CMR Engineering College

Kandlakoya (V), Medchal Road, Hyderabad

Department of Electronics & Communication Engineering

COURSE FILE

Sub: CONTROL SYSTEMS **A.Y:2022-2023**
Year: II Year B.Tech II Semester

CONTENTS

HOD **PRINCIPAL**

1. Department of Electronics and Communication Engineering

Vision of the Institute:

To be recognized as a premier institution in offering value based and futuristic quality technical education to meet the technological needs of the society.

Mission of the Institute:

1. To impart value based quality technical education through innovative teaching and learning methods.
2. To continuously produce employable technical graduates with advanced technical skills to meet the current and future technological needs of the society.
3. To prepare the graduates for higher learning with emphasis on academic and industrial research.

1. Vision of the Department:

To promote excellence in technical education and scientific research in electronics and communication engineering for the benefit of society.

Mission of the Department:

- To impart excellent technical education with state of art facilities inculcating values and lifelong learning attitude.
- To develop core competence in our students imbibing professional ethics and team spirit.
- To encourage research benefiting society through higher learning
-

2. PEOs:

1. Excel in professional career & higher education in Electronics & Communication Engineering and allied fields through rigorous quality education.
2. Exhibit professionalism, ethical attitude, communication skills, team work in their profession and adapt to current trends by engaging in lifelong learning.
3. Solve real life problems relating to Electronics & Communications Engineering for the benefits of society.

PROGRAM OUTCOMES (PO's):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and

leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSO's):

1. Ability to apply concepts of Electronics & Communication Engineering to associated research areas of electronics, communication, signal processing, VLSI, Embedded systems.

2. Ability to design, analyze and simulate a variety of Electronics & Communication functional elements using hardware and software tools along with analytic skills.

3. Mapping of course out comes with POs and PSOs

COURSE CODE & NAME	COURSE OUTCOMES
EC503PC.1	**Classify** the control systems and concept of feedback in control systems.
EC503PC .2	**Apply** different rules and techniques to determine the transfer function of the block diagrams, signal flow graphs and mathematical models.
EC503PC .3	**Analyze** time response of different ordered systems. Also **analyze** the stability of the systems using R-H criterion & root locus techniques.
EC503PC .4	**Determine** the stability of the system using BODE plot, polar plot & Nyquist plot.
EC503PC .5	**Develop** the state models from block diagram.
EC503PC .6	**Discuss** the observability & controllability and compensators

CO-PO Matrix:

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
EC503PC.1	2	-	-	-	-	-	-	-	-	-	-	-
EC503PC.2	2	2	-	-	-	-	-	-	-	-	-	-
EC503PC.3	2	2	2	-	-	-	-	-	-	-	-	-
EC503PC.4	2	2	3	-	-	-	-	-	-	-	-	-
EC503PC.5	-	-	2	-	-	-	-	-	-	-	-	-
EC503PC.6	-	2	1	-	-	-	-	-	-	-	-	-

Course Outcome (CO)-Program Specific Outcome (PSO) Matrix:

CO's/ PSO's	**PSO1**	**PSO2**
EC503PC.1	2	-
EC503PC.2	2	-
EC503PC.3	2	2
EC503PC.4	2	2
EC503PC.5	-	-
EC503PC.6	2	-

4. SYLLABUS – R20

UNIT-I **Introduction to Control Problem:** Introduction to Control Systems, Feedback Control Open-Loop and Closed-loop systems. Benefits of Feedback, Industrial Control examples Mathematical models of physical Systems, Control hardware and their models. Transfer function models of linear time-invariant systems, Block diagram algebra, Signal Flow Graph.

UNIT - II Time Response Analysis of Standard Test Signals: Time response of first and second order systems for standard test inputs Application of initial and final value theorem Design specifications for second order systems based on the time-response Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis Root-Locus technique, Construction of Root-loci.

UNIT - III Frequency-Response Analysis: Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion - gain and phase margin closed loop frequency response.

UNIT - IV Introduction to Controller Design: Stability, steady-state accuracy transient accuracy, disturbance rejection insensitivity and robustness of control systems Root-loci method of feedback controller design specifications in frequency-domain. Frequency-domain methods of design Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs Analog and Digital implementation of controllers.

UNIT-V State Variable Analysis and Concepts of State Variables: State space model Diagonalization of State Matrix Solution of state equations Eigen values and Stability Analysis. Concept of controllability and observability Pole-placement by state feedback. Discrete-time systems Difference Equations. State-space models of linear discrete-time systems Stability of linear discrete-time systems

UNIT-I
OBJECTIVE

- Types of Control Systems and its examples
- Study the effect of feedback on control system
- Mathematical modeling of various types of control systems
- Study of Control hardware and their models.
- Block diagram representation
- Signal Flow Graph

SYLLABUS

Introduction to Control Problem: Introduction to Control Systems, Feedback Control Open-Loop and Closed-loop systems. Benefits of Feedback, Industrial Control examples Mathematical models of physical Systems, Control hardware and their models. Transfer function models of linear time-invariant systems, Block diagram algebra, Signal Flow Graph.

UNIT –II

OBJECTIVE

- Study of some signal representations
- Study of Characteristic parameters of first- and second-order systems
- Study of Steady state response and error constants
- Study of Stability and RH Criteria, its analysis.
- Construction of Root-loci

SYLLABUS

Time Response Analysis of Standard Test Signals: Time response of first and second order systems for standard test inputs Application of initial and final value theorem Design specifications for second order systems based on the time-response Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis Root-Locus technique, Construction of Root-loci.

UNIT – III

OBJECTIVE

- Study of Frequency domain specifications
- Study of Bode plot method of analyzing the stability of control system
- Concepts of phase margin and gain margin
- Study of Polar plot and Nyquist plot

SYLLABUS

Frequency-Response Analysis: Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion - gain and phase margin closed loop frequency response.

