71**
Academic Year	:	**2023-24**
Semester	:	**VII**
Name of the Course Coordinator	:	**Dr. Pramod V Badyankal**

Name and Signature of HOD with Date

H.O.D.
Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225

Signature of Course Coordinator with Date

18/1/24

ALVA'S INSTITUTE OF ENGINEERING & TECHNOLOGY
(A Unit of Alva's Education Foundation)
Shobhavana Campus, Mijar-574225, Moodbidri, D.K
Phone: 08258-262725, Fax: 08258-262726
Affiliated to VTU Belagavi and Approved by AICTE, New Delhi, Recognized by Govt. of Karnataka

ATTENDANCE BOOK

Academic Year : 2023 - 24

Semester : 7 Section ……

Period of the Semester : From 11/9/23 to 06/01/24

Subject with Code : 18ME71 [Control Engineering]

Name of the Faculty : Pramod V.B

Department : Mechanical Engineering

VISION OF THE INSTITUTE

"Transformative education by pursuing excellence in Engineering and Management through enhancing skills to meet the evolving needs of the community"

MISSION OF THE INSTITUTE

- To bestow quality technical education to imbibe knowledge, creativity and ethos to students community.
- To inculcate the best engineering practices through transformative education.
- To develop a knowledgeable individual for a dynamic industrial scenario.
- To inculcate research, entrepreneurial skills and human values in order to cater the needs of the society.

DEPARTMENT OF MECHANICAL ENGINEERING
ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY
Shobhavana Campus, Mijar-574 225, Moodbidri.
Dakshina Kannada, Karnataka, INDIA.
Email: aietmech08@gmail.com

VISION OF THE DEPARTMENT

Impart Quality Technical Education to excel in Mechanical Engineering to meet the needs of the community.

MISSION OF THEDEPARTMENT

1. Empower Student knowledge in basic and applied areas of Mechanical Engineering.
2. Strengthening collaboration with industries, research organisations and institutes for internship, joint research and consultancy.
3. To inculcate entrepreneurial skills and human values in order to cater the needs of society.
4. Exposure to industrial practices for managerial skills & professionalism

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Provide opportunity for the students to expand knowledge in mechanical engineering.
2. Be able to provide solutions for technical and social problems through research and innovation.
3. Educate students to develop continuous learning attitude, ethics and values.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Will be able to analyse, interpret and provide solutions to engineering and social problems.
2. Adapt to the dynamic challenges and scenario in the industries.

Updated on 16.04.2020/28092020

B. E. MECHANICAL ENGINEERING Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER – VII			
CONTROL ENGINEERING			
Course Code	18ME71	CIE Marks	40
Teaching Hours / Week (L:T:P)	3:0:0	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To develop comprehensive knowledge and understanding of modern control theory, industrial automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyse a system using root locus plots.
- To study different system compensators and characteristics of linear systems.

Module-1

Introduction: Components of a control system, Open loop and closed loop systems.
Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers.
Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.

Module-2

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

Module-3

Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

Module-4

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus.

Module-5

Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

Assignment:

1.Study of On-Off Controller for Flow/ Temperature.
2. Study of Control Modes like P, PD, PI, PID for Pressure / Temperature / Flow.
3. Assignment on Root Locus, Bode Plots and Polar Plots.
4. Use of Software 'MATLAB' on the above topics.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Identify the type of control and control actions.
CO2: Develop the mathematical model of the physical systems.
CO3: Estimate the response and error in response of first and second order systems subjected standard input signals.
CO4: Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
CO5: Analyse a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain.

CO6: Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.

Question paper pattern:

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

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Automatic Control Systems	Farid G., Kuo B. C	McGraw Hill Education	10th Edition,2018
2	Control systems	Manik D. N	Cengage	2017
Reference Books				
1	Modern control Engineering	K. Ogeta	Pearson	5th Edition, 2010
2	Control Systems Engineering	Norman S Nice		Fourth Edition, 2007
3	Modern control Systems	Richard C Dorf	Pearson	2017
4	Control Systems Engineering	IjNagrath, M Gopal	New Age International (P) Ltd	2018
5	Control Systems Engineering	S Palani	Tata McGraw Hill Publishing Co Ltd	ISBN-13 978007067193

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Department of Mechanical Engineering

SEMESTER-VII	
Course Code: 18ME71	Course Name: **CONTROL ENGINEERING**
Course Teacher: **Pramod V Badyankal**	

Course Outcomes: After studying this course, students will be able to,

CO Numbers	Course Outcomes	Blooms Level	Target Level
CO1	Understand concepts of feedback, automatic controls, compensation systems, controllability and observability	Understand	3
CO2	Determine the system governing equations for physical models (Electrical, thermal, mechanical, electro mechanical)	Evaluate	3
CO3	Calculate the gain of system using Block diagram and signal flow graph	Analyse	3
CO4	Illustrate the response of 1st and 2nd order systems	Apply	2
CO5	Analyze the stability of control systems using Polar plots, Nyquist plot, Bode plots and Root locus plots	Analyze	3

CO-PO/PSO Mapping Matrix:

CO Numbers	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		2						2	1	2	
CO2	3	2	3	1							1	1	1	
CO3	2	2	3		2							1		2
CO4	1	2	3	2	3							1		2
CO5	1	2	3	2	3						3	1		2

Justification of Course Outcome and Program Outcome mapping:

CO	POs	Level	Justification, Students can
CO1	PO1	3	Applying the engineering knowledge to basic control systems
	PO3	1	Design solutions for complex engineering problems and design systems for the analyses of any error or stability
	PO5	2	Using appropriate techniques and resources for understanding the limitation associated with control systems
	PO11	2	Principles and apply to any automatic system to manage environments
	PO12	1	Life long learning ability to engage in independent technological changes
	PSO1	2	Interpret and provide solutions to engineering changes and social problems
CO2	PO1	3	For the particular problems of thermal, mechanical, and etc apply technique to complex engineering problems
	PO2	2	Design the systems based on the design and development of physical systems for the problem analysis
	PO3	3	Development the system for the safety to the society and environmental consideration
	PO4	1	Investigations the problems occurring in the complex system and interprete the data and synthesis to valid conclusions

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			leader to manage projects and in multidisciplinary environments
	PO12	**1**	**Change in the technology will change the rule and regulation and usuage to the system, so need to be updated.**
	PSO1	**1**	Interpret and provide solutions to engineering changes and social problems
CO3	**PO1**	**2**	For any system transfer can be calculated using block and signal flow diagram, to apply in engineering problems
	PO2	**2**	Analyse the problem in complex design components that meet the specified needs to the public and safety
	PO3	**3**	Design and develop complex engineering problems to solve any systems
	PO5	**2**	Create, select and apply appropriate techniques, resources and IT tools in understanding limitations for the systems
	PO12	**1**	Life long learning for change in the technology
	PSO2	**2**	Accepts the challenges in the industries
CO4	**PO1**	**1**	Applying the engineering knowledge to any first and second order systems
	PO2	**2**	Analyse the problem in complex design components that meet the specified needs to the public and safety
	PO3	**3**	Development the system for the safety to the machine systems.
	PO4	**2**	Investigate the complex problems and method to apply to solve first and second order problems
	PO5	**3**	Create, select and apply appropriate techniques, resources and IT tools in understanding limitations for the systems
	PO12	**1**	Life long learning for change in the technology
	PSO2	**2**	Accepts the challenges in the industries
CO5	**PO1**	**1**	Applying different technique to plot and analyse the stability of any control systems
	PO2	**2**	Identify and formulate and analyser complex engineering problems graphically
	PO3	**3**	Development the system for the safety to the machine systems.
	PO4	**2**	Investigate the complex problems and method to check for stability in the systems
	PO5	**3**	Create, select and apply appropriate techniques, modern technique for the determination of the stability in the system
	PO11	**3**	Applying methods to own application and work as a leader to manage projects and in multidisciplinary environments
	PO12	**1**	Life long learning for change in the technology
	PSO2	**2**	Accepts the challenges in the industries

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Course Teacher
Signature with date

IQAC Member
Signature with date

IQAC Chairman
Signature with date

H.O.D.
Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225

USN | | | | | | | | | | |

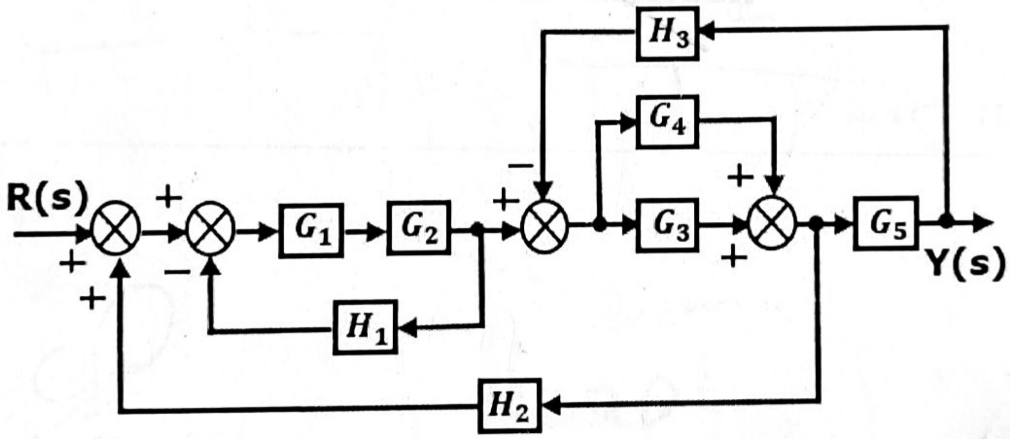
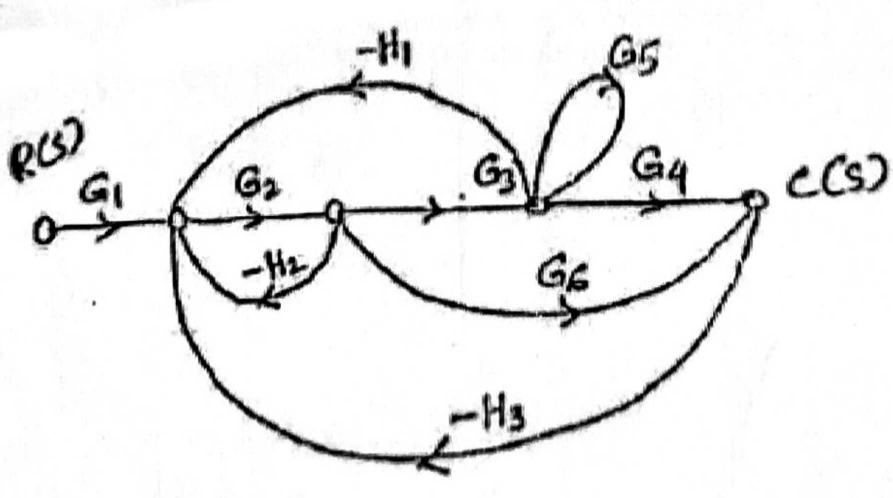
Alva's Institute of Engineering & Technology, Moodbidri

Department of Mechanical Engineering

Continuous Internal Evaluation Test-I ODD Semester 2023-24

ALVA'S Education Foundation

Course Title : **Control Engineering**		Course Code: **18ME71**
Date: 26 -10-2023	Time: **9:30 AM to 11:00 AM**	Semester:**7th**
Faculty: Pramod V B		Max. Marks: 30

Q. No.		Questions	Marks	COs	BTL
1	a)	What are requirements of an ideal control system? With neat sketch, explain the working of an automatic tank-level control system	7.5	1	1
	b)	Define control system compare open loop and closed loop control system with an example for each type	7.5	1	1
		OR			
2	a)	With a block diagram, explain i) Proportional Plus Integral controller (PI) ii) Proportional+integral+derivative controller	7.5	1	1
	b)	Define: i) Actuating signal ii) Disturbance iii) Controller iv) control system	7.5	1	1
		Part B			
3	a)	Obtain the overall transfer function for the block diagram shown in figure 	7.5	2	2
	b)	Using Masons gain formula, find the gain of the following system shown in figure 	7.5	2	2
		OR			

4	a)	A feedback control system has open loop transfer function $$G(s)H(s) = \frac{K}{s(s+4)(s^2+4s+20)}$$ Construct the root locus plot for the system and hence determine range of values of 'k' for the system to be stable.	15	3	2

Faculty Signature

IQAC Members

HOD/IQAC Chairman

USN | | | | | | | | | |

Alva's Institute of Engineering & Technology, Moodbidri

Department of Mechanical Engineering

Continuous Internal Evaluation Test-I ODD Semester 2023-24

ALVA'S
Education Foundation

Control Engineering (18ME71)[1st IA]	
Faculty Name: Pramod V Badyankal	
Scheme of evaluation	Marks
PART – A	
Find the Attachment Next 14 Pages.	

Faculty Signature

HOD/IQAC Chairman
H.O.D.
Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225

IQAC Members

what are the requirements of an ideal Control System? with neat Sketch explain the working of an automatic tank level control System.

→ Requirements are

1] Accuracy : must be very high as error should be corrected.

2] Sensitivity : A ideal Control System senses quick changes in the output due to Environment, Parametric design etc.

3] Noise : it is unwanted Signal and good Control System should be sensitive to these types of disturbances.

Any 6 → 3M Each ½M.

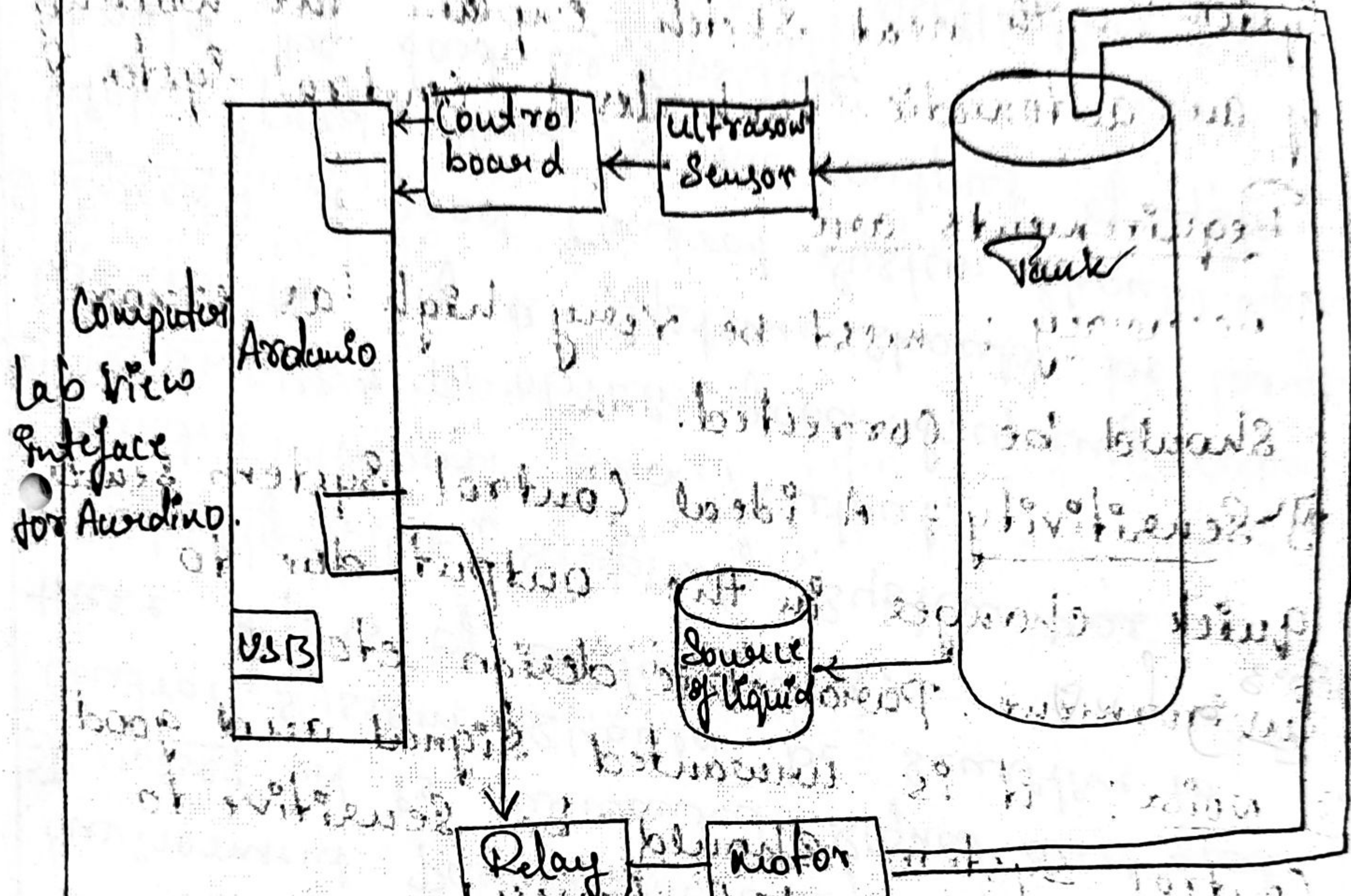
4] Stability : The stability System has bounded input and output.

