Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–III EXAMINATION – WINTER 2025

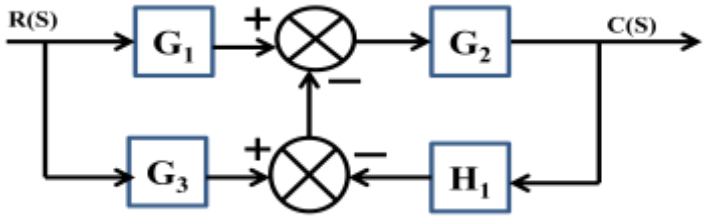
Subject Code:3130905 **Date:22-12-2025**

Subject Name: Control System Theory

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Explain properties of Laplace transform.	**03**
	(b)	Explain transfer function and State advantages and dis advantages.	**04**
	(c)	Solve the block diagram to find transfer function of the system shown in figure. 	**07**
Q.2	**(a)**	Explain with example the first order system.	**03**
	(b)	Write note on steady state error and error constants	**04**
	(c)	Solve the expression of response of first order system for a unit step input and unit impulse. Is it possible to get expression of response for impulse input if the expression is available for unit step input? If yes why?	**07**
		OR	
	(c)	Determine Stability using R-H criteria $$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$	**07**
Q.3	**(a)**	State the nyquist stability criteria. Why the nyquist criteria are called a frequency response method?	**03**
	(b)	Define the gain margin and phase margin when gain and phase crossover frequency is zero and infinity in the bode plot?	**04**
	(c)	The open loop transfer function of a unity feedback system is given by G(s)=k/ $s(Ts+1)$ where k and T are constants. By what factor should the amplifier gain be reduced so that the peak overshoot of the system is reduced from 75% to 25% ?	**07**
		OR	

Q.3	**(a)**	Simplify the significance of PI control.	**03**
	(b)	Distinguish state variable approach verses the classical approach of transfer function for the analysis of control systems.	**04**
	(c)	Define the following terms- 1-Gain Margin 2-Phase Margin 3-Bandwidth 4-Resonant Frequency 5-Gain Crossover Frequency 6-Frequency Domain 7-Resonant Peak	**07**
Q.4	**(a)**	List out types of compensation and explain any one.	**03**
	(b)	Explain bode plot of Lag-Lead compensator	**04**
	(c)	Explain in detail the steps to design a lag compensator.	**07**
		OR	
Q.4	**(a)**	Explain the advantages of bode plot.	**03**
	(b)	Explain how do you determine the gain crossover frequency and phase crossover frequency from the bode plot?	**04**
	(c)	Explain step by step procedure to obtain Root locus design.	**07**
Q.5	**(a)**	Explain polar plots with a sketch of a simple example	**03**
	(b)	Write the applications of frequency response methods.	**04**
	(c)	Assuming zero initial conditions derive the transfer function for the system described by the standard state variable model.	**07**
		OR	
Q.5	**(a)**	Explain following terms. 1) State variable 2) State trajectory 3) State vector	**03**
	(b)	Decide that How stability can be ensured from Routh Table?	**04**
	(c)	Investigate Controllability of the system $$X(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -4 & -2 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$ $$c(t) = [5 \quad 1 \quad 0]x(t)$$	**07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–III (NEW) EXAMINATION – WINTER 2024

Subject Code:3130905 **Date:10-12-2024**

Subject Name: Control System Theory

Time:10:30 AM TO 01:00 PM **Total Marks:70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	What is control system? Give classifications of control systems.	**03**
	(b)	What are the components of feedback control system?	**04**
	(c)	Determine the transfer function of the system shown in figure 1 below by using block diagram reduction technique.	**07**

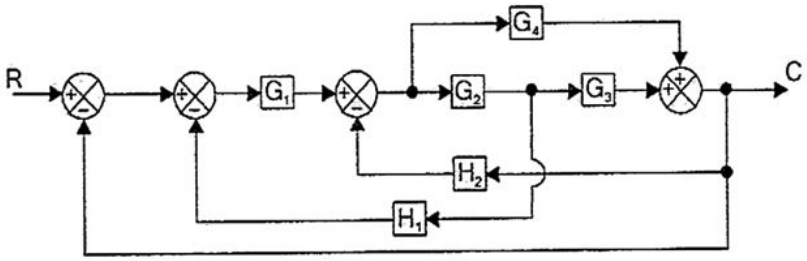


Figure-1

Q.2	**(a)**	Distinguish between type and order of the system.	**03**
	(b)	Explain the time constant of the first-order system.	**04**
	(c)	Determine the transfer function for the given mechanical system shown in figure 2 and draw equivalent electrical circuit for F-V and F-I analogy.	**07**