UNIT - IV

OBJECTIVE

- Study of Concept of stability
- Root locus analysis of control system
- Design and Specifications in frequency domains
- Introduction to controllers and its design
- Applications and Implementations of Controllers
- Study of Compensation Techniques

SYLLABUS

Introduction to Controller Design: Stability, steady-state accuracy transient accuracy, disturbance rejection insensitivity and robustness of control systems Root-loci method of feedback controller design specifications in frequency-domain. Frequency-domain methods of design Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs Analog and Digital implementation of controllers.

UNIT - V

OBJECTIVE

- State space models
- Concept of controllability and observability
- linear discrete-time systems Stability of linear discrete-time systems
- Discrete-time systems Difference Equations

SYLLABUS

State Variable Analysis and Concepts of State Variables: State space model Diagonalization of State Matrix Solution of state equations Eigen values and Stability Analysis. Concept of controllability and observability Pole-placement by state feedback. Discrete-time systems Difference Equations. State-space models of linear discrete-time systems Stability of linear discrete-time system.

5. INDIVIDUAL TIME TABLE

II-C, D & II-A, D ICA LAB-LAB

DAY/ TIME	9:10-10:10	10:10-11:00	11:00-11:50	11:50-12:40	12:40-01:20	01.20-02:20	02:20-03:10	03.10-4.00
MON	CS-D		CS-C		L		ICA LAB-A	
TUE	ICA LAB-D		ICA LAB-A		U	CS-C	CS-D	
WED					N			
THU	ICA LAB-D			CS-D	C		CS-C	
FRI		CS-D				CS-C		
SAT	CS-D		CS-C		H			

6. Detailed Lecture Plan

Subj. Code	Name of the subject	Year/Branch	Name of the Faculty
EC405PC	CONTROL SYSTEMS	II B.Tech II Sem ECE	Mrs.K.VANI

S.NO	JNTU syllabus	No. of Lecturers Required
UNIT-I		
1	Industrial Control examples	01
2	Mathematical models of physical systems	03
3	Control hardware and their models	01
4	Transfer function models of linear time-invariant systems	01
5	Feedback Control: Open-Loop and Closed-loop systems	03
6	Benefits of Feedback	01
7	Block diagram algebra, Signal Flow Graph	04
8	Problems	02
	No. Of Classes Required	16
UNIT II		
9	Time response of first and second order systems for standard test inputs	03
10	Application of initial and final value theorem	02
11	Design specifications for second order systems based on the time-response	03
12	Concept of Stability,Routh-Hurwitz Criteria	03
13	Relative Stability analysis. Root-Locus technique	03
14	Problems	01
	No. Of Classes Required	15
UNIT III		
20	Relationship between time and frequency response	02
21	Polar plots	03
22	Bode plots	03
23	Nyquist stability criterion. Relative stability using Nyquist criterion	03
24	Gain and Phase margin. Closed-loop frequency response	02
	No. Of Classes Required	13
UNIT IV		
27	Stability, steady-state accuracy, transient accuracy, disturbance rejection	02
28	Insensitivity and robustness of control systems	02
29	Design specifications in frequency-domain	02
30	Frequency-domain methods of design	02
31	Application of Proportional, Integral and Derivative	01

	Controllers	
32	Lead and Lag compensation in designs	02
33	Analog and Digital implementation of controllers	02
	No.Of Classes Required	13
	UNIT V	
40	State space model. Diagonalization of State Matrix	01
41	Solution of state equations. Eigen values and Stability Analysis	02
42	Concept of controllability and observability	02
43	Pole-placement by state feedback	01
44	Discrete-time systems. Difference Equations	02
	State-space models of linear discrete-time systems. Stability of linear discrete-time systems	02
	No.Of Classes Required	10
	Total No.Of Classes Required	67

7. Session Execution Log:

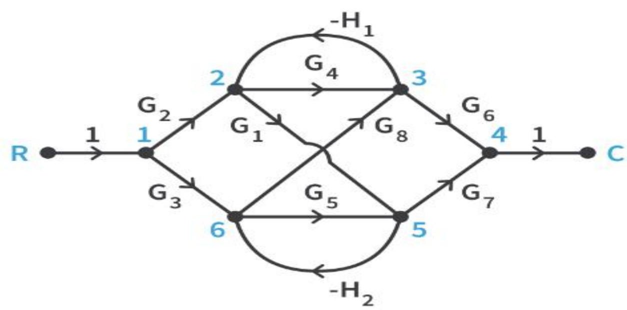
II B.Tech II Sem D-Section

Sl.no	Syllabus	Scheduled completion date	Completed date	Remarks
1	UNIT-I	06/03/2023	15/04/2023	Completed
2	UNIT- II	17/04/2023	13/05/2023	Completed
3	UNIT-III	15/05/2023	24/06/2023	Completed
4	UNIT-IV	02/07/2023	19/07/2023	Completed
5	UNIT-V	26/06/2023	06/07/2023	Completed

8. ASSIGNMENT QUESTIONS
MID-I

SET-I

1. Determine the Transfer function for given signal flow graph. [C0 2] [BL 3]



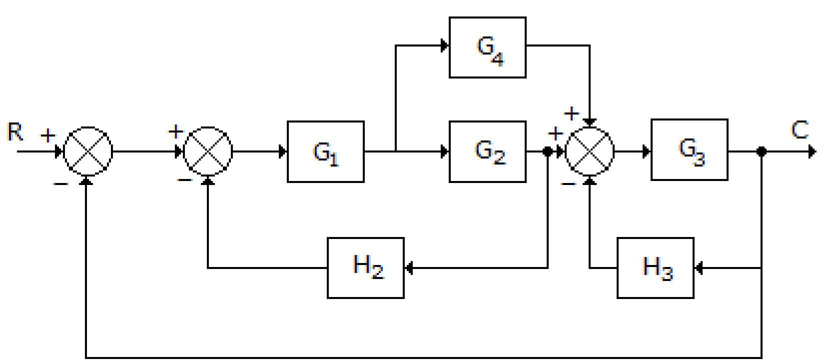
2. Explain Closed Loop Control System with examples. [CO 1][BL 1]
3. Define following Time domain specifications and illustrate them [CO 1][BL 1]
   i) Delay Time ii) Peak Time iii) Rise Time iv) Settling Time v) Maximum Peak overshoot.