5] Bandwidth : To obtain good frequency response bandwidth of a System should be large.

6] Speed : A good Control System should have high Speed, that is the output of System should be fast as Possible.

7] Oscillations : For good C.S oscillations in the output should be Constant and must follow Barkhausein's Criteria.

working of automatic tank level control System.



Working

* when the liquid level drops a lower set point the on control unit actively the pump by opening liquid I/L value this allows more liquid flow in the tank
* when the liquid level rises absolute an upper set point control unit deactivately the pump & may open the liquid o/l value neccessary presents over filling
* The control continuously monitors liquid & adjustments as needed to maintain desired specific range.

b] Define Control System Compare open Loop and closed Loop control System with an example for each type.

⇒ Control System

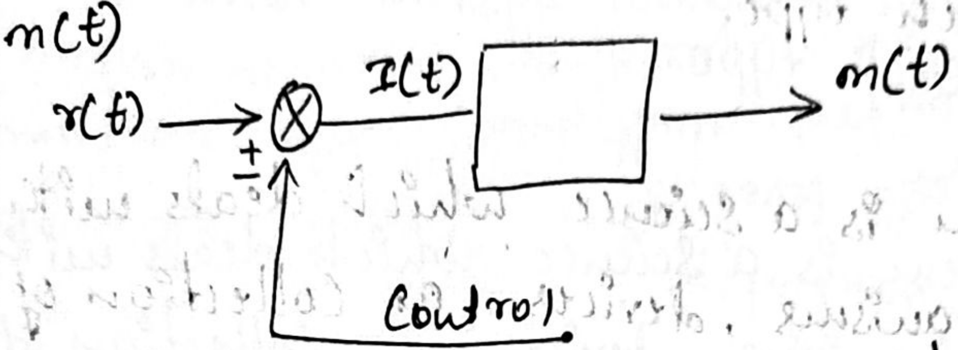
Control System is a science which deals with Systems mechanisms, devices, or collection of object joined to have some form of interac-ions with a purpose.

Comparison

open Loop	closed Loop
Simple in design	Complex in design
error detector is absent	error detector is present.
inaccurate and unreliable	accurate and reliable
Low cost.	high cost.
High Sensitive to the disturbance	Less Sensitive to the disturbance.
ex:- ~~Ship Stabilization System~~ Electric Switch	ex:- Automatic driving System.

2] with block diagram explain

i] proportional plus integral controller.



is a feed back Control System in which the output forcing function is a linear combin-ation of the error and its first time derivative.

The mathematical expression

$$m(t) \propto e(t)$$

$$m(t) = \frac{K_P}{T_i}\int e(t).d(t) + K_P e(t)$$

$$= \frac{K_P}{T_i}\left[\frac{e(t)}{t}\right] + K_P e(t)$$

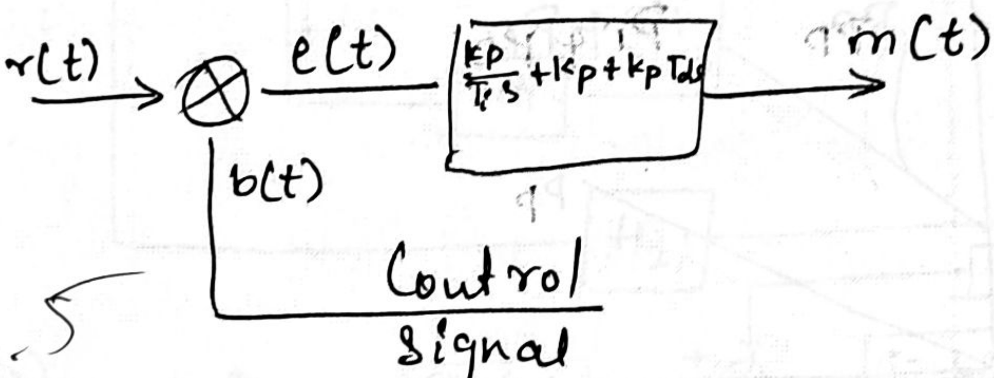
$$m(t) = e(t)\left[\frac{K_P}{T_i t} + K_P\right]$$

By using Laplace transform

$$m(s) = E(s)\left[\frac{K_P}{T_i s} + K_P\right]$$

$$\boxed{TF = \frac{M(s)}{E(s)} = \frac{K_P}{T_i s} + K_P.}$$

ii) Proportional + Integral + derivative Controller is a feed back control system in which the output forcing function is a linear combination of the error, its first time derivative and its time integral.



$m(t) \propto e(t)$

$$m(t) = k_p e(t) + \frac{k_p}{T_i}\int e(t)\,dt + k_p e(t) + k_p T_d \frac{de(t)}{dt}.$$

$$m(t) = \frac{k_p}{T_i}\frac{e(t)}{t} + k_p \cdot e(t) + k_p T_d e(t)\, t$$

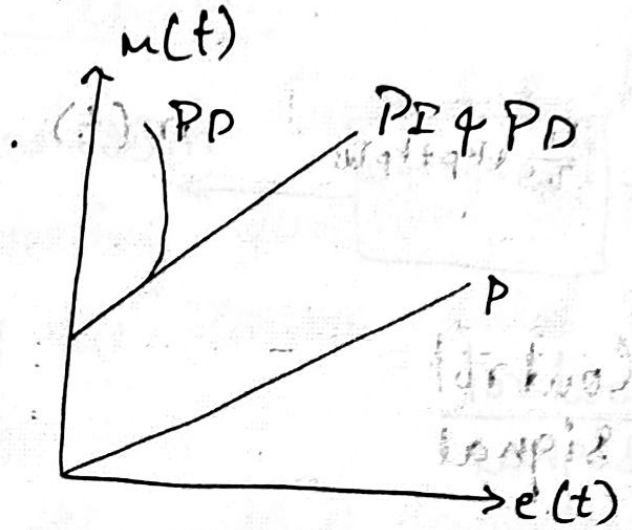
$$m(s) = \frac{k_p}{T_i}\cdot\frac{e(s)}{s} + k_p e(s) + k_p T_d e(s)\cdot s$$

$$m(s) = e(s)\left[\frac{k_p}{T_i \cdot s} + k_p + k_p \cdot T_d \cdot s\right]$$

$$\boxed{\frac{m(s)}{e(s)} = \frac{k_p}{T_i s} + k_p + k_p T_d s = T_F}$$

This combination has all Advantages
3 individual Control System.

- System is stable
- Steady state error is zero
- initial connective measures.

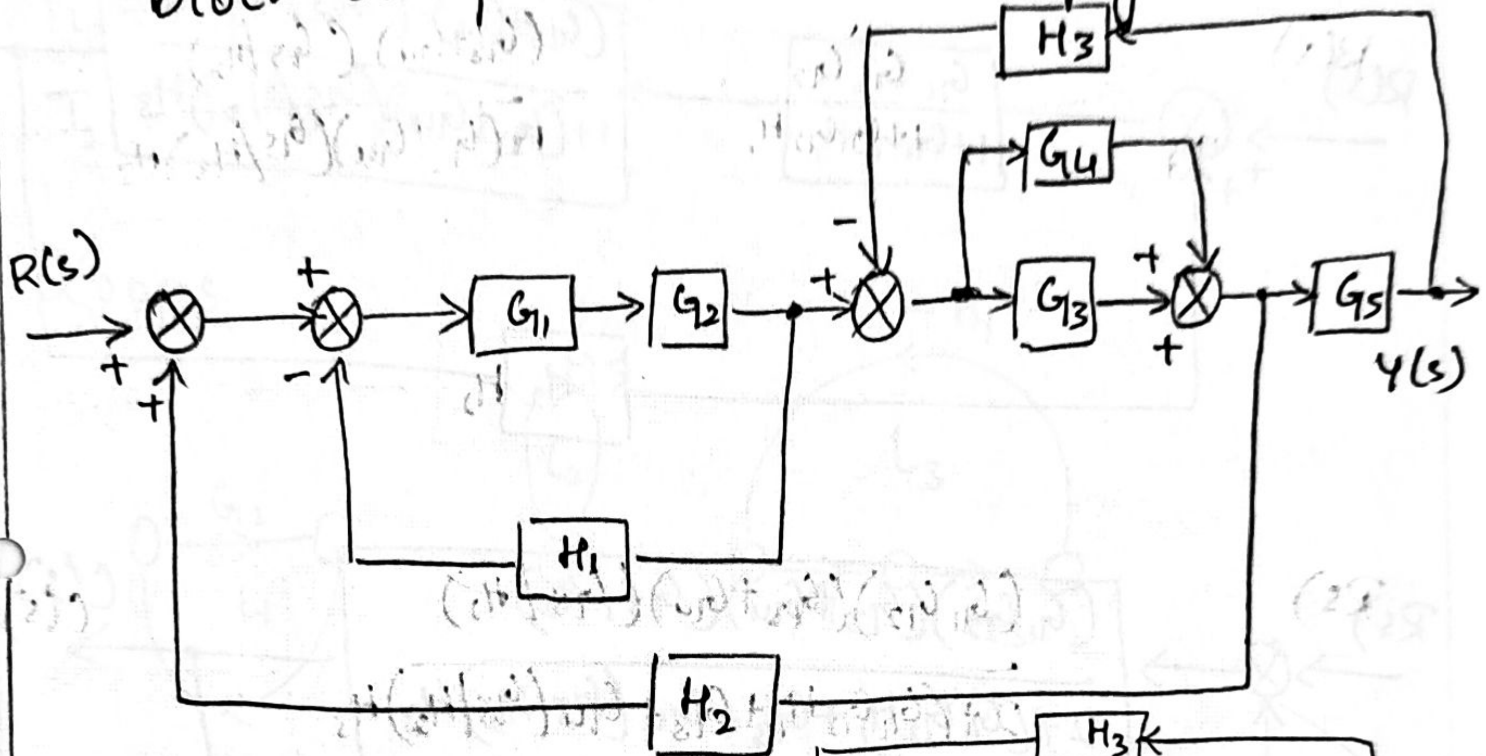


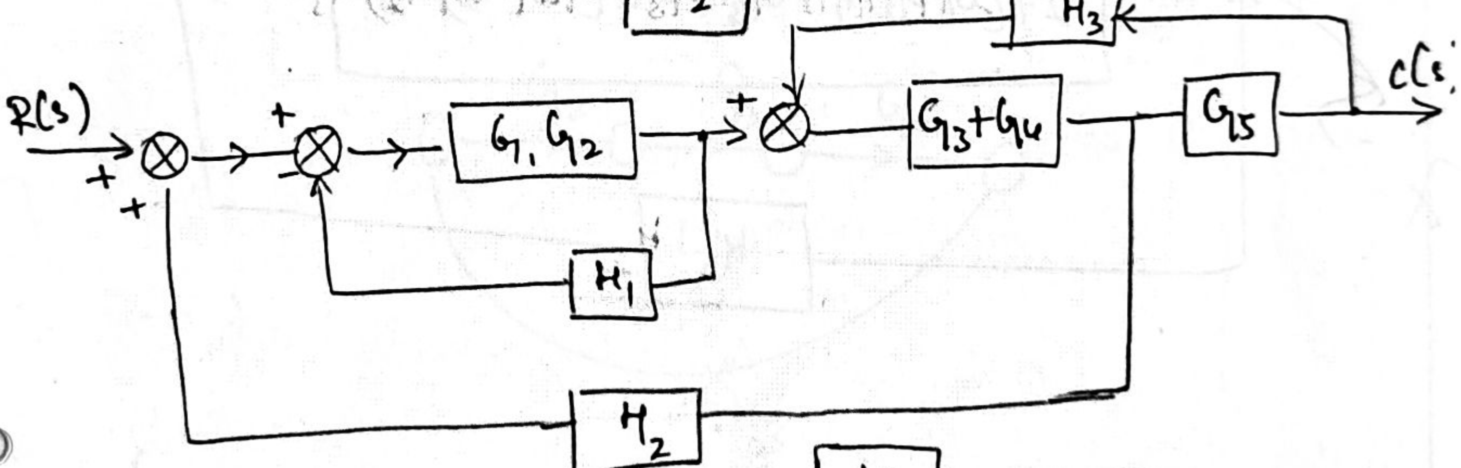
b) i) Actuating Signal

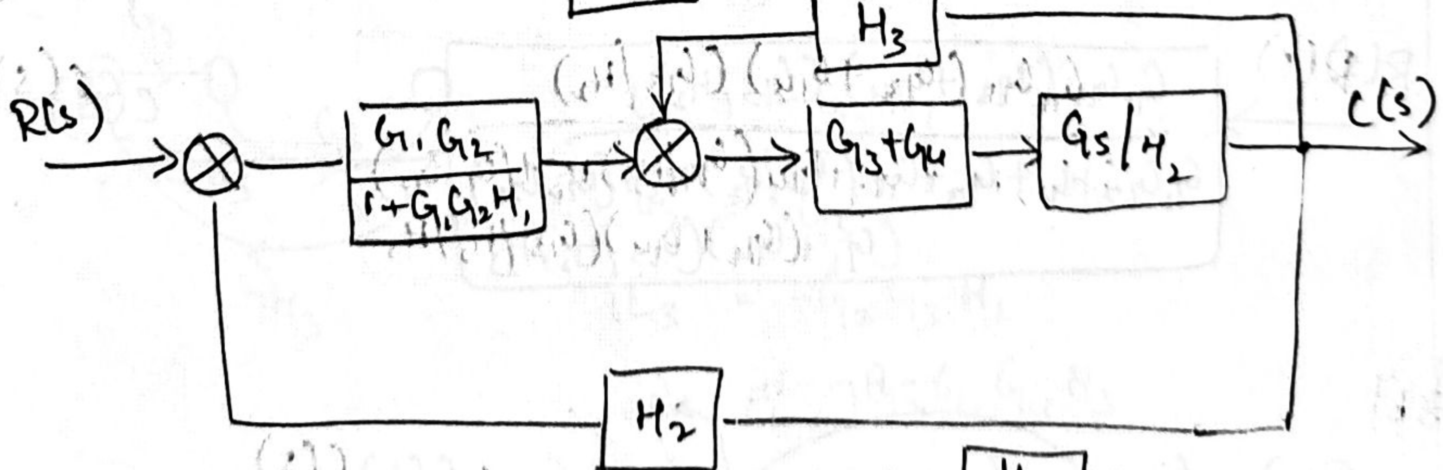
it is the diff b/w reference variabl. and response is called Acutating Signal

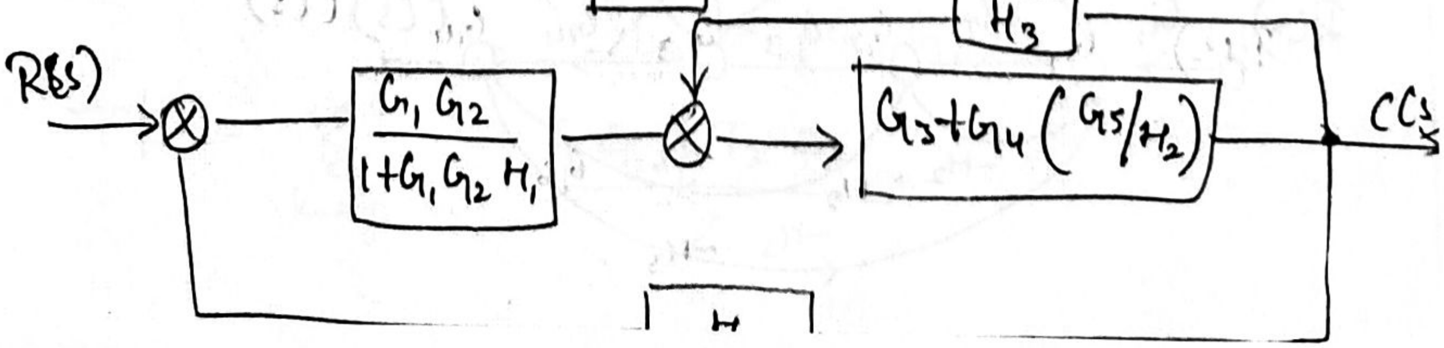
ii) Disturbance: it is a Signal which tends to adversly effect the value of the output of the system.