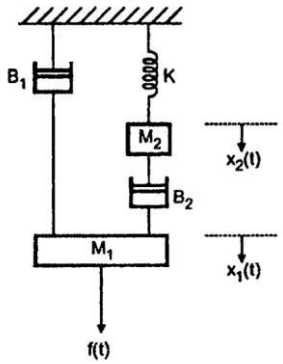


Figure-2

OR

	(c)	Explain Type 0, Type 1 and Type 2 control system. Derive equation for the steady state error of the Type 2 control system for step, ramp and parabolic input.	**07**
Q.3	**(a)**	Explain Standard Test Signals used in control system.	**03**
	(b)	For the system $s^4+22s^3+10s^2+s+K$, find K_{marg} and ω_{marg}.	**04**

	(c)	With neat sketch explain all the time response specifications.	**07**

OR

Q.3	**(a)**	Explain Gain margin and Phase margin.	**03**
	(b)	Draw the polar plot of $$G(s) = \frac{1}{1+sT}$$	**04**
	(c)	State and explain Nyquist stability criteria.	**07**

Q.4	**(a)**	Define compensation. List out different types of compensations.	**03**
	(b)	List the advantages and disadvantages of phase lag network.	**04**
	(c)	Draw the root locus for the transfer function given by $G(s)=K/(s(s^2+4s+20))$	**07**

OR

Q.4	**(a)**	What is the significance of integral controller and derivative controller in a PID controller?	**03**
	(b)	What is the effect of PI controller on the system performance?	**04**
	(c)	Explain the design of lead compensator using bode plot.	**07**

Q.5	**(a)**	Define (a) state variable (b) state vector (c) state space	**03**
	(b)	Define the state transition matrix's properties.	**04**
	(c)	Check controllability and observability for the system described by $$x = \begin{bmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix} u$$ $$y = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix} x$$	**07**

OR

Q.5	**(a)**	What are the advantages of state space representation?	**03**
	(b)	Explain the concepts of controllability and observability**.**	**04**
	(c)	Draw a series RLC circuit. Obtain its state space model considering current and capacitor voltage as state variables.	**07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2023

Subject Code:3130905 Date:25-01-2024

Subject Name:Control System Theory

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Draw the block diagrams of open loop and closed loop control systems.	**03**
	(b)	Compare conventional control method and modern control method.	**04**
	(c)	Determine the overall transfer function for the mechanical translational system shown in fig.1.	**07**
Q.2	**(a)**	Define the following terms related to signal flow graph: 1. Source node 2. Sink node 3. Chain node.	**03**
	(b)	Compare open loop and closed loop control systems.	**04**
	(c)	The characteristic equation of feedback control system is given by $S^4+20S^3+S^2+2S+K=0$ 1) Calculate the range of K for the system to be stable. 2) Can the system be marginally stable? If so, find the required value of k and frequency of sustained oscillation.	**07**
		OR	
	(c)	Determine the transfer function of the system shown in fig.2 by using block diagram reduction technique.	**07**
Q.3	**(a)**	State the condition for stability of control system with respect to bode plot and Nyquist stability criterion.	**03**
	(b)	Explain Standard Test Signals used in control system.	**04**
	(c)	Draw the time response of second order system and define all the time response specification.	**07**
		OR	
Q.3	**(a)**	Explain Gain margin and Phase margin.	**03**
	(b)	Explain Routh stability criterion method.	**04**
	(c)	Draw the root locus for the transfer function given by $G(S)= K/ S (S+4) (S^2+4S+20)$.	**07**
Q.4	**(a)**	State the advantages of bode plot.	**03**
	(b)	Draw the polar plot for the transfer function given by $G(S)= 2/(S+1) (S+2) (S+3)$.	**04**
	(c)	Write Nyquist contour and Nyquist stability criterion in brief.	**07**
		OR	
Q.4	**(a)**	List out the different types of Controllers.	**03**
	(b)	Explain derivative control mode. State its characteristics.	**04**
	(c)	Explain Proportional-Integral-Derivative (PID) Controller.	**07**
Q.5	**(a)**	Define compensation and explain series-parallel compensation.	**03**
	(b)	State the limitations and effects of phase Lead compensation.	**04**
	(c)	Write steps to design Lag Compensator using Root Locus.	**07**

OR

Q.5 **(a)** Give advantages of state space approach. **03**

(b) Obtain the state space representation for transfer function $C(S)/R(S)=1/S^2+2S+3$ **04**