4. Define Root Locus. Explain the Procedure of Root Locus. [CO 4][BL 2]
5. Examine the stability of the Characteristic equation given below [CO 4][BL 3]

$$S^6 + 3S^5 + 4S^4 + 6S^3 + 5S^2 + 3S + 2 = 0.$$

SET-II

1. With the help of Block diagram reduction methods obtain the equivalent T.F. [CO 2] [BL 3]



2. The open-loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{10}{(s+2)(s+5)}$$

Determine the settling time and peak overshoot,rise time,Peak time when the system is excited with unit

step input. [CO 3] [BL 3]

3. Determine the range of K so that the system having the characteristic equation will be stable

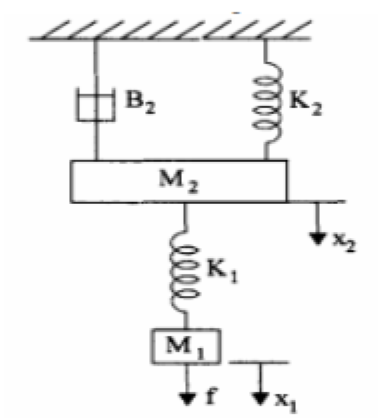
$S^4 + 4S^3 + 7S^2 + 4S + 2K = 0.$ [CO 4][BL 3]

4. Find the steady state errors for the unit step, unit ramp and unit parabolic inputs for the system whose transfer function is $G(S) = \frac{1000(S+1) \quad 1000(S+1)}{(S+10)\,(S+50)(S+10)\,(S+50)}$ and H(S) = 1. [CO 3][BL 3]

5. Define Root Locus. Explain the Procedure of Root Locus with an Example. [CO 4][BL 2]

SET-III

1. Obtain the Transfer function $X_2(S)/F(S)$ for the following Mechanical Translational system. [CO 2][BL 3]



2. a)Explain the control system with an example. [CO 1][BL 2]

b) Distinguish between open loop and closed loop control systems. .[CO 1][BL 1]

3. Define following terms, write the formula for it. [CO 3][BL 2]

i) Delay Time ii) Peak Time iii) Rise Time iv) Settling Time v) Maximum Peak overshoot.

4.Define Steady State Error and Explain the error constants. [CO 3][BL 2]

5. Examine the stability of the Characteristic equation given below [CO 4][BL 3]

$$S^6 + 3S^5 + 4S^4 + 6S^3 + 5S^2 + 3S + 2 = 0$$

MID-II

SET-I

1. Sketch the Bode plot and determine the Phase Margin and Gain Margin for the open loop transfer function given

$$, G(s) == \frac{8}{s(1+0.3s)(1+0.1s)}$$ (CO4)

2. Define Compensator? Explain the types of the compensators? (CO 4)

3. A system is described by

$$\dot{x} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} x$$

Find the Transfer function. (CO 5)

4. The open loop transfer function of the unity feedback system is given by $G(s)= 1/s^2(1+s)(1+2s)$. Sketch the polar plot and determine the gain margin and phase margin. (CO4)

5.a) Define observability and controllability? (CO 5)

b) Find the State transition matrix for the following $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$ matrix,

Set-II

1. The forward path transfer function of a Unity-feedback control system is given. Draw the Bode plot of G(s) and find the value of K so that the gain margin of the system is 20 db. (CO4)

$$G(s) = \frac{K}{s(1+0.1s)(1+0.5s)}$$

2. Define Compensator? Explain the types of the compensators? (CO 4)

3. Construct the Nyquist plot for a system whose open loop transfer function is given by $G(s)H(s)=K(1+s)^2/s^3$. Find the range of K for stability. (CO 4)

4. Explain the following control action with neat schematic diagram and derive its necessary equations. (CO4)

i) Proportional ii) Integral iii) Derivative iv) Proportional plus integral.

5. a) Calculate the transfer function of the system represented in the state space model as, (CO5)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} [u] \qquad Y = [0 \quad 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b)Write the properties of state transition matrix. (CO5)

SET-III

1. The open loop transfer function of the unity feedback system is given by

$$G(s)= 1/s^2(1+s)(1+2s)$$

Sketch the polar plot and determine the gain margin and phase margin.
(CO4)
2. Define Compensator? Explain the types of the compensators? (CO 4)
3. Construct the Nyquist plot for a system whose open loop transfer function is given by

$$G(s)\,H(s) = \frac{10}{s(s+3)(s+6)}$$

Find the range of K for stability.
(CO4)
4. The state variable formulation of a system is given by

$$[\dot{x}] = \begin{bmatrix} -3 & 2 \\ -1 & 0 \end{bmatrix}[x] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 0 \end{bmatrix}[x]$$

Find the Transfer function of the system.
(CO5)
5. Explain the Construction Procedure of Bode Plot? (CO 4)

9. Sample Assignment Scripts
(Attached Separately)

10. Unit Wise Subject Material.
(Attached separately)

11. Mid Exam Question Papers:

MID-I Question Paper

CMR ENGINEERING COLLEGE
UGC AUTONOMOUS
(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)
Kandlakoya (V), Medchal (M), Medchal - Malkajgiri (D)-501401

II.B.TECH- II-SEM -II MID EXAMINATIONS, Date: 12-05-2023 Time: 10:00 AM TO 11:30 AM
Subject: CONTROL SYSTEMS Branch: ECE Marks: 25 M

Note: Question paper contains two parts, Part - A and Part - B.
Part-A is compulsory which carries 10 marks. Answer all questions in part-A.
Part-B consists of (2 1/2) units. Answer any one full question from each unit. Each question carries 5 marks and may have a, b, c sub questions.