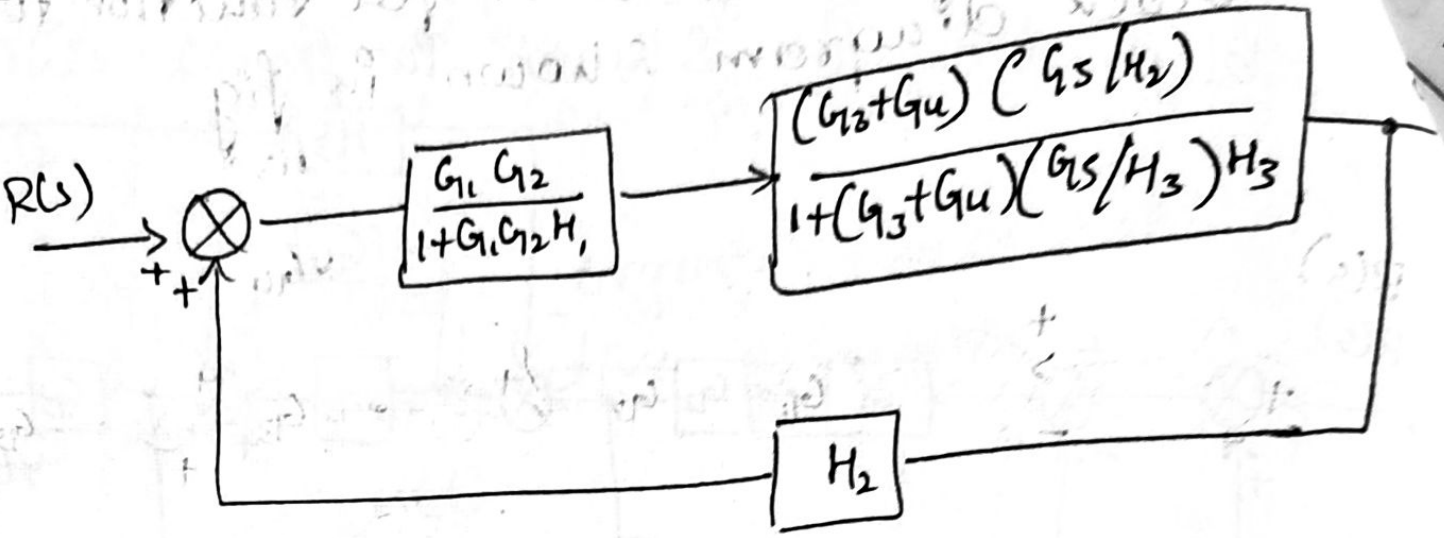
iii) Controller: it compares the actual value of the output with the reference input determine the deviation and produce a controlled Signal that will reduce the deviation to zero or to obtain the overall transfer function for block diagram shown in fig.

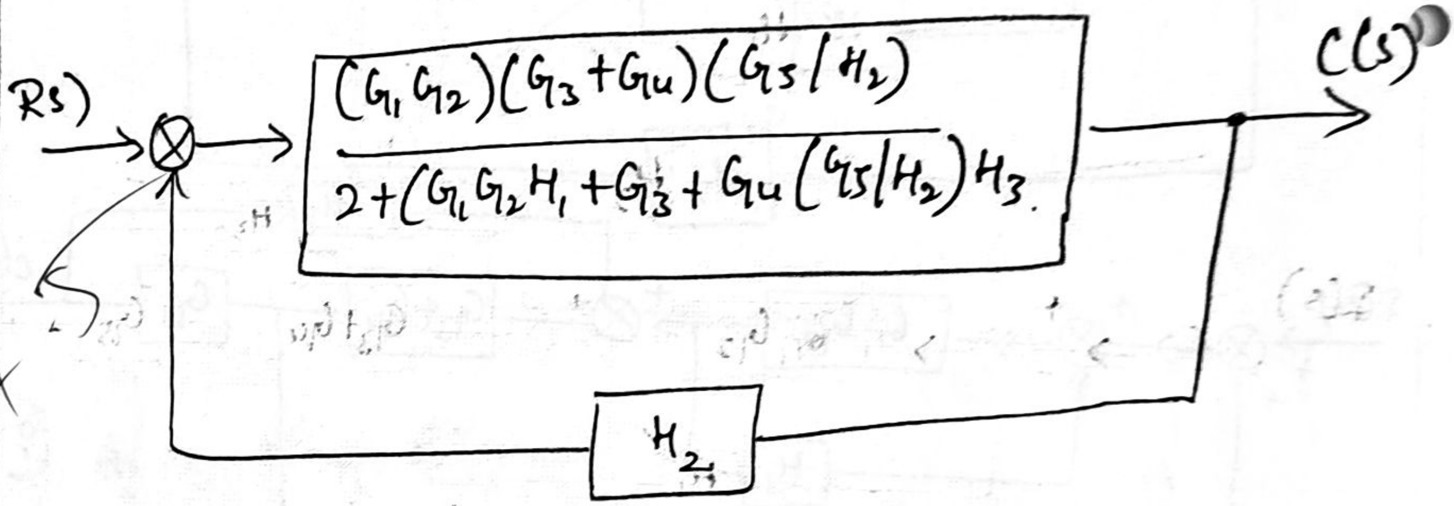


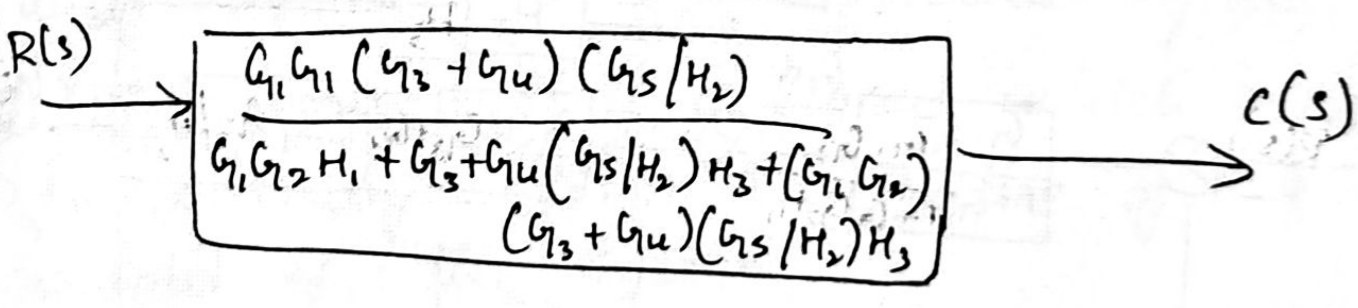




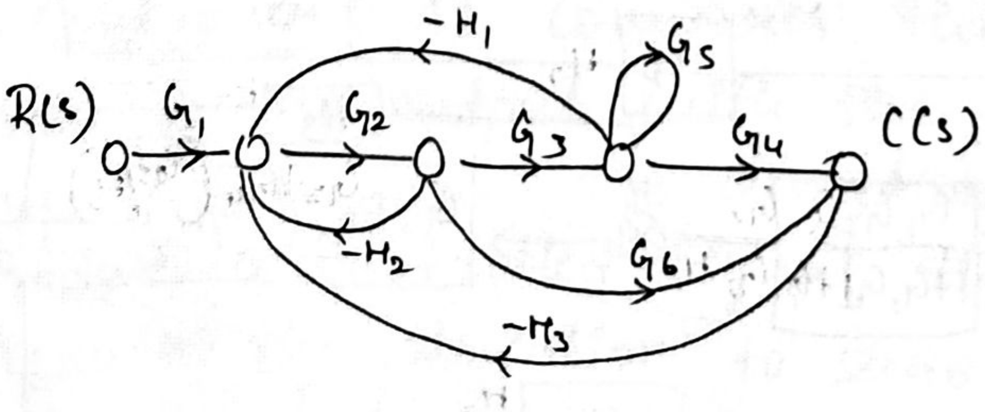



R(s)
$\frac{G_1 G_2}{1+G_1G_2H_1}$
$\frac{(G_3+G_4)(G_5/H_2)}{1+(G_3+G_4)(G_5/H_3)H_3}$
H_2


R(s)
C(s)
$\frac{(G_1G_2)(G_3+G_4)(G_5/H_2)}{2+(G_1G_2H_1+G_3+G_4(G_5/H_2)H_3}$
H_2


R(s)
C(s)
$\frac{G_1G_1(G_3+G_4)(G_5/H_2)}{G_1G_2H_1+G_3+G_4(G_5/H_2)H_3+(G_1G_2)(G_3+G_4)(G_5/H_2)H_3}$

3b]

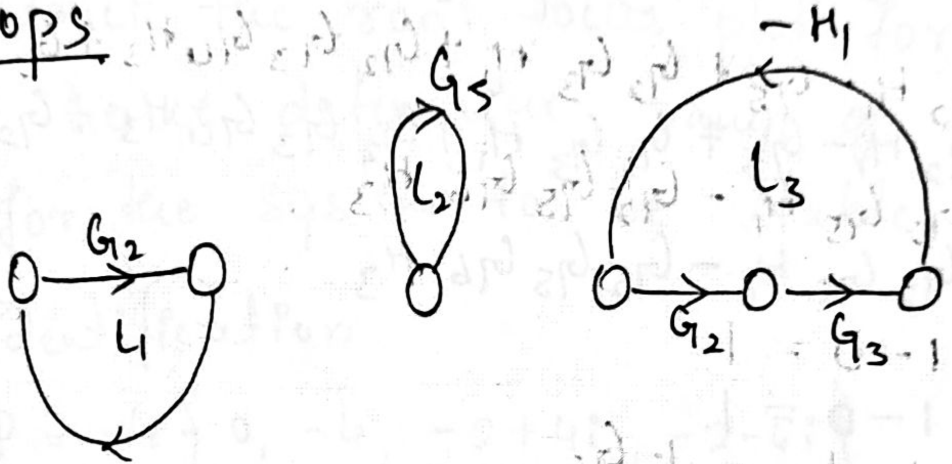

$-H_1$
G_5
R(s)
G_1
G_2
G_3
G_4
C(s)
$-H_2$
G_6
$-H_3$

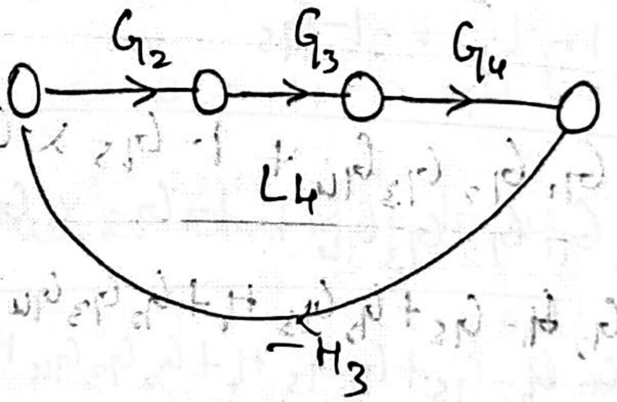
$K = 2$

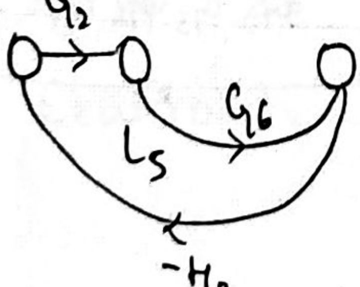
$T_1 = G_1 G_2 G_3 G_4$

$T_2 = G_1 G_2 G_6$

Loops







$L_1 = -G_2 H_1$

$L_2 = G_5$

$L_3 = -G_2 G_3 H_1$

$L_4 = -G_2 G_3 G_4 H_3$

$L_5 = -G_2 G_6 H_3$

$$TF = \sum_{k=0}^{\infty} = \frac{T_1 \Delta_1 + T_2 \Delta_2}{\Delta}$$

$$\Delta = 1 - [L_1 + L_2 + L_3 + L_4 + L_5] + [L_1 L_2 + L_2 L_5]$$

$$= 1 - [-G_2 H_1 + (G_5) + (-G_2 G_3 H_1) + (-G_2 G_3 G_4 H_3) + (-G_2 G_6 H_3)] + [-G_2 G_5 H_1 - G_2 G_5 G_6 H_3].$$

$$\Delta = 1 + G_2 H_1 - G_5 + G_2 G_3 H_1 + G_2 G_3 G_4 H_3 + G_2 G_6 H_3 - G_2 G_5 H_1 - G_2 G_5 G_6 H_3$$

$$\Delta_1 = 1 - 0 = 1$$

$$\Delta_2 = 1 - L_2 = 1 - G_5$$

$$TF = \frac{G_1 G_2 G_3 G_4 + 1 - G_5 \times G_1 G_2 G_6}{1 + G_2 H_1 - G_5 + G_2 G_3 H_1 + G_2 G_3 G_4 H_3 + G_2 G_6 H_3 - G_2 G_5 H_1 - G_2 G_5 G_6 H_3}$$

A feedback Control System has open loop transfer function.

$$G(s)\,H(s) = \frac{k}{s(s+4)(s^2+4s+20)}$$

Construct the root locus plot for the system and hence determine range of values of k for the system to be stable.