PART A **5 x 2=10**

1. What is control system? Classify them. [CO 1] [BL 1]
2. Define Transfer Function. [CO 2] [BL 1]
3. Define Rise Time and Peak Time. [CO 3] [BL 2]
4. Explain Error Constants Kp, Kv, Ka. [CO 3] [BL 2]
5. Determine the range of K so that the system having the characteristic equation will be stable $S^4 + 4S^3 + 7S^2 + 4S + 2K = 0$. [CO 4] [BL 3]

PART B **3x5=15**

6. Determine the Transfer function for given signal flow graph. [CO 2] [BL 3]

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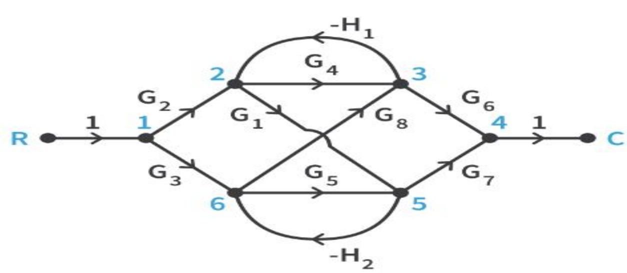
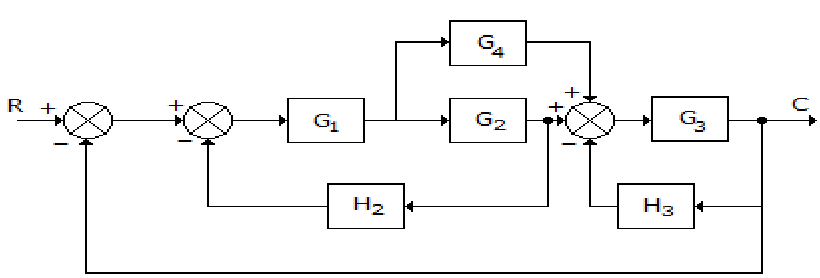
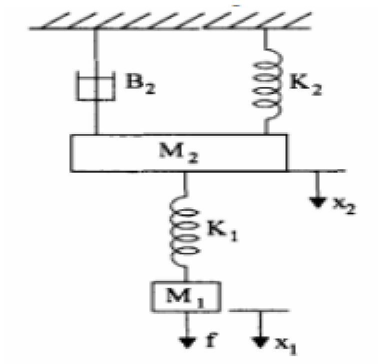


(OR)

7. With the help of Block diagram reduction methods obtain the equivalent T.F. [CO 2] [BL 3]



8. Obtain the Transfer function $X_1(S)/F(S)$ for the following Mechanical Translational system. [CO 2] [BL 3]



(OR)

9. a)Explain the control system with an examples. [CO 1] [BL 2]
b) Distinguish between open loop and closed loop control systems. [CO 1] [BL 1]

10. The open-loop transfer function of a unity feedback control system is given by

$$G(s) = \frac{10}{(s+2)(s+5)}$$

Determine the settling time and peak overshoot, rise time, Peak time when the system is excited with unit step input. [CO 3] [BL 3]

(OR)

11. Define Root Locus. Explain the Procedure of Root Locus. [CO 4] [BL 2]

MID-II Question Paper

CMR ENGINEERING COLLEGE

UGC AUTONOMOUS

(Approved by AICTE - New Delhi. Affiliated to JNTUH and Accredited by NAAC & NBA)

Kandlakoya (V), Medchal (M), Medchal - Malkajgiri (D)-501401

II.B.TECH- II-SEM -II MID EXAMINATIONS, Date: 28-07-2023 Time: 10:00 AM TO 11:30 AM

Subject: CONTROL SYSTEMS Branch: ECE Marks: 25 M

Note: Question paper contains two parts, Part - A and Part - B.

Part-A is compulsory which carries 10 marks. Answer all questions in part-A.

Part-B consists of (2 1/2) units. Answer any one full question from each unit. Each question carries 5 marks and may have a, b, c sub questions.

PART A **5 x 2=10**

1. What is Compensation. [CO 1] [BL 1]
2. Draw the Pole zero Plot of Lead compensator. [CO 2] [BL 1]
3. Define Gain Margin and Phase Margin. [CO 3] [BL 2]
4. Define Controllability and Observability. [CO 3] [BL 2]
5. Derive the solution of state equation. [CO 4] [BL 3]

PART B **3x5=15**

6. Draw the Bode plot for the given transfer function. [CO 2] [BL 3]

G(s) =2500/s(s+5) (s+50)

(OR)

7. The open loop transfer function of the unity feedback system is given by

G(s) = 1/s(1+s)(1+2s)

Sketch the polar plot and determine the gain margin and phase margin. [CO 2] [BL 3]

8. Explain the Procedure to Design the Lag compensator using Bode Plot. [CO 2] [BL 3]

(OR)

9. Derive the Transfer Function of Lag Compensator and Draw the frequency Response. [CO 1] [BL 2]

10. The state variable formulation of a system is given by [CO 3] [BL 3]

$$[\dot{x}] = \begin{bmatrix} -3 & 2 \\ -1 & 0 \end{bmatrix} [x] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 0 \end{bmatrix} [x]$$

(OR)

11.Find the State Transition Matrix for given 2x2 Matrix A . [CO 4] [BL 2]

$$A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$$

12. Scheme of Evaluation:

MID-I

Branch: ECE **Subject: CS**

Year: II-II **Date: 12/05/2023**

Total marks: 25 **Time: 10 A.M To 11:30 A.M**

Scheme of Evaluation

S.NO	THEORY	MARKS	TOTAL
	PART-A		
1	Definition of Control Systems	1	2 Marks
	Classification of Control Systems	1	
2	Definition of Transfer Function	2	2 Marks
3	Definition of Rise Time, Formula	1	2 Marks
	Definition of Peak Time, Formula	1	
4	Formulas for Kp,Kv,Ka	2	2 Marks
5	RH Array Tabulation	1	2 Marks
	Comment on stability of system	1	
	PART-B		
6	Finding Forward Paths, Loops	2	5 Marks
	Calculation of Δ, Δ_k	2	
	Final Transfer Function	1	
7	Reduction rules with Step by Step Procedure of given Block Diagram	4	5 Marks
	Transfer Function	1	
8	Free Body Diagram	2	5 Marks
	Force Balance Equation	1	
	Final Transfer Function	2	
9	a)Explanation of Control system with example	3	5 Marks
	b)Difference between Open and Closed Loop(4 Points)	2	
10	Calculation of Settling time and Peak overshoot	2.5	5 Marks
	Calculation of Peak time and Rise time	2.5	
	Definition of Root Locus	1	

11	Step by step Procedure of Root Locus	4	5 Marks

MID-II

Branch: ECE **Subject: CS**
Year: II-II **Date: 28/07/2023**
Total marks: 25 **Time: 10 A.M To 11:30 A.M**

Scheme of Evaluation

S.NO	THEORY	MARKS	TOTAL
PART-A			
1	Definition of Compensation	1	2 Marks
2	Pole Zero Plot of Lead Compensator	2	2 Marks
3	Definition of Gain Margin	1	2 Marks
	Definition of Phase Margin	1	
4	Definition of Observability	1	2 Marks
	Definition of Controllability	1	
5	Derivation of State Equation	2	2 Marks
PART-B			
6	Finding the Magnitude of given Transfer function	2	5 Marks
	Finding the Phase of given Transfer function	2	
	Sketch of Bode Plot	1	
7	Finding the Magnitude of given Transfer function	2	5 Marks
	Finding the Phase of given Transfer function	2	
	Determination of Gain Margin and Phase Margin, Sketch Polar Plot	1	
8	Design Procedure for Lag Compensator using Bode Plot		5 Marks
9	Derivation of Lag Compensator	3	5 Marks
	Frequency Response	2	
10	State Variable Formation	2	5 Marks
	Calculation of Transfer function	3	
11	State Transition Matrix Formula	1	5 Marks
	Calculation of State Transition Matrix	4	

13. Sample Mid Answer Scripts:

(Attached Separately)

CS LECTURE NOTES.rar

14. Material collected from Internet/Websites

cs chapter-1.rar

15. ICT Materials

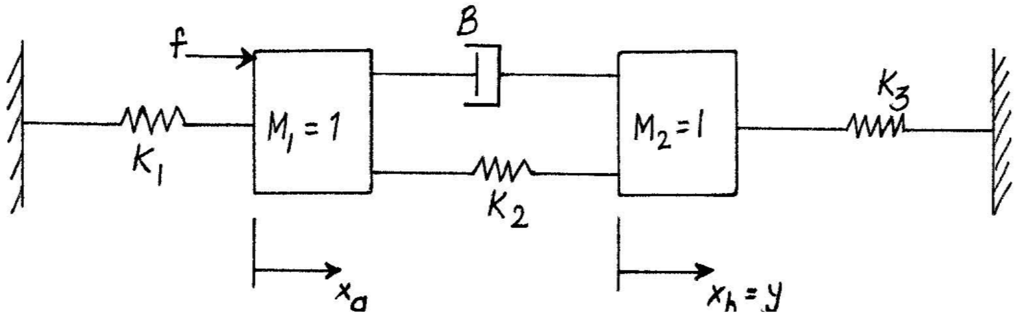
Cs-ppts.rar

16. Previous Question Papers (Question Bank)

UNIT-I

1.Explain open loop & closed loop control systems by giving suitable examples & also highlights their merits & demerits.

2. Write the advantages and disadvantages of open loop and closed loop systems.
3. What are the characteristics of feedback?
4. Explain the effects of feedback in control systems.
5. With suitable example explain the classification of control systems.
6. Explain the following terms
   a. Transfer function
   b. Open loop system
   c. Closed loop system
   d. Sensitivity
7. List out the limitations of open loop systems over a closed loop systems.
8. Give the advantages of feedback using feed control system.
9. Derive the differential equation relating the position y(t) and the force f(t) as shown in Figure (IES 2003)



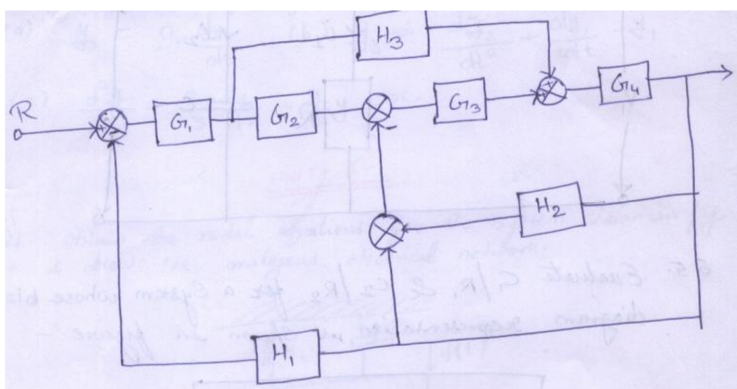
10. What is a mathematical model of a physical system? Explain briefly?

11. Distinguish between open loop and closed loop system.

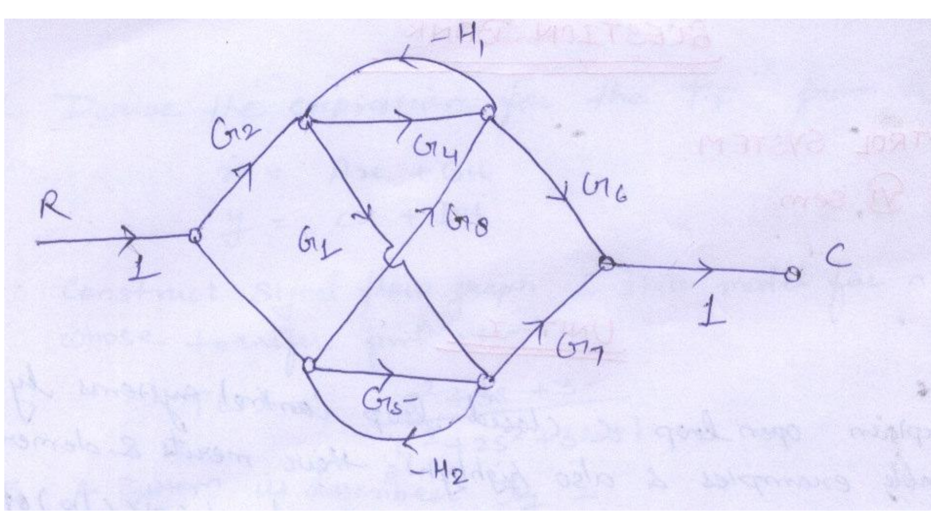
12. Define transfer function and discuss its limitations.