⇒ i] Identification

$P = 4 \{0, -4, -2+4i, -2-4i\}$

$z = 0$

$P > z \quad N = P \quad P - z = 4 - 0 = 4$ {4 angles}

ii] Root locus and non Root locus

$A = \Sigma p + \Sigma z = 1 + 0 = 1$ [odd RL]

$B = \Sigma p + \Sigma z = 2 + 0 = 2$ [even NRL]

iii] Centroid. $(\sigma) = \frac{\Sigma p - \Sigma z}{|P - z|} = \frac{\{0 - 4 - 2 + 4i - 2 - 4i\}}{4}$

$\boxed{\sigma = -2}$

iv] Angle $\theta_{A_1} = \frac{180(2q+1)}{|P-z|} = 45° \quad q = 0$

$\theta_{A_2} = 135° = q = 1$

$\theta_{A_3} = 225° = q = 2$

$\theta_{A_4} = 315° = q = 3.$

v] Break away Point & Break in Point.

$$G(s)\,H(s) = \frac{K}{s(s+4)(s^2+4s+20)}$$

$$\frac{1}{1} + \frac{K}{s(s+4)(s^2+4s+20)}$$

$$\left[s^4 + 8s^3 + 36s^2 + 80s + K\right] = 0$$

$$K = -\left[s^4 + 8s^3 + 36s^2 + 80s\right]$$

$$\frac{dK}{ds} = 0 = 4s^3 + 24s^2 + 72s + 80$$

$$\left[s = -2,\ -2 \pm 2.4i,\ -2\right]$$

vi] imaginary axis & Real

$$H(s)\,G(s) = 0$$

$$\frac{1}{1} + \frac{K}{s(s+4)(s^2+4s+20)}$$

$$\left[s^4 + 8s^3 + 36s^2 + 80s\right] + K = 0$$

by replacing $s = j\omega$.

$$\left[(j\omega)^4 + 8(j\omega)^3 + 36(j\omega)^2 + 80j\omega\right] + K = 0$$

$$\omega^4 + 8(-j)\omega^3 + 36(-1)\omega^2 + 80j\omega + K = 0$$

$$\omega^4 - 36\omega^2 + K + j(80\omega - 8\omega^3) = 0.$$

find ω value

$(80\omega - 8\omega^3) = 0$. imaginary.

$\omega(80 - 8\omega^2) = 0$

$\omega^2 = \frac{80}{8}$

$\omega = \pm\sqrt{\frac{80}{8}}$

$\omega = 3.16$ rad/sec

Real par

$\omega^4 - 36\omega^2 + K = 0$

$(3.16)^4 - 36(3.16) + K = 0$

$K = 260$

7] Angle of Departure.

$\theta = \Sigma\theta_p - \Sigma\theta_z$

$\theta_{p_1} = 180 - \theta$

$= 180 - 270$

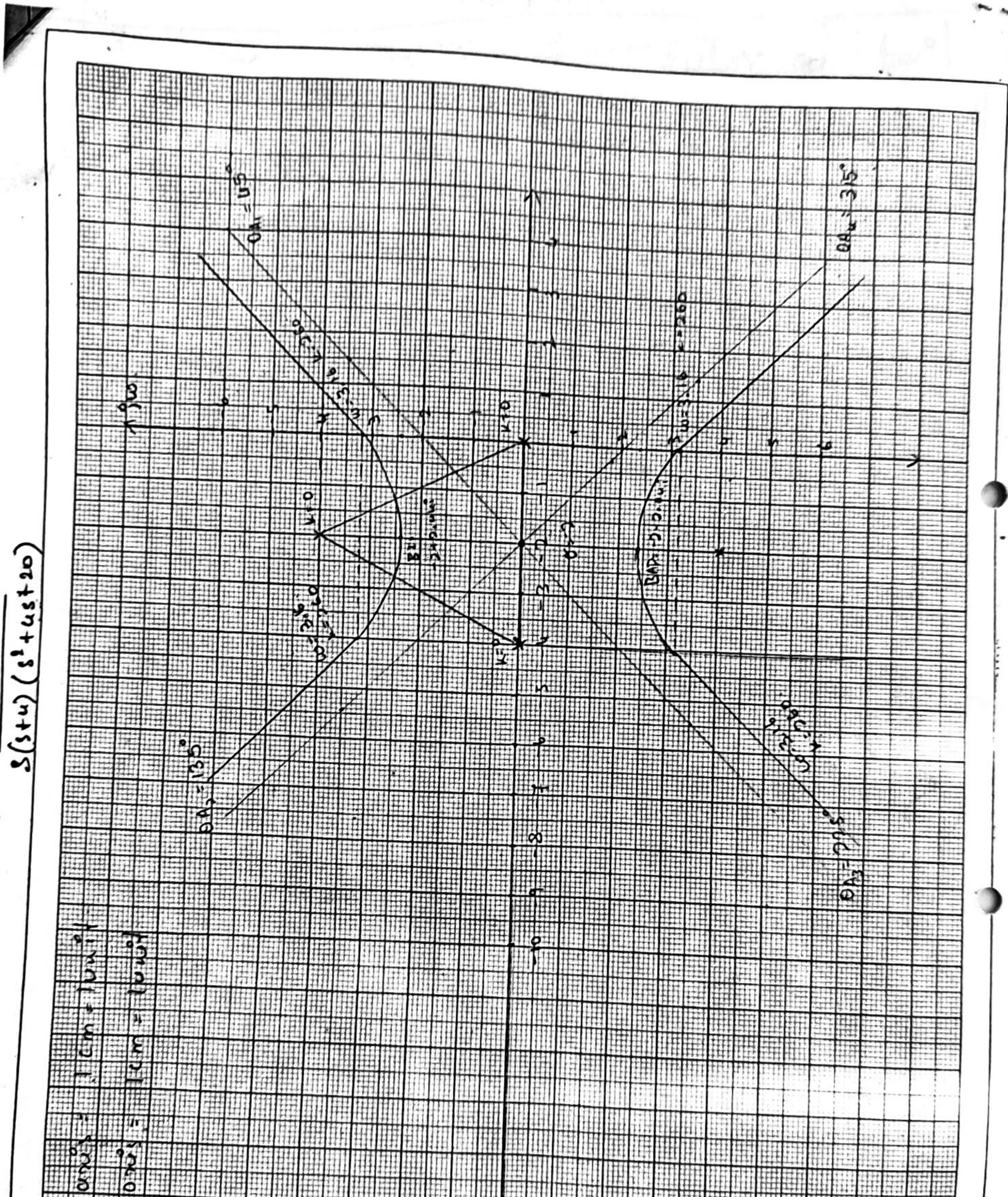
$\theta_{p_1} = -90^\circ$

$\theta = \Sigma\theta_p - \Sigma\theta_z$

$= (135 + 45 + 90) - 0$

$\theta = 270^\circ$

$S(s+4)(s^2+4s+20)$



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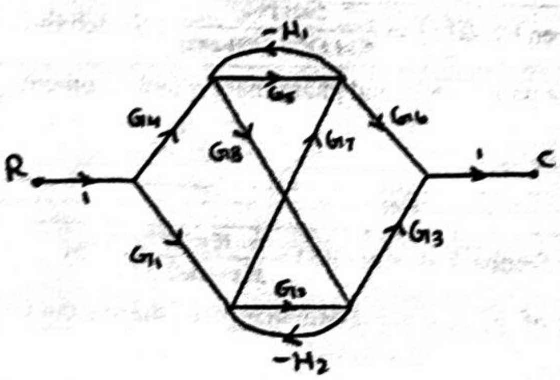
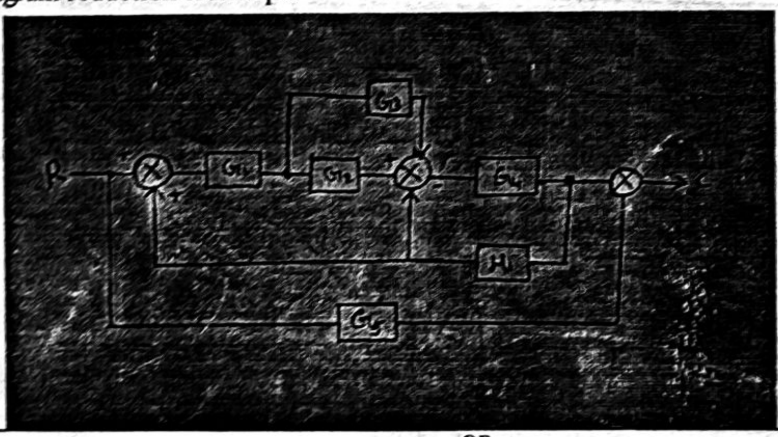
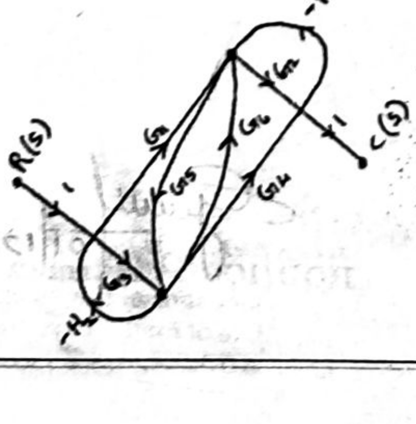
Alva's Institute of Engineering & Technology, Moodbidri

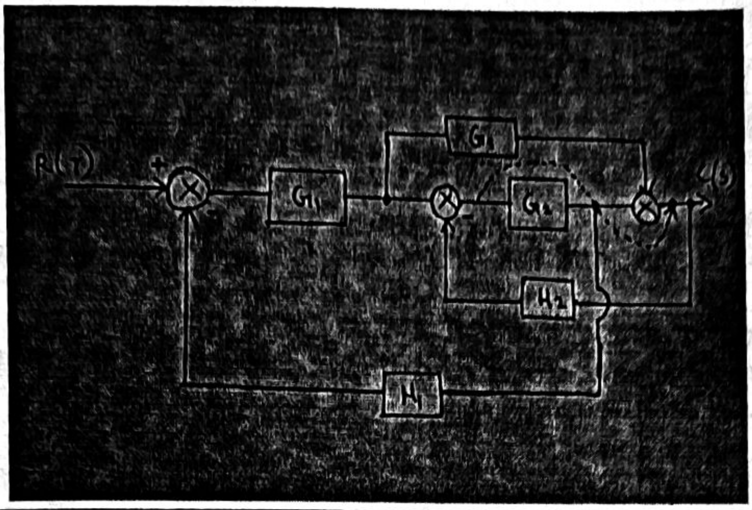
Department of Mechanical Engineering

Continuous Internal Evaluation Test-II ODD Semester 2023-24

Course Title : Control Engineering		Course Code: 18ME71
Date: 04 -12-2023	Time: 9:30 AM to 11:00 AM	Semester:7th
Faculty: Pramod V Badyankal		Max. Marks: 30

Note: Answer ONE complete question from each Part.

Q. No.		Questions	Marks	COs	BTL
		Part A			
1	a)	Determine the transfer function for the given signal flow diagram using Mason's Gain formula 	7.5	3	3
	b)	Find the transfer function for the closed loop system as shown in the figure using Block diagram reduction technique 	7.5	3	3
		OR			
2	a)	Determine the transfer function for the given signal flow diagram using Mason's Gain formula 	7.5	3	3

	b)	Find the transfer function for the closed loop system as shown in the figure using Block diagram reduction technique 	7.5	3	3
		Part B			
3		A particular unit feedback system given by, $G(S) = \frac{242(S+5)}{S(S+1)(S^2+5S+121)}$, Sketch the Bode plot. Find W_{gc} , W_{pc} . Calculate gain margin and phase margin and comment on stability.	15	5	3
		OR			
4		Open loop transfer function of a unit feedback system $G(S) = \frac{Ke^{-0.1S}}{S(1+0.1S)(1+S)}$, by drawing the plot determine the value of 'K' so that the gain margin of the system is +20dB.	15	5	3

CO Numbers	Course Outcomes	Blooms Level	Target Level
CO1	Understand concepts of feedback, automatic controls, compensation systems.	Understand	3
CO2	Determine the system governing equations for physical models (Electrical, thermal, mechanical, electro mechanical), controllability and observability by kalman and gilbert test.	Evaluate	3
CO3	Calculate the gain of system using Block diagram and signal flow graph	Analyse	3
CO4	Illustrate the response of 1st and 2nd order systems	Apply	2
CO5	Analyze the stability of control systems using Polar plots, Nyquist plot, Bode plots and Root locus plots	Analyze	3

Faculty Signature

IQAC Members

01/12/2023

HOD/IQAC Chairman

Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225

Control Engineering (18ME71)[2nd IA] [AY – 2023-24]

Faculty Name: Pramod V Badyankal

Scheme of evaluation			Marks
PART – A			
Q.No.1	a	$u = 6$ —— 2 $T_1 - T_6 = ?$ —— 2 Loops = 3 —— 2 TF = ? —— 1.5 } Refer Attachment.	7.5
	b	Each Step Carries → 2M final Answer → TF = 0.5	7.5
Q.No.2	a	$u = 4$ → 2 $T_1 - T_4$ → 2 Loops = 5 → 2 TF = → 1.5 } Refer Attachment.	7.5
	b	Each step Carries → 2M final Answer → TF = 0.5	7.5
PART – B			
Q.No.3	a	Refer figure → log Scale.	15
Q.No.4	a	Refer figure → log Scale	15

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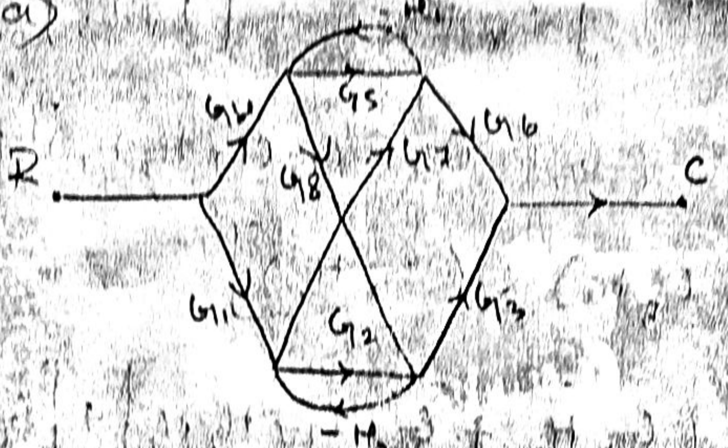
(1) 1) a)



K = 6 — 2

$T_1 = G_4 \; G_8 \; G_3$

$T_2 = G_4 \; G_5 \; G_6$

$T_3 = G_1 \; G_2 \; G_{13}$

$T_4 = G_1 \; G_7 \; G_6$ — 2

$T_5 = -G_1 \; G_7 \; H_2 \; G_8 \; G_{13}$.