13. (a) Determine the overall transfer function (C/R) of the system shown in figure by block diagram reduction technique

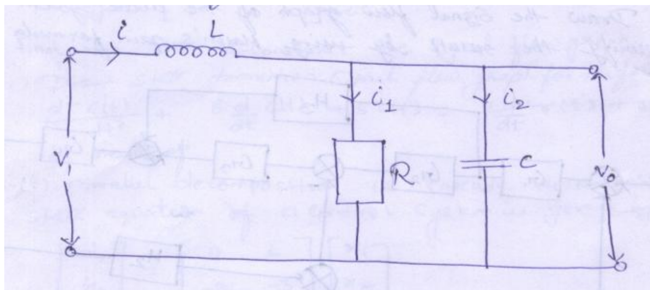
(b) Draw the Signal flow graph of the above system & verify the result by using Mason's gain formula.



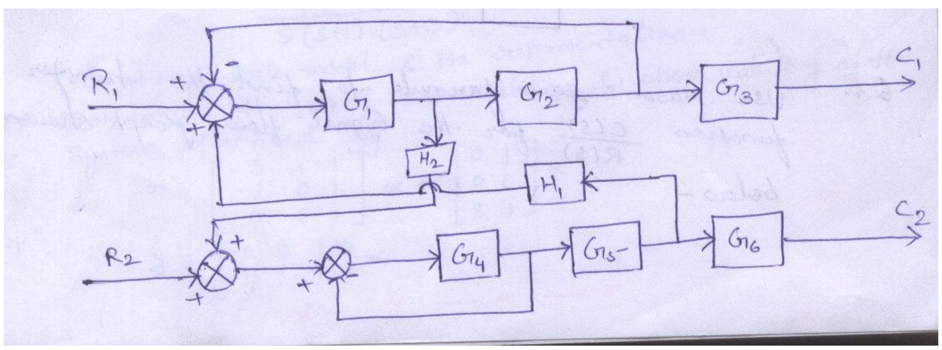
14.Use Mason's gain formula to find the transfer function C(s)/R(s) for the signal flow graph shown below (IES 2008)



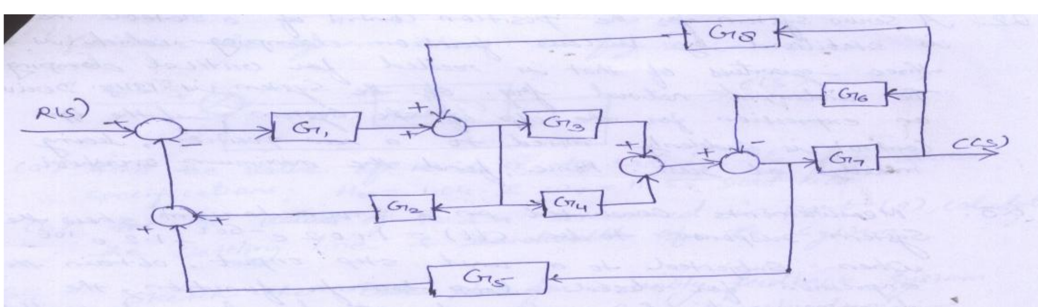
15.Find the transfer function of the electrical network shown in figure (GATE 1999)



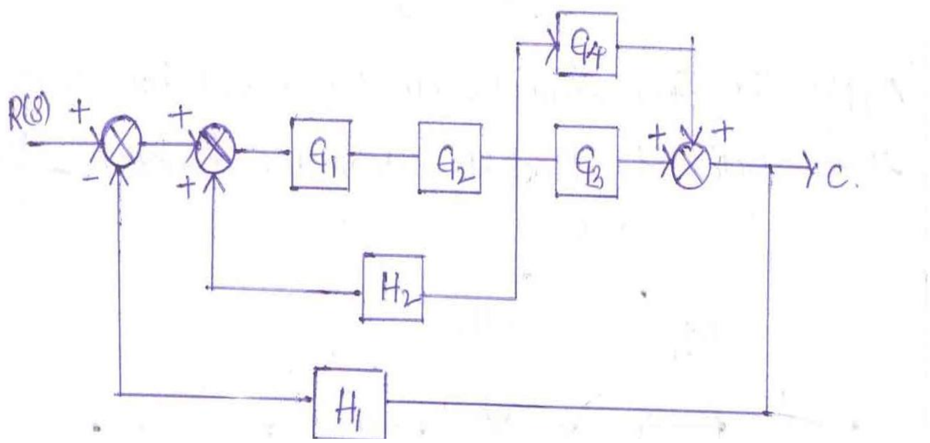
16. Evaluate C1/R1 & C2/R2 for a system whose block diagram representation is shown in figure



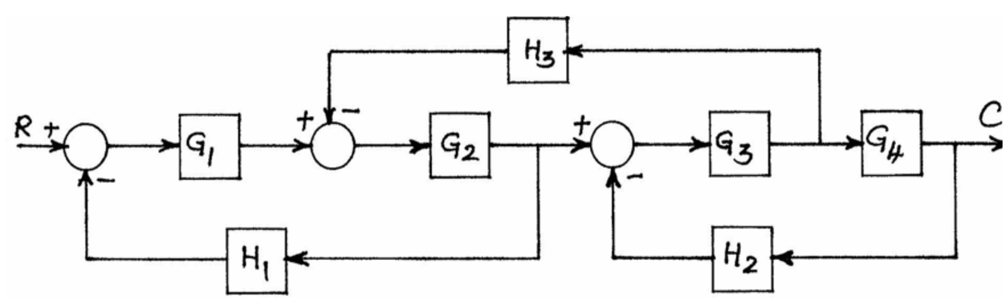
17. Find the transfer function of a AC servo motor
18. Explain the Armature voltage controlled DC servomotor and obtain its transfer function.
19. Determine C(s)/R(s) (IES 2006)