$T_6 = -G_4 \; G_8 \; H_2 \; G_7 \; G_6$

$$TF = \frac{C}{R} = \sum_{x=1} \frac{T_K \, \Delta}{\Delta}$$

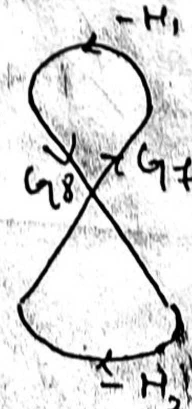
$$TF = \frac{T_1\Delta_1 + T_2\Delta_2 + T_3\Delta_3 + \dots T_6\Delta_6}{\Delta}$$

Loops:

(1)

$L_1 = -G_5 H_1$

$L_2 = -G_2 H_2$



— 2

$L_3 = -G_8 \; G_7 \; H_2 \; H_1$

$$\Delta = 1 - [L_1 + L_2 + L_3] + [L_1 L_2]$$

$$= 1 + [(-G_5 H_1) + (-G_2 H_2) + (-G_8 G_7 H_2 H_1)] + [(-G_5 H_1) \times (-G_2 H_2)]$$

$$\Delta = 1 + [G_5 H_1 + G_2 H_2 + G_8 G_7 H_2 H_1] + [G_5 H_1 + G_2 \ldots$$

$T_1 \; \Delta_1 = 1 - 0 = 1$

$T_2 = \Delta_2 = 1 - L_1 = 1 + G_5 H_1$

$T_3 = \Delta_3 = 1 - L_2 = 1 + G_2 H_2$

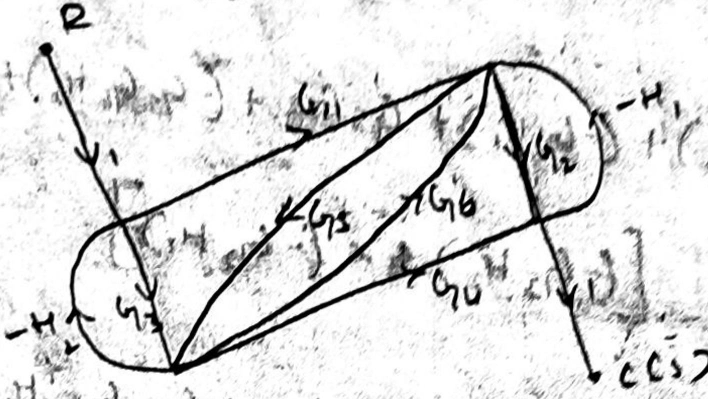
$T_4 = \Delta_4 = 1 - 0 = 1$

$T_5 = \Delta_5 = 1 - 0 = 1$

$T_6 = \Delta_6 = 1 - 0 = 1$

$$TF = \frac{G_4 G_8 G_3 + G_4 G_5 G_6 + G_1 G_2 G_3 + G_4 G_7 G_6 + G_7 G_1 H_1 G_8 G_3 + G_4 G_8 H_2 G_7 G_6}{1 + [G_5 H_1 + G_2 H_2 + G_8 G_7 H_2 H_1] + [G_5 H_1 + G_2 H_2]}$$

2(a)



K = 4   2

$T_1 = G_1 G_2$

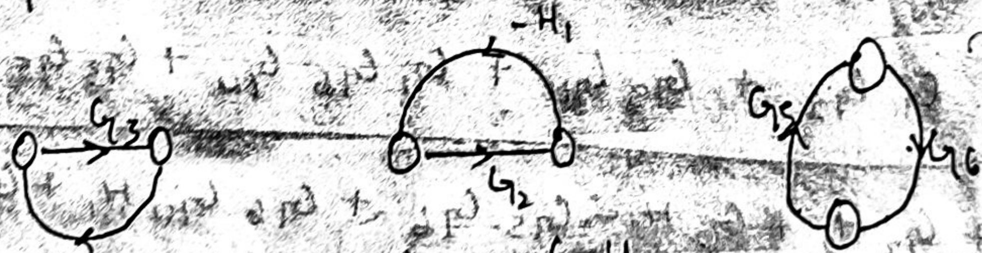
$T_2 = G_3 G_4$

$T_3 = G_1 G_6 G_4$

$T_4 = G_3 G_5 G_2$

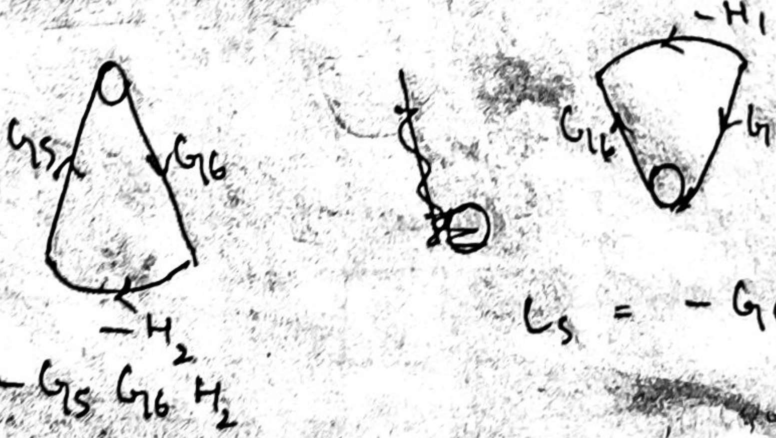
2

Loops.



$L_1 = -G_3 H_2$ $L_2 = -G_2 H_1$ $L_3 = G_5 G_6$.

2



$L_5 = -G_6 G_4 H_1$

$L_4 = -G_5 G_6 H_2$

$$\Delta = 1 + [L_1 + L_2 + L_3 + L_4 + L_5] + [L_1 L_2]$$

$$= 1 - [(-G_3 H_2) + (-G_2 H_1) + G_5 G_6 + (-G_5 G_6 H_2) + (-G_6 G_4 H_1)] + [(-G_3 H_2) \times (-G_2 H_1)].$$

$$\Delta = 1 + [G_3 H_2 + G_2 H_1 + G_5 G_6 + G_5 G_6 H_2 + G_6 G_4 H_1] + [G_3 H_2 + G_2 H_1]$$

$$\Delta_1 = 1 - 0 = 1$$

$$\Delta_2 = 1 - 0 = 1$$

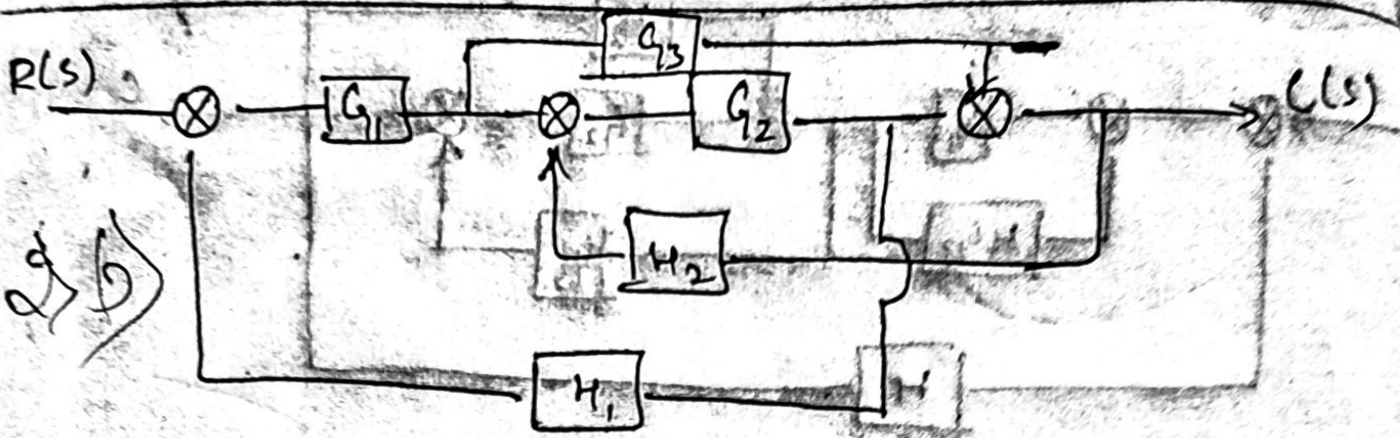
$$\Delta_3 = 1 - 0 = 1$$

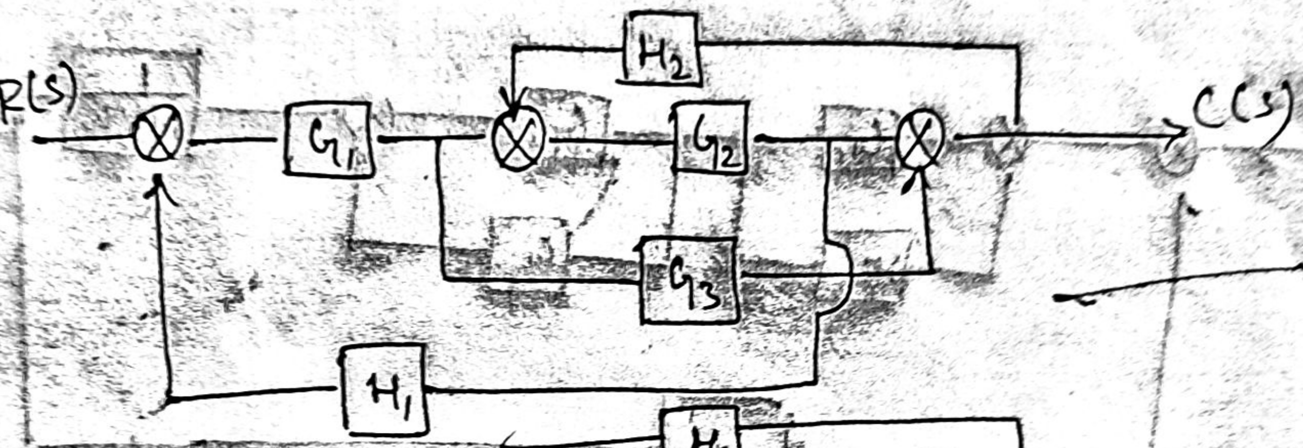
$$\Delta_4 = 1 - 0 = 1$$

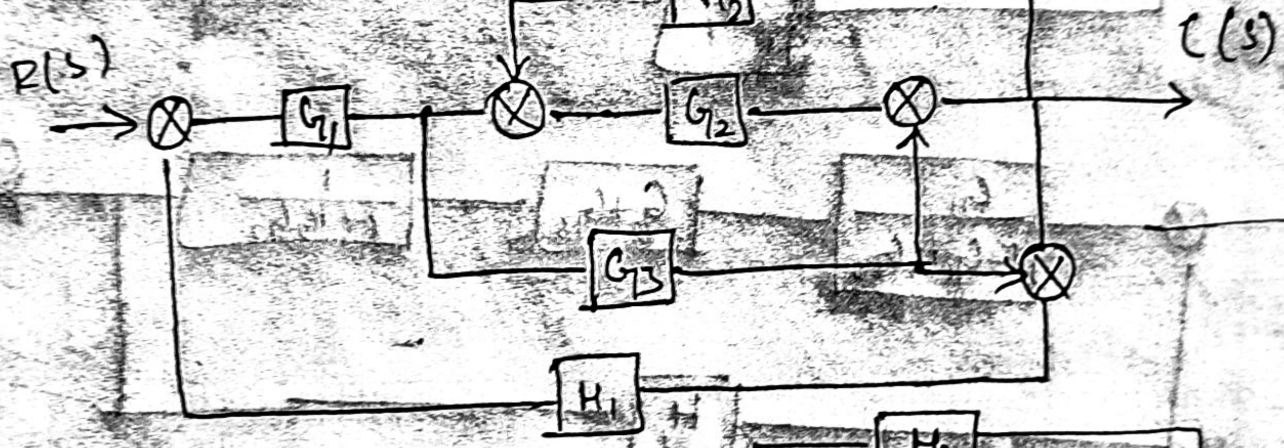
~~TF = $G_1 G_3 + G_2 H_1 + G_5 G_6 + G_6 G_6$~~

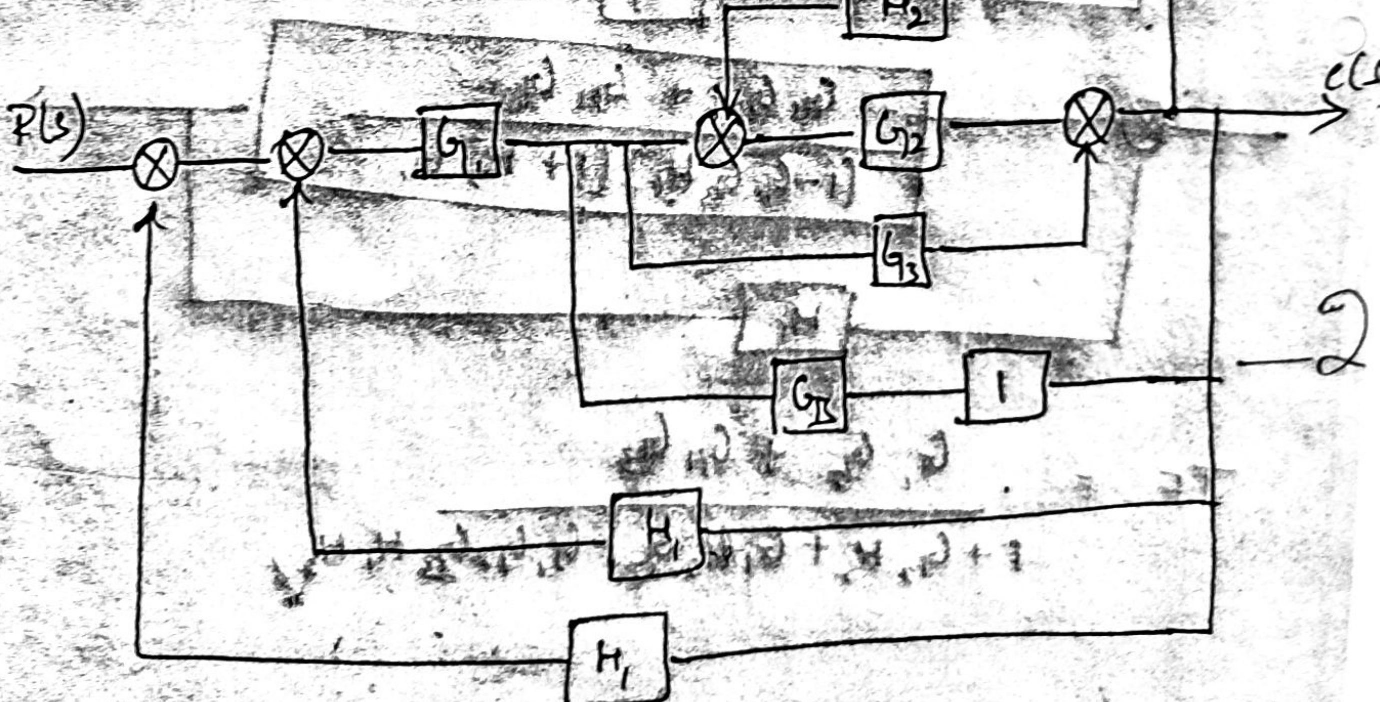
$$TF = \frac{G_1 G_2 + G_3 G_4 + G_1 G_6 G_4 + G_3 G_5 G_2}{1 + G_3 H_2 + G_2 H_1 - G_5 G_6 + G_6 G_4 H_1 + G_1 G_6 H_2 + G_3 G_2 H_2 H_1}$$ //

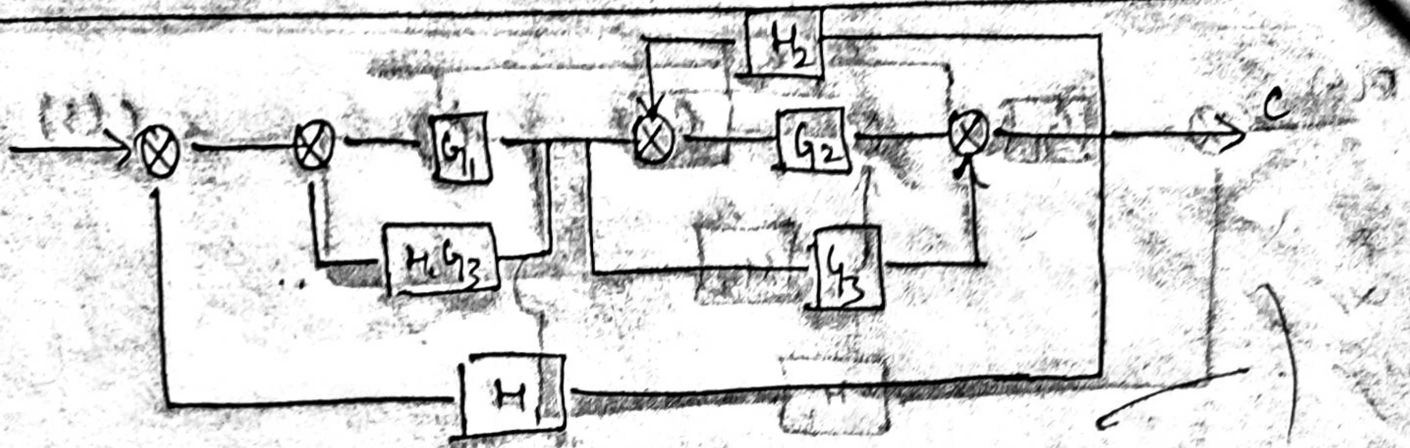
6)