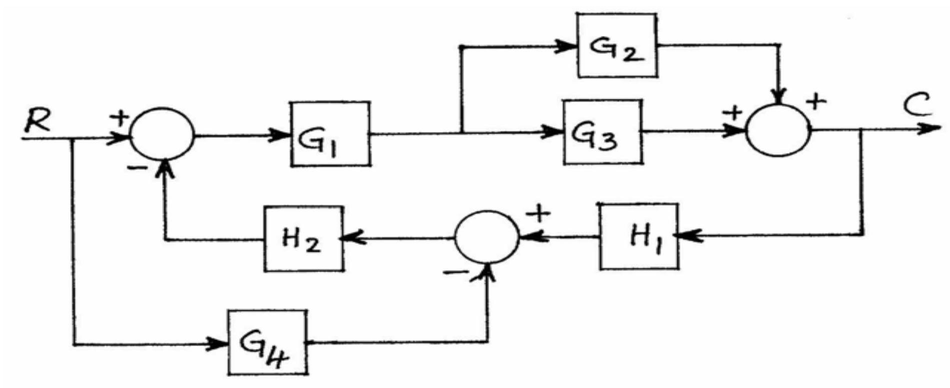
20. Using block diagram reduction techniques, find the closed loop transfer function of the system whose block diagram is given in Figure and verify the result using signal flow graph technique



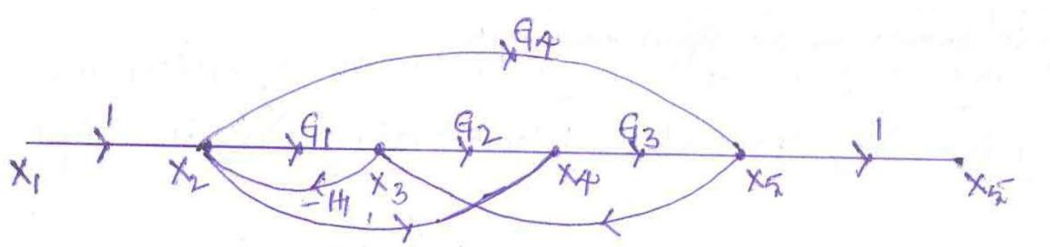
21. Explain Mason's gain formula.
22. Find the transfer function of the system shown in Figure. (GATE 2001)



23. Using block diagram reduction techniques find the closed loop transfer function of the system whose block diagram is given in Figure 11 and verify the result using signal flow graph technique.



24. Using Mason's gain formula, find the transfer function of the system whose signal flow graph is shown in below. (IES 2004)



25. Explain synchros with neat sketches.
26. What are advantages and limitations of block diagram representation of a system.
27. Explain the properties of signal flow graph?
28. Explain the synchros transmitter and receiver and write its advantages

UNIT-II

1. For a unity feedback system whose open loop transfer function is $G(s) = 50/(1+0.1s)(1+2s)$, find the position, velocity & acceleration error constants.
2. A feedback control system is described as $G(s) = 50/s(s+2)(s+5)$, $H(s) = 1/s$ For a unit step input, determine the steady state error constants & errors.
3. The closed loop transfer function of a unity feedback control system is given by $C(s)/R(s) = 10/(s2+4s+5)$ Determine
   (i) Damping ratio
   (ii) Natural undammed resonance frequency (GATE 2000)
   (iii) Percentage peak overshoot
   (iv) Expression for error response.

4. Obtain the unit step response of a unity feedback system whose open loop transfer function is $G(S) = 4/S (S+5)$. (GATE 2005)
5. Determine the step, ramp and parabolic error constants of the unity feedback control system. The open loop transfer function is following. $G(S) = 1000/(1+0.1S)(1+10S)$.

6. Obtain the unit ramp response of a unity feedback system, whose open loop transfer function is $G(S) = 5/S(S+4)$. (IES 2000)
7. The open loop transfer function of a unity feedback control system is $G(S) = 100/S(1+0.1S)$. Determine the steady state error of the system when the input $r(t) = (2+5t)\,u(t)$.
8. Write the specifications of a second order system.
9. Sketch the impulse response of a second order system when damping factor is
   i) 0 ii) Between 0 and 1 iii) Greater than
10. What are the time response specifications? Explain each of them.
11. Explain error constants Kp, Kv, Ka for type I system.

UNIT-III

1. With the help of Routh Hurwitz criterion comments upon the stability of the system having the following characteristic equation
2. (a) The closed loop transfer function of an antenna control system is given by-
   $T(s) = k/ S(S+2)$
   Determine the range in which k must lie for the system to be stable.
   (b) How many roots does each of the following polynomials have in the right half of the s-plane.
   (i)
   (ii)
3. Sketch the root-locus of $G(s) = k/ S(S+2)(S+3)$ (IES 2002)
4. The open loop transfer function of a unity gain feedback is given by-
   $G(s) = k(s+2)/ (S+1)(S+3)$, $k>=0$
   (a) Determine all the poles & zeros of G(s).
   (b) Draw the root locus.
5. a) Write the necessary conditions for stability.
   b) Consider a sixth order system with the characteristic equation, $S^6+2S^5+8S^4+13S^3+20S^2+16S+16 = 0$. Using routh stability criterion, find whether the system is stable or not, give the reasons. (GATE & IES 2001)
6. a) A unity feedback controlled system is characterized by open loop transfer function $G(S) = k(S+13)/s(S+3)(S+7)$ using routh criterion calculate the range of value k for the system to be stable.
   b) Write the root locus of the system whose open loop transfer function is $G(S)\,H(S) = k/S(S+5)$. (GATE 2006)
7. a) The characteristic equation for certain feedback control systems is given below. $S^4+4S^3+13S^2+36S+k = 0$. Determine the range of K for the system to be stable.
   b) Write the important rules of root locus to construct.
8. Sketch the root locus plot of a unit feedback system with the open loop transfer function
   $G(S) = K/S(S+2)(S+4)$. (GATE 2003)
9. Sketch the root-locus diagram of a control system whose loop transfer function is
   G(s) H(s) =
   Using the diagram or otherwise find the values of gain at breakaway points and at point of intersection of the loci with the imaginary axis.

10. Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system.
11. Determine the range of value of k for the system to be stable which is characterized by the equation. (GATE 1999)
12. The open loop transfer function of a feedback control system with unity feedback is

G(s) = .

Sketch the root loci of the characteristic equation of the closed loop system for

, with

(a) n=3

(b) n=4. Show all important information on the root loci.

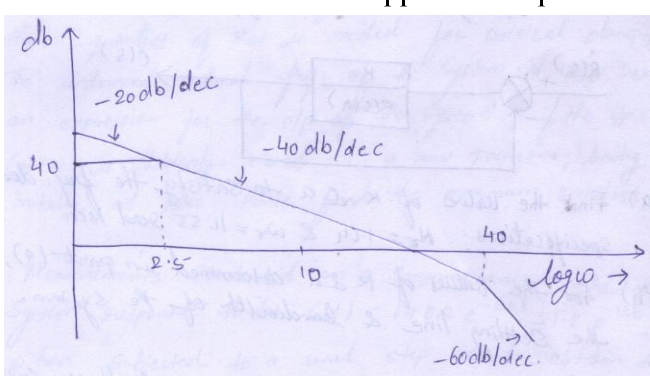
UNIT-IV

1. Sketch the Bode Plot for a unity feedback system characterized by the open loop transfer function G(s) = 1000/(1+0.1s)(1+0.001s) find
(a) Gain Margin
(b) Phase Margin
(c) Stability of the System.

2. Draw the Bode Plot for the transfer function G(s) = 50/s(1+0.25s)(1+0.1s)
From the plot determine Gain Margin & Phase Margin.

3. Draw the Bode Plot for a system having G(s) H(s) = 100/s(s+1)(s+2) find
(a) Gain Margin
(b) Phase Margin
(c) Gain Crossover freq.
(d) Phase crossover freq.

4.Determine the transfer function whose approximate plot shown in figure



5. Sketch the bode plots for the transfer function G(S) = 200/S(S+5)(S+10). Calculate gain margin and phase margin.

6. a) For the given transfer function G(S) = 10/(S+2). Sketch magnitude in dB VS frequency.
b) From the above plot calculate the following.
i) Gain crossover frequency.
ii) Actual magnitude at corner frequency.

7. a) Define gain crossover frequency, phase crossover frequency, gain margin and phase margin.

b) Sketch the bode plot for the transfer function G(S) = 10/S(S+5). Calculate gain crossover frequency.

8. Sketch the magnitude in dB vs. Frequency and phase vs. Frequency for the given transfer function G(S) = 10(S+2)/S(S+5).

9.Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency !c to be 5 rad/sec.

G(s) = Ks2

10. (a) Explain the following terms:

i. Frequency response

ii. Phase and gain margins.

(b) Sketch the Bode plot for the following transfer function

11. Sketch the polar plot for the following transfer function G(s) = 1/s(s+1)

12 .Investigate the stability of a closed loop system with the following open loop transfer function using Nyquist stability criterion G(s) H(s) = k(s+3)/s(s-1)

13. Sketch the Nyquist Plot for a unity feedback system having open-loop transfer function given by G(s) = k/s(1+s)(1+2s)(1+3s)

Determine the range of values of k for which the system is stable.

14. Sketch the polar plot for G(S) = K/S(S+1)(S+2) and for what value of K it is stable. (GATE)

15. Find the stability of k for the transfer function G(S) = K/S(S+5)(S+10) using polar plot.

16. a) Differentiate between polar plot and Nyquist plot.

b) Explain the Nyquist stability criterion. Write its advantages.

17. How to calculate phase margin and gain margin using polar plots. (GATE 2003)

18. Sketch the polar plot for G(S) = k/(S+5)(S+10). (GATE 2009)

19. (a) State and explain the Nyquist stability criterion.

(b) Sketch the Nyquist plot for the transfer function G(s) H(s) = .

Discuss its stability.

20.(a) Explain the Nyquist criterion for assessing the stability of a closed loop system.

(b) Sketch the polar plot of the transfer function G(s) = Determine the frequency at which the polar plot intersects the real and imaginary axis of G(jw) plane

21. A unity feedback system has an open loop transfer function

Design a Lead-Lag compensator to meet the following specifications:

(a) Phase margin is at least 400

(b) Steady state error for ramp input is 0.04 rad.

22. Locate the poles and zeros of lead-lag network and sketch its magnitude bode plot.

23. Locate the poles and zeros of lag network and lead network and sketch their polar

24. Obtain the transfer function of Lag and Lead networks. Locate their poles and zeors and write their advantages.

25. a) Why lag network and lead network are called compensating networks?

b) Write the advantages of PID controllers and their applications.

26 .A unity feedback systems has an open loop transfer function

Design a Lead-Lag compensator to meet the following speci_cations:

(a) Phase margin is at least 400

(b) Steady state error for ramp input is 0.04 rad. (GATE 2003)

27. Explain about lag, lead, lag-lead compensators

UNIT-V

1. Derive the Expression for the Transfer function from the state model
2. Construct signal flow graph & state model for a system whose transfer
   Function is T(s) = (s2+3s+3)/(s3+2s2+3s+1)
3. A system is described by-

$$\dot{x} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} x$$

Find the T.F. & construct the signal flow graph.

4. Draw state transition signal flow graph for the following system
   By means of
   (i) Parallel decomposition
   (ii) Cascade decomposition
5. State equation of a control system is given by-

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

   Obtain the state-transition Matrix.
6. A feedback system has a closed loop transfer function 10(s+4)/s(s+1) (s+3)
   Construct state model & its representation
7. Determine the state controllability & observability of the system described by

$$\dot{x} = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} x$$

8. a) Define controllability and observability.
   b) Evaluate the controllability of the system with the matrix.
9. (a) Write the properties of state transition matrix.
   (b) Evaluate the observability of the system with the following matrices.
10. a) Explain state variable and state transition equation.
    b) Describe the properties of state transition matrix.