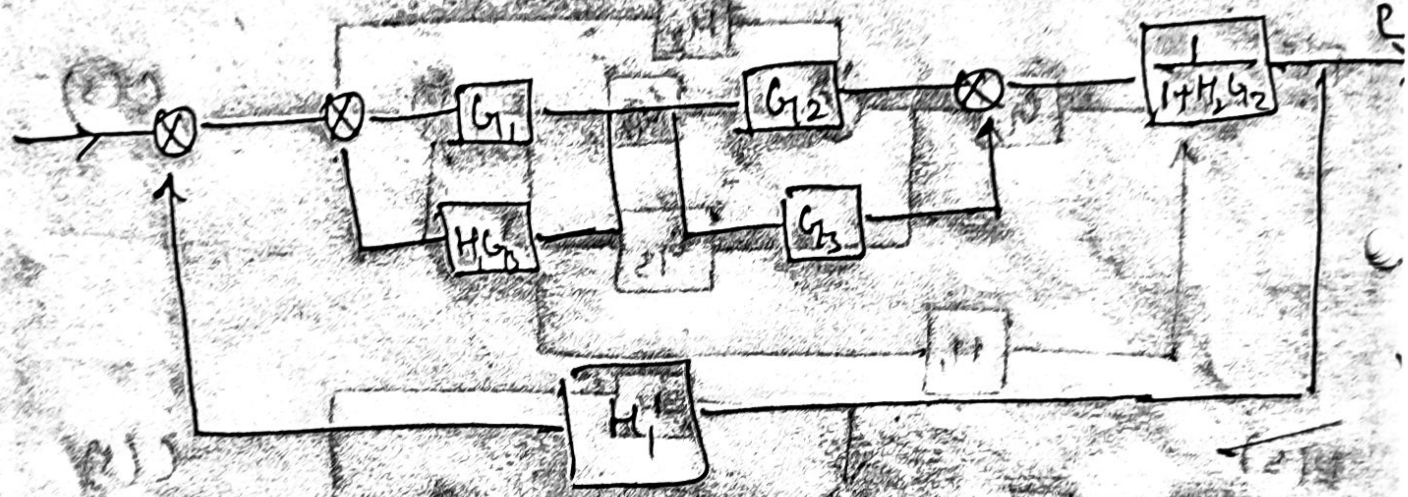

R(s)
G1
G3
G2
C(s)
H2
H1

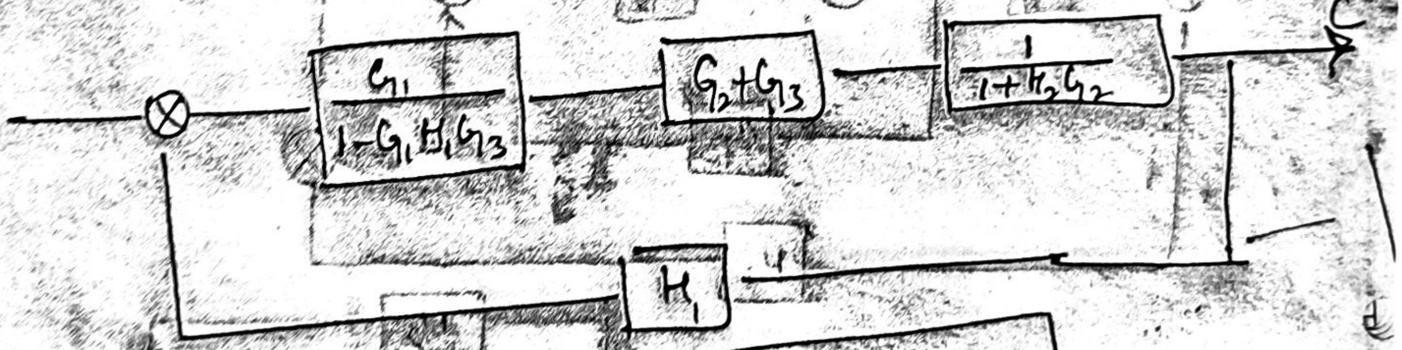

R(s)
G1
H2
G2
C(s)
G3
H1


H2
C(s)
R(s)
G1
G2
G3
H1


H2
R(s)
G1
G2
G3
1
H1
H1





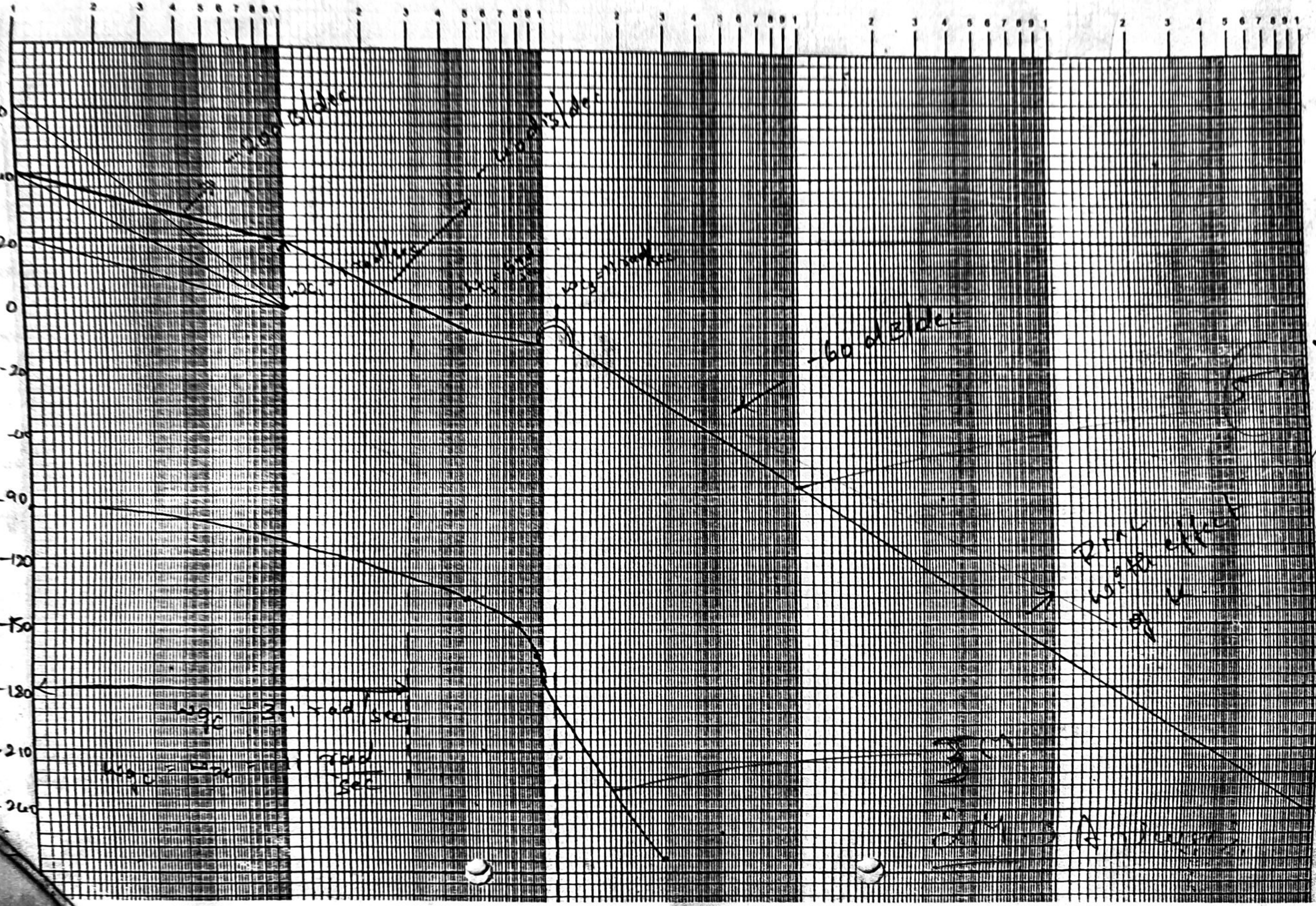


$$TF = \frac{G_1 G_2 + G_1 G_3}{1 + G_2 H_2 + G_1 H_2 G_2 - G_1 G_2 G_3 H_1 H_2}$$

0.5

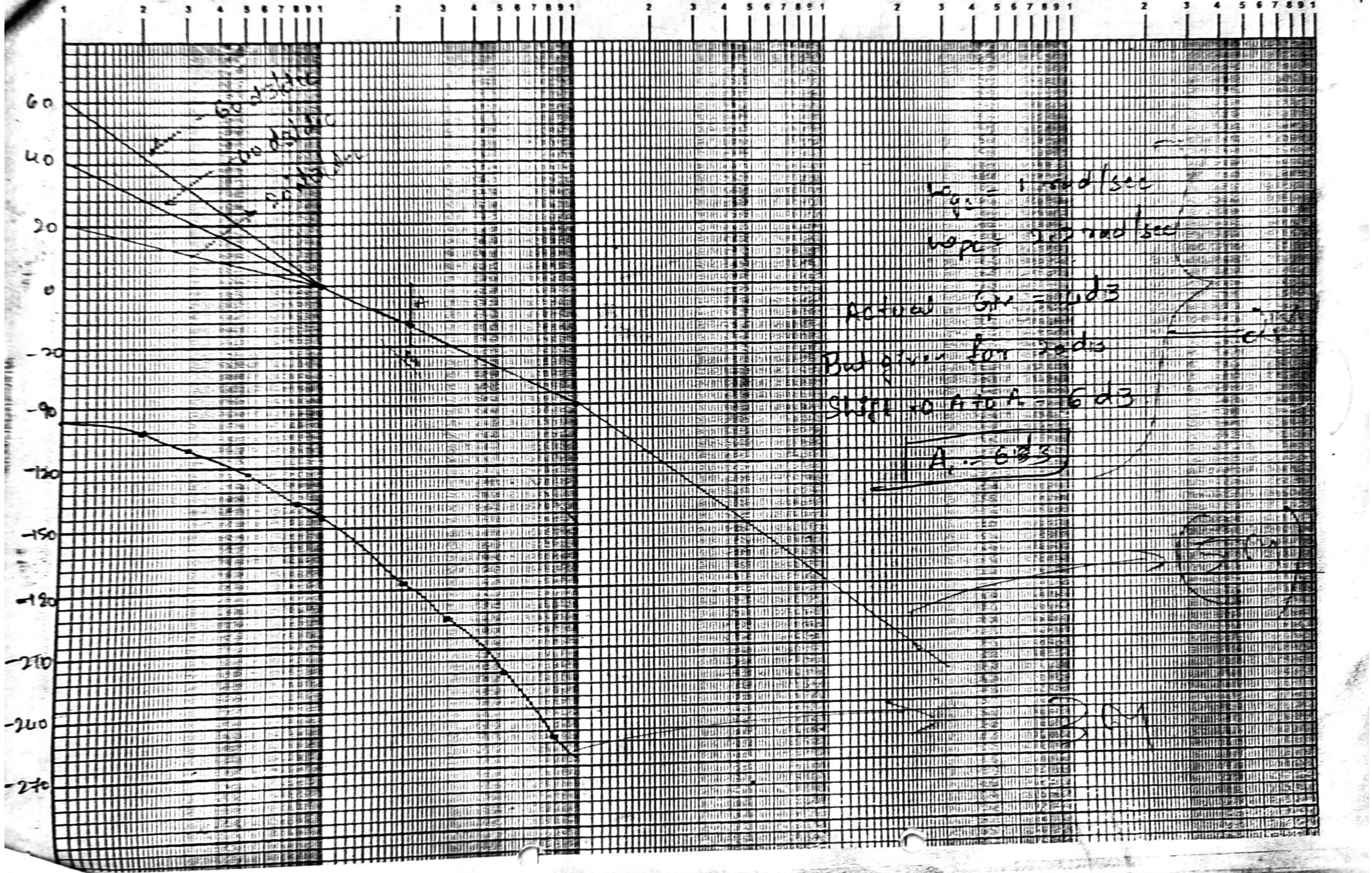
SEMI - LOG graph

$$\frac{242(s+5)}{s(s+1)(s^2+5s+121)}$$



SEMI - LOG graph

$$G(s) = \frac{K}{s(1+0.1s)(1+s)}$$



3

$$G(s) = \frac{242(s+5)}{s(s+1)(s^2+5s+121)}$$

3)

$$\frac{1}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

$$\frac{1}{\frac{s^2}{\omega_n^2} + \frac{2\xi\omega_n s}{\omega_n^2} + 1} = \frac{1}{1 + 2\xi\frac{s}{\omega_n} + \frac{s^2}{\omega_n^2}}$$

Replace s by $j\omega$

$$\frac{1}{1 + 2\xi\frac{j\omega}{\omega_n} + \left(\frac{(j\omega)^2}{\omega_n^2}\right)}$$

$$= \frac{1}{1 + 2\xi j\left(\frac{\omega}{\omega_n}\right) + \left(\frac{\omega^2}{\omega_n^2}\right)}$$

$\frac{\omega}{\omega_n} = r$

$\frac{\omega^2}{\omega_n^2} = r^2$

$$= \frac{1}{1 + 2\xi j\left(\frac{\omega}{\omega_n}\right) - \left(\frac{\omega^2}{\omega_n^2}\right)} = \frac{1}{(1-r^2)^2 + 2\xi j r}$$ //

~~$G(s) = \frac{242 \times 5 (1 + s/5)}{}$~~

magnitude

$$|G(s)H(s)| = \left| \frac{1}{\frac{(1-r^2)^2}{P} + \frac{2\xi r}{b}} \right|$$

$$M = \frac{1}{\sqrt{(1-r^2)^2 + 4\xi^2 r}}$$

Phase

$$\boxed{\phi = -\tan^{-1}\left(\frac{2\xi r}{1-r^2}\right)}$$

$$G(s) = \frac{242 \times 5 \left(1 + s/5\right)}{s(1+s) \times 121 \left[\frac{s^2}{121} + \frac{5s}{121} + 1\right]}$$

$$G(s) = \frac{10\left(1 + s/5\right)}{s(1+s)\left[\frac{s^2}{121} + \frac{5s}{121} + 1\right]}$$

$K = 10$

$M = 20 \log_{10} 10$

$M = 20$ dB

$\phi = 0°$

$\left(\frac{1}{s}\right) = -20 \log_{10}$ dB/dec

$\phi = -90°$

$\left(1+\frac{s}{5}\right) \approx \left(\frac{1}{1+Ts}\right)$

$T = \frac{1}{5}$.

$\omega_c = \frac{1}{T} = \frac{1}{1/5} = 5$ rad/sec.

$\phi = -\tan^{-1}(\omega \times 0.2)$

$M = 0 + 0 - 20 \log_{10}$ dB/dec.

$\omega_n^2 = 121$

$\omega_n = 11 = \omega_{c_3} = 11$ rad/sec

$\frac{s^2}{\omega_n} + \frac{5s}{\omega_n^2} + 1$

$\frac{2\xi}{11} + \frac{5}{121} + 1$

$\boxed{\xi = 0.23}$ — 2

$M = -20 \log_{10} 2\xi$

$= -20 \log_{10} 2 \times 0.22$

$M = 6.17$ dB/dec — 2

$\omega_{c_1} = \frac{1}{T}$

$T_1 = 1$

$\omega_{c_1} = \frac{1}{1} = 1$ rad/sec

ω	-90°	$\tan^{-1}(\omega/5)$	$-\tan^{-1}(\omega x \ldots)$	$\tan^{-1}\left(\frac{2\xi r}{1-r^2}\right)$	φR
0.1					-94
1					-125
5					-137
8					-149
10					-177
20					-82
30					-86.

4) $e^{-0.1s} = e^{-0.1s\omega}$

Replace s by $j\omega$

$G(s) = \frac{K e^{-0.1 j\omega}}{(j\omega)(1+0.1 j\omega)(1+j\omega)}$

$|\cos(0.1\omega) - \sin(0.1\omega)|$

$0.99 \approx 1$

$M = -20 \log_{10} 1 = 0$

$\angle e^{-0.1 j\omega} = -0.1\,\omega \times \frac{180}{\pi} = \phi$

$\phi = \underline{5.72}\ \omega$ — 2

$\frac{1}{s}$ $M = -20\log_{10}$

$\phi = -90°$

$\frac{1}{1+0.1s} \approx \frac{1}{1+Ts}$

$T = 0.1$ $w_c = \frac{1}{T} = \frac{1}{0.1} = 10$ rad/sec

$\phi = \tan^{-1}(\omega \times 0.1)$ — 2

$$\frac{1}{1+s} \approx \frac{1}{1+Ts}$$

$$\omega_c = \frac{1}{T} = \frac{1}{1} = 1 \text{ rad/sec}$$

$$\phi = -\tan^{-1}(\omega \times 1)$$

ω	5.73 CLO	$-90°$	$-\tan^{-1}(\omega \times 0.1)$	$-\tan^{-1}(\omega \times 1)$	ϕ_R
0.1	0.572	-90	-0.572	-5.71	-95.71
1	5.72	-90	-5.71	-45	-131.44
			-11.309	-63.43	-176.19
2	-11.46	-90			
			-16.69	-71.56	-195.44
3	-17.19	-90			

9h

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Alva's Institute of Engineering & Technology, Moodbidri

Department of Mechanical Engineering

Continuous Internal Evaluation Test-III ODD Semester 2023-24

Course Title : Control Engineering		Course Code: 18ME71
Date: 01 -01-2024	Time: 9:30 AM to 11:00 AM	Semester: 7th
Faculty: Pramod V Badyankal		Max. Marks: 30

Note: Answer ONE complete question from each Part.

Q. No.		Questions	Marks	COs	BTL
		Part A			
1	a)	Obtain an expression for response of first order system for unit step input	7	2	2
	b)	Explain different types of input signals	8	2	2
		OR			
2	a)	Obtain an expression for response of first order system for parabolic input	8	2	2
	b)	Derive an expression for steady state error and explain error constants	7	2	2
		Part B			
3	a)	Define: (i) Delay time (ii) Rise time (iii) Peak time (iv) Maximum overshoot (v) setting time	5	2	2
	b)	A second order system is given by $\frac{c(s)}{R(s)} = \frac{20}{s^2+6s+25}$. Find the Following transient response specifications, (i) Rise time (ii) Delay time (iii) Peak time (iv) Peak overshoot (v) Setting time. Also find the expression for the output response. C(t) when subjected to unit step response.	10	2	3
		OR			
4	a)	Derive an expression for a second order sender damped system which is subjected to unit step response	11	2	2
	b)	A second order system has natural frequency $\omega_n = 5$ rad/sec and damping ratio is 0.6. Calculate (i) Delay time (ii) Rise time (iii) Peak time (iv) Maximum overshoot	4	2	3

CO Numbers	Course Outcomes	Blooms Level	Target Level
CO1	Understand concepts of feedback, automatic controls, compensation systems.	Understand	3
CO2	Determine the system governing equations for physical models (Electrical, thermal, mechanical, electro mechanical), controllability and observability by kalman and gilbert test.	Evaluate	3
CO3	Calculate the gain of system using Block diagram and signal flow graph	Analyse	3
CO4	Illustrate the response of 1st and 2nd order systems	Apply	2
CO5	Analyze the stability of control systems using Polar plots, Nyquist plot, Bode plots and Root locus plots	Analyze	3

Faculty Signature

HOD/IQAC Chairman 29/12/23

IQAC Members 29/12/23

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Control Engineering: 3rd IA → 01-01-2024

1 a) $r(t) = r(t) = 1$ when $t \geq 0$ ——— (1)

$R(s) = LT[r(t)] = \frac{1}{s}$

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

$C(s) = \frac{R(s)}{1+sT}$ ——— (1)

$C(s) = \frac{1}{s} \cdot \frac{1}{(1+sT)}$

$= \frac{1}{s} \cdot \left[\frac{1/T}{1/T + s}\right]$

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

$L^{-1}[C(s)] = L^{-1}\left[\frac{1}{s} - \frac{1}{s+\frac{1}{T}}\right] = c(t)$

$= L^{-1}[1/s] - L^{-1}\left[\frac{1}{s+1/T}\right]$

$= u(t) - e^{-t/T}$

$\boxed{c(t) = 1 - e^{-t/T}}$ when $t \geq 0$ ——— (1)

——— (1)

→ In time domain error signal

$e(t) = r(t) - c(t)$

$= 1 - [1 - e^{-t/T}]$ ——— (2)

$\boxed{e(t) = e^{-t/T}}$

Types of test Signals :-

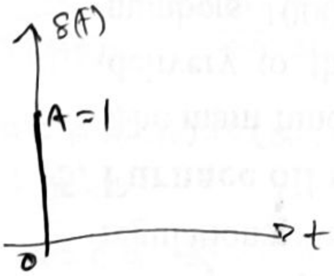
1. Impulse Signal
2. step Signal
3. Ramp Signal
4. Parabolic Signal.

1. Impulse Signal

→ Sudden shock

→ $\delta(t) = \begin{cases} A & t = 0 \\ 0 & t \neq 0 \end{cases}$ — (1)

→ If $A = 1$ the impulse signal is called unit impulse signal

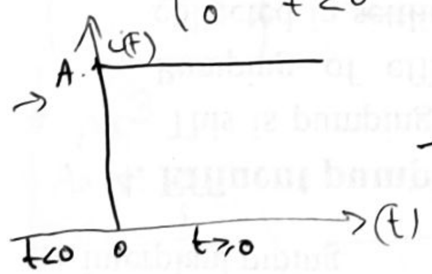
→ 

— (1)

2. step Signal :-

→ Sudden change.

→ $u(t) = \begin{cases} A & t \geq 0 \\ 0 & t < 0 \end{cases}$ — (1)

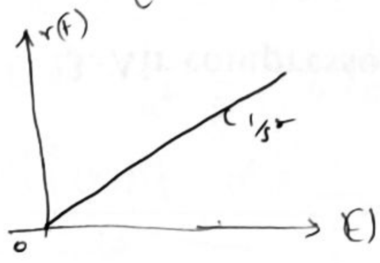
→ 

— (1)

3. Ramp Signal :-

– Constant Velocity.

→ $r(t) = \begin{cases} At & t \geq 0 \\ 0 & t < 0 \end{cases}$ — (1)

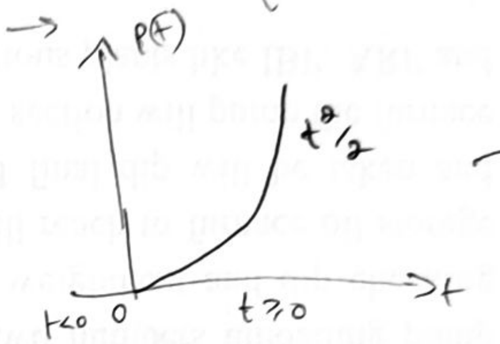
→ 

— (1)

4. Parabolic Signal :- p(t)

→ Constant acceleration.

→ $p(t) = \begin{cases} \frac{At^2}{2} & t \geq 0 \\ 0 & t < 0 \end{cases}$ — (1)

→ 

— (1)

First order System for parabolic input

- put $a = \frac{1}{T}$

$$R(s) = \frac{1}{s^3}$$

$$TF = \frac{C(s)}{R(s)} = \frac{a}{(s+a)} \longrightarrow (1)$$

$$C(t) = t^2 - Tt + T^2(1 - e^{-t/T}) \longrightarrow (1)$$

$$C(s) = R(s) \cdot \frac{a}{s+a}$$

$$C(s) = \frac{1}{s^3} \cdot \frac{a}{s+a}$$

$$C(s) = \frac{A}{s} + \frac{B}{s^2} + \frac{C}{s^3} + \frac{D}{s+a}$$

$$\frac{a}{s^3(s+a)} = \frac{A}{s} + \frac{B}{s^2} + \frac{C}{s^3} + \frac{D}{s+a} \longrightarrow (A)$$

$$\frac{a}{s^3(s+a)} = \frac{As^2(s+a) + B(s+a)s + C(s+a) + Ds^3}{s^3(s+a)}$$

$$\rightarrow a = As^2(s+a) + B(s+a)s + C(s+a) + Ds^3 - (1)$$

put $s = 0$

$$a = Ca \Rightarrow C = \frac{a}{a} \quad \boxed{C = 1} \longrightarrow (1)$$

$\rightarrow s = -a$

$$a = D(-a)^3$$

$$\boxed{D = -\frac{1}{a^2}} \longrightarrow (1)$$

$\rightarrow As^3$

$$A + D = 0$$

$$\boxed{A = \frac{1}{a^2}} \longrightarrow (1)$$

$$\rightarrow Aa + B = 0$$

$$\frac{1}{a} a + B = 0$$

$$\boxed{B = -\frac{1}{a}} \longrightarrow (1)$$

$$\rightarrow C(s) = \frac{1}{a^2} \cdot \frac{1}{s} + \left(-\frac{1}{a}\right)\frac{1}{s^2} + \frac{1}{s^3} + \left(-\frac{1}{a^2}\right)\left(\frac{1}{s+a}\right)$$

$$\rightarrow L^{-1}[C(s)] = c(t) = \frac{1}{a^2} - \frac{1}{a}t + t^2 - \frac{1}{a^2} e^{-at}$$

$$\boxed{c(t) = t^2 - \frac{1}{a}t + \frac{1}{a^2}(1 - e^{-at})} \longrightarrow (1)$$

b) Steady state error & error constant

$\rightarrow E(s) = R(s) - C(s).H(s)$

$C(s) = E(s)\,G(s)$

$\rightarrow TF = \frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s).H(s)}$

$\frac{E(s).G(s)}{R(s)} = \frac{G(s)}{1+G(s).H(s)}$

$E(s) = \frac{R(s)}{1+G(s).H(s)}$

$\rightarrow e_{ss} = \lim_{t\to\infty} e(t) = e(\infty)$

$= \lim_{s\to 0} s.E(s)$

$e_{ss} = \lim_{s\to 0} s.\frac{R(s)}{1+G(s).H(s)}$ ——— (1)

Error constant :

(a) Position error constant (K_p)

$e_{ss} = \lim_{s\to 0} \frac{s.R(s)}{1+G(s).H(s)}$

$= \lim_{s\to 0} \frac{s.1/s}{1+G(s)}$

$= \lim_{s\to 0} \frac{1}{1+G(s)}$

$e_{ss} = \lim_{s\to 0} \frac{1}{1+K_p}$ ——— (2)

b) Velocity error constant (K_v)

$\rightarrow R(s) = \frac{1}{s^2}$

$\rightarrow e_{ss} = \lim_{s\to 0} \frac{s.R(s)}{1+G(s).H(s)} = \lim_{s\to 0} \frac{s.R(s)}{1+G(s)}$

$e_{ss} = \lim_{s\to 0} \frac{s.1/s^2}{1+G(s)} = \lim_{s\to 0} \frac{1}{s+s.G(s)} = \frac{1}{\lim_{s\to 0} s.G(s)}$

$e_{ss} = \frac{1}{K_v}$ ——— (2)

(c) Acceleration error constant (K_a)

$\rightarrow R(s) = \frac{1}{s^3}$

$\rightarrow e_{ss} = \lim_{s\to 0} \frac{s.R(s)}{1+G(s)H(s)}$

$= \lim_{s\to 0} \frac{s.R(s)}{1+G(s)}$

$e_{ss} = \lim_{s\to 0} \frac{s.1/s^3}{1+G(s)}$

$= \lim_{s\to 0} \frac{1}{s^2+s^2G(s)}$

$= \frac{1}{\lim_{s\to 0} s^2 G(s)}$

$e_{ss} = \frac{1}{K_a}$ ——— (2)

(4)

Define:-

(i) Delay time —— (1)

(ii) Rise time —— (1)

(iii) Peak time —— (1)

(iv) Maximum overshoot. —— (1)

(v) Setting time. —— (1)

3(b) $\frac{C(s)}{R(s)} = \frac{20}{s^2+6s+25}$

→ $\omega_n^2 = 20$, $\omega_n = \sqrt{20} = 4.47$ rad/sec

→ $2\xi\omega_n = 20$

$\boxed{\xi = 0.447}$

→ (i) Rise time:-

$T_r = \frac{\pi - \theta}{\omega_d}$ | $\theta = \tan^{-1}\left(\frac{\sqrt{1-\xi^2}}{\xi}\right)$ | $\omega_d = \omega_n\sqrt{1-\xi^2}$

$= \tan^{-1}\left(\frac{\sqrt{1-0.447^2}}{0.447}\right)$ | $\omega_d = 4.47 \times \sqrt{1-0.447^2}$

$\boxed{T_r = -15.11}$ | $\boxed{\theta = 63.440}$ | $\omega_d = 3.99$ rad/sec. —— (2)

→ (ii) Delay time:-

$T_D = \frac{1+0.7\xi}{\omega_n}$ —— (2)

$= \frac{1+0.7 \times 0.447}{4.47}$

$\boxed{T_D = 0.29 sec}$

→ (iii) Peak time:-

$T_p = \pi/\omega_d = \frac{\pi}{3.99} = 0.78 sec.$ —— (2)

(iv) Peak overshoot.

$M_p = e^{-\pi\xi/\sqrt{1-\xi^2}}$ —— (2)

$= e^{-\pi \times 0.447/\sqrt{1-0.447^2}}$

$\boxed{M_p = 0.208}$

$\%M_p = 0.208 \times 100$

$\boxed{\%M_p = 20.80\%}$

(v) Setting time:-

$T_s = 4/\xi\omega_n = \frac{4}{0.447 \times 4.47}$ —— (2)

$\boxed{T_s = 2.001 sec}$

(5)

Second Order → unit step Responce :–

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2}$$

$$C(s) = \frac{1}{s}\cdot\frac{\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2} \quad \left\{R(s)=\frac{1}{s}\right\}$$ ——→ (1)

→ By partial fraction of above eqn is.

$$C(s) = \frac{1}{s} - \frac{s+2\xi\omega_n}{(s^2+2\xi\omega_n s+\omega_n^2)}$$

$$C(s) = \frac{1}{s} - \frac{s+2\xi\omega_n}{(s^2+2\xi\omega_n s+\xi^2\omega_n^2+\omega_n^2-\xi^2\omega_n^2)}$$ ←— (2)

$$= \frac{1}{s} - \frac{s+2\xi\omega_n}{(s+\xi\omega_n)^2+\omega_n^2(1-\xi^2)}$$ ←— (2)

$$= \frac{1}{s} - \frac{s+2\xi\omega_n}{(s+\xi\omega_n)^2+\omega_d^2} \quad \left\{\omega_d = \omega_n\sqrt{1-\xi^2}\right\}$$ —(2)

$$= \frac{1}{s} - \frac{s+\xi\omega_n}{(s+\xi\omega_n)^2+\omega_d^2} - \frac{\xi\omega_n}{(s+\xi\omega_n)^2+\omega_d^2}$$

$$= \frac{1}{s} - \frac{s+\xi\omega_n}{(s+\xi\omega_n)^2+\omega_d^2} - \frac{\xi}{\sqrt{1-\xi^2}}\frac{\omega_d}{(s+\xi\omega_n)^2+\omega_d^2}$$ ——(2)

$$C(t) = 1 - e^{-\xi\omega_n t}\cdot\cos\omega_d t - \frac{\xi}{\sqrt{1-\xi^2}}e^{-\xi\omega_n t}\cdot\sin\omega_d t.$$

$$C(t) = 1 - e^{-\xi\omega_n t}\left[\cos(\omega_d t) + \frac{\xi}{\sqrt{1-\xi^2}}\sin(\omega_d t)\right]$$ ———— (2)

b) $\omega_n = 5$ rad/sec, $\xi = 0.6$.

(i) Delay time

$$T_d = \frac{1+0.7\xi}{\omega_n} = \frac{1+0.7(0.6)}{5} = 0.284 \text{ sec}$$

(1)

(2) Rise time:-

$$T_r = \frac{\pi - \theta}{\omega_d} \qquad \theta = \tan^{-1}\left(\frac{\sqrt{1-\xi^2}}{\xi}\right)$$

$$\omega_d = \omega_n\sqrt{1-\xi^2} \qquad \theta = \tan^{-1}\left(\frac{\sqrt{1-0.6^2}}{0.6}\right)$$

$$= 5\sqrt{1-(0.6)^2}$$

$$\omega_d = 4 \qquad \theta = 53.13 \times \pi/180 = 0.927$$

$T_r = 0.553$ sec

(1)

(3) Peak time:-

$$T_p = \frac{\pi}{\omega_d} = \frac{\pi}{4} = 0.785 \text{ sec}$$

(1)

(4) Maximum overshoot:-

$$M_p = e^{-\frac{\pi\xi}{\sqrt{1-\xi^2}}} \times 100$$

$$e^{-\frac{\pi \times 0.6}{\sqrt{1-0.6^2}}} \times 100$$

$$M_p = 0.094 \times 100$$

$M_p = 9.4\%$

(1)

Faculty Sig.

H.O.D
Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
Mijar, MOODBIDRI - 574 225
1/1/2024

IQAC member.

Sl. No.	Name of the Student	USN
1	Adhwith	4AL20ME001
2	Akshar N	4AL20ME002
3	Babugouda Shankaragouda	4AL20ME003
4	Chandan Bhosale Urf Hagedal	4AL20ME004
5	Chiranth H S	4AL20ME006
6	Dileep P R	4AL20ME007
7	Frison Nikhil Martis	4AL20ME008
8	Girish B Bannikoppa	4AL20ME009
9	Jenny Fernandes	4AL20ME011
10	Manoj Kumar Karnam	4AL20ME012
11	Manu K N	4AL20ME013
12	Mohammed Swahid	4AL20ME014
13	Mohammed Fahad H	4AL20ME015
14	Navyashree H B	4AL20ME016
15	Pallavi P	4AL20ME017
16	Pavankumar H R	4AL20ME018
17	Rakshith S	4AL20ME019
18	Varun S Bhandary	4AL20ME021
19	Vignesh	4AL20ME022
20	Doddamallia	4AL21ME400
21	Rahul Kambar	4AL21ME401
22	Rakesh Kelagadi	4AL21ME402
23	Sachin Rathod	4AL21ME403
24	Sandeep Jarale	4AL21ME404

ALVA'S INSTITUTE OF ENGINEERING AND TECHNOLOGY

MIJAR, MOODBIDRI - 574 225

ATTENDANCE CUM INTERNAL ASSESSMENT

Class : 7

Subject : Control Engineering

No. of Classes held : 52

Subject :

	Sl. No.	U.S.N.	Name	1 (1/9)	2 (13/9)	3 (15/9)	4 (16/9)	5 (20/9)	6 (22/9)	7 (25/9)	8 (26/9)	9 (27/9)	10 (29/9)	11 (3/10)	12 (4/10)	13 (6/10)	14 (9/10)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	60	No. of Class Attended	% of Attendance	IA I	IA II	IA III	Ag	Average Marks
26	1 (30)	4AL20ME 001	Adhwith	1	2	3	4	5	6	7	.	8	9	10	11	12	13	4	15	16	17	18	19	20	21	22	23	24	25	26	27	28		48	92	16	19	11	15	25
36	2 (40)	002	Akshar. N	1	2	3	4	5	6	7	8	9	10	11	12	13	14		17	18	19	20	21	22	23	24	25	26	27	28	29	30		49	94	28	27	21	26	36
32	3 (36)	003	Babygowda. S	1	2	3	4	5	6	7	8	9	10	11	12	13	14		17	18	19	20	21	22	23	24	25	26	27	28	29	30		50	96	25	20	19	22	32
37	4 (40)	004	Chandan. B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	6	17	18	19	20	21	22	23	24	25	26	27	28	29	30		50	96	25	24	30	27	37
30	5 (34)	006	Chiranth. H.S	1	2	3	4	5	6	7	8	9	10	11	12	13	14		17	18	19	20	21	22	23	24	25	26	27	28	29	30		51	98	22	20	17	20	30
30	6 (34)	007	Dileep. P.R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	6	17	18	19	20	21	22	23	24	25	26	27	28	29	30		48	92	18	17	23	20	30
32	7 (36)	008	Frison. Nikhil. M	1	2	3	4	5	5	5	5	6	7	8	9	10	11	3	14	15	16	17	18	19	20	21	22	23	24	25	26	27		47	90	30	23	12	22	32
37	8 (40)	009	Girish. B. B	1	2	3	3	4	5	6	6	7	8	9	10	11	12	4	15	16	17	18	19	20	21	22	23	24	25	26	27	28		46	88	28	30	22	27	37
40	9 (40)	011	Jenny. F	1	2	3	4	5	6	7	7	8	9	10	11	12	13	-	16	17	18	19	20	21	22	23	24	25	26	27	28	29		48	92	30	30	30	36	40
36	10 (40)	012	Manoj kumar. K	1	2	3	4	5	6	7	7	8	9	10	11	12	13	-	16	17	18	19	20	21	22	23	24	25	26	27	28	29		47	90	29	26	21	26	36
(36)	11 (40)	013	Manu. K. N	1	2	3	4	5	6	7	7	8	9	10	11	12	13	4	15	16	17	18	19	20	21	22	23	24	25	26	27	28		49	94	29	30	19	26	36
32	12 (36)	014	Mohammed S	1	2	3	4	5	6	7	7	8	8	9	10	11	12	2	13	13	14	14	15	16	17	18	19	20	21	22	23	24		46	88	09	27	28	22	32
37	13 (40)	015	Mohammed. Fahad	1	2	3	4	5	6	7	8	9	10	10	10	11	12	4	15	16	17	18	19	20	21	22	23	24	25	26	27	28		49	94	25	30	26	27	37
38	14 (40)	016	Navyashree. H.B	1	2	3	4	5	6	7	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22	23	24	25	26	27	28	28		50	96	30	25	28	28	38
(36)	15 (40)	017	Pallavi. P	1	2	3	4	5	6	7	7	8	9	10	11	12	13	3	14	15	16	17	18	19	20	21	22	23	24	25	26	27		46	88	28	23	27	26	36
(36)	16 (40)	018	Pavankumar. H.R	1	2	3	4	5	6	7	8	9	10	11	12	13	14	5	17	18	19	20	21	22	23	24	25	26	27	28	29	30		49	94	27	19	30	26	36
39	17 (40)	019	Rakshith S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	6	17	18	19	20	21	22	23	24	25	26	27	28	29	30		45	86	28	27	30	29	39
31	18 (35)	021	Varun. S.B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	6	17	18	19	20	21	22	23	24	25	26	27	28	29	30		47	90	18	26	17	21	31
30	19 (34)	022	Vignesh.	1	2	3	4	5	6	7	7	8	9	10	11	12	13	-	16	17	18	19	20	21	22	23	24	25	26	27	28	29		48	92	15	29	14	20	30
31	20 (35)	4AL21ME 400	Doddamallia	1	2	3	4	5	6	7	7	8	9	10	10	11	12	4	15	16	17	18	19	20	21	22	23	24	25	26	27	28		52	100	22	22	19	21	31
(38)	21 (40)	401	Rahul. K	1	2	3	4	5	6	7	7	8	9	10	11	12	13	5	16	17	18	19	20	21	22	23	24	25	26	27	28	29		52	100	23	30	30	28	38
29	22 (33)	402	Rakesh.	1	2	3	4	5	6	7	8	9	10	10	11	12	13	5	16	17	18	19	20	21	22	23	24	25	26	26	27	28		51	98	04	27	24	19	29
40	23	403	Sachin Rathod	1	2	3	4	5	6	7	8	9	9	10	10	11	12	14	15	16	17	18	18	19	20	21	22	23	24	25	26	27		49	94	30	30	30	30	39 40
35	24 (39)	404	Sandeep Jarale	1	2	3	4	5	6	7	7	8	9	10	11	12	13	5	16	17	18	19	20	21	22	23	24	25	26	26	27	28		46	88	25	27	22	25	35
	25																																							
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	28																																							
	29																																							
	30																																							
	Staff Initials																																							

Manoj Kumar Karnam

4AL20ME011

AIET	ASSIGNMENTS	Format No. ACD 10 Issue No. 01 Rev. No. 00

Department	Mechanical Engineering	Academic Year	2023-24
		Semester	7th

Sl.No.	Title	Books / Journals / Magazines referred	Date of Announcement	Date of Submission	Signature of the faculty
1.	Module-1	Books.	14/9/23	21/9/23	
2.	Module 3	Books	31/10/23	18/10/23	
3.	Module 4.	Books.	19/10/23	9/11/23	
4.	Module 5	Books	29/11/23	2/12/23	
5.	Module 2	Books	16/12/23	06/12/23	

6/1/24

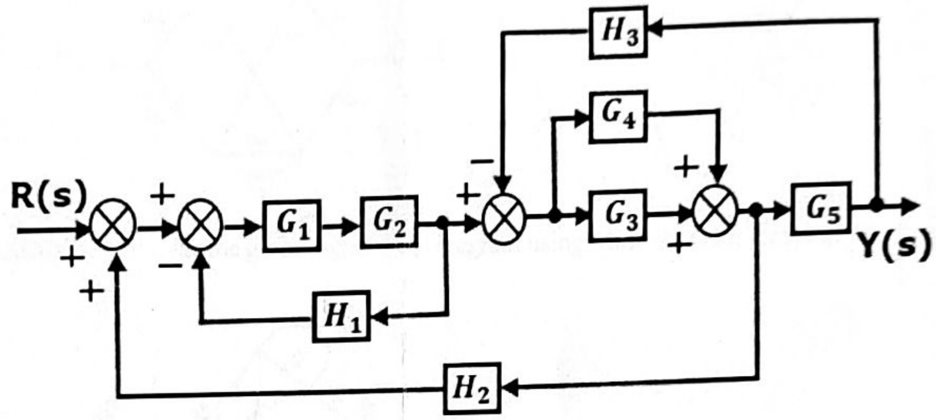
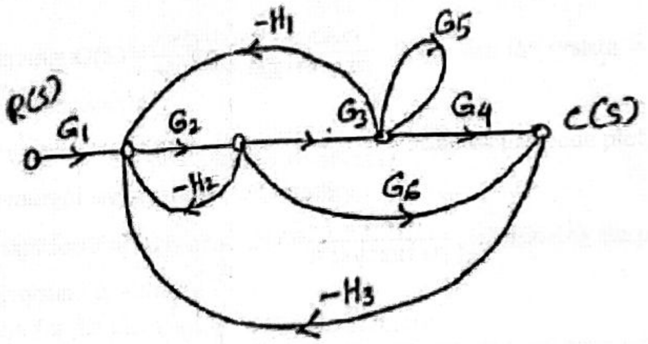
AIET	INTERNAL EXAM RESULT ANALYSIS	Format No. ACD 12 Issue No. 01 Rev. No. 00

Department	Mechanical Engineering	Semester	7
		Subject Code	18ME71
Total No. of Students	24.	Academic Year	2023-24

Test	Date	Number of Students				Signature		Remarks
		Attended	0-14	12-20	21-30	Faculty	HOD	
T_1	26/10/23	24	04	05	15			
T_2	4/12/23	24	–	05	19			
T_3	1/1/24	24	01	04	19			
T_4								
T_5								

Signature of Staff in - charge

HOD's Signature 6/1/24

1	a)	What are requirements of an ideal control system? With neat sketch, explain the working of an automatic tank-level control system
	b)	Define control system compare open loop and closed loop control system with an example for each type
2	a)	With a block diagram, explain i) Proportional Plus Integral controller (PI) ii) Proportional+integral+derivative controller
	b)	Define: i) Actuating signal ii) Disturbance iii) Controller iv) control system
3	a)	Obtain the overall transfer function for the block diagram shown in figure 
	b)	Using Masons gain formula, find the gain of the following system shown in figure 
4	a)	A feedback control system has open loop transfer function $$G(s)H(s) = \frac{K}{S(S+4)(S^2+4S+20)}$$ Construct the root locus plot for the system and hence determine range of values of 'k' for the system to be stable.

Drill Test - I   Date: 12/10/2023

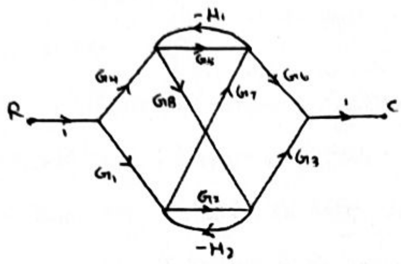
Control Engineering → 2023-24

Drill-Test – 2 [Control Engineering] **10-11-2023**

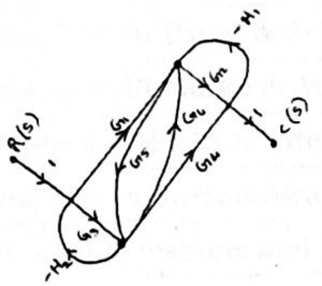
1) An aeroplane with Auto-pilot in the longitudinal mode has a simplified open loop transfer function, G(S) H(S)= $\frac{K(S+1)}{S(S-1)(S^2+4S+16)}$, Sketch the root locus plot and determine the range of 'K' and stability.

2) Sketch the root locus plot for a control system whose open loop transfer function is, G(S) H(S) = $\frac{K}{S(S+3)(S^2+2S+2)}$ for what value of 'K', the system is stable.

3) Determine the transfer function for the given signal flow diagram using Mason's Gain formula



4) Determine the transfer function for the given signal flow diagram using Mason's Gain formula



5) Draw the Bode plot for system having, G(S) = $\frac{K(1+0.2S)(1+0.025S)}{S^3(1+0.001S)(1+0.005S)}$, Show that the system is conditionally stable. Find the range of 'K' for which the system is stable.

6) A particular unit feedback system given by, $G(S) = \frac{242(S+5)}{S(S+1)(S^2+5S+121)}$, Sketch the Bode plot. Find W_{gc} , W_{pc} . Calculate gain margin and phase margin and comment on stability.

7) Open loop transfer function of a unit feedback system G(S) = $\frac{K\,e^{-0.1S}}{S(1+0.1S)(1+S)}$, by drawing the plot determine the value of 'K' so that the gain margin of the system is +20dB.

8) Obtain the overall transfer function for the block diagram shown in figure.