(c) Comment on the controllability and observability of the system described by the following state variable model. **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

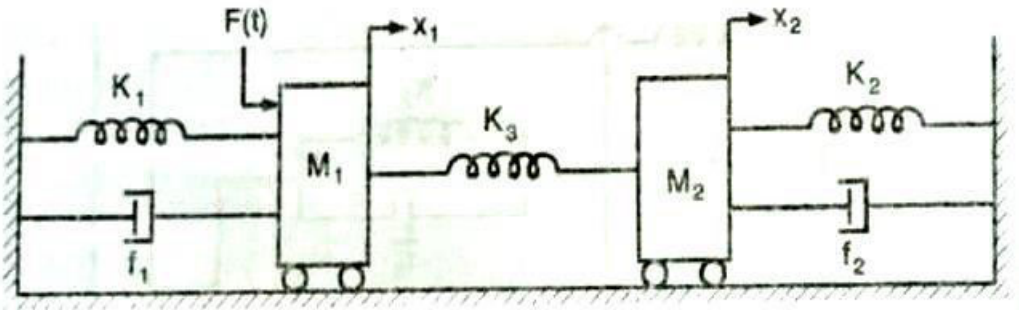


Fig. 1

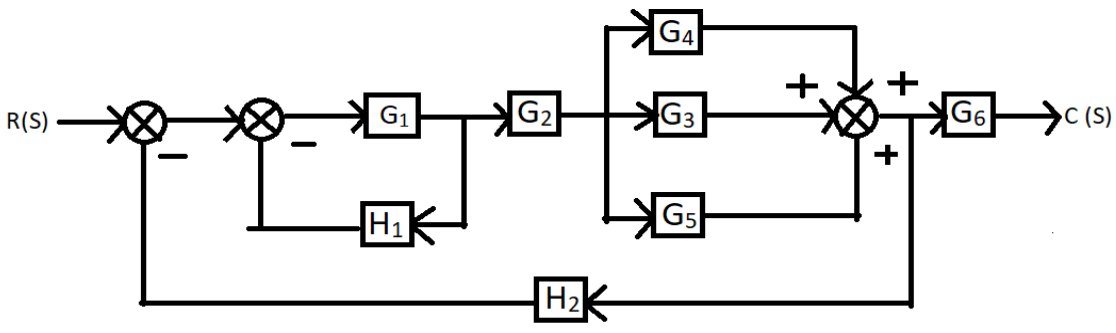


Fig.2

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BE - SEMESTER– III(NEW) EXAMINATION – WINTER 2022

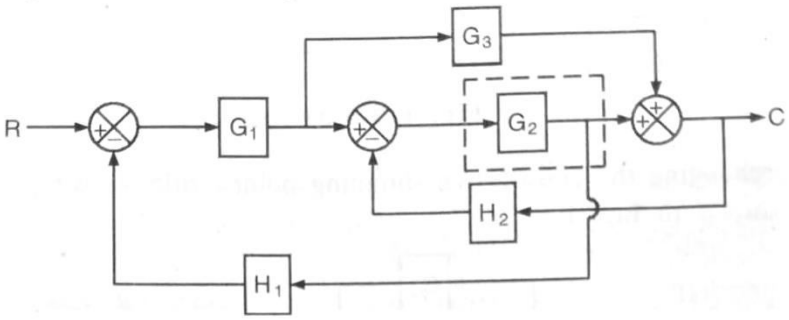
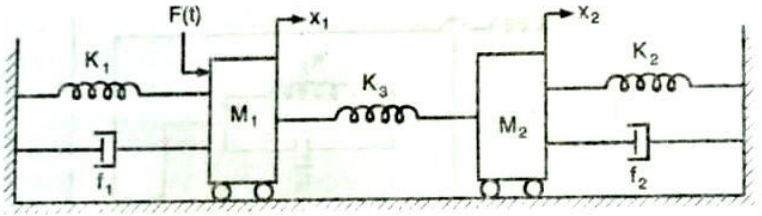
Subject Code:3130905 Date:27-02-2023

Subject Name:Control System Theory

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Explain Standard Test Signals used in control system.	**03**
	(b)	What are the limitations of open-loop systems over closed-loop systems? List the advantages of closed-loop system over open-loop system.	**04**
	(c)	Determine the overall transfer function $\frac{C}{R}$ for the system whose block diagram is shown in fig. below using block diagram reduction technique. 	**07**
Q.2	**(a)**	Define the following: (1) Rise time (2) Delay time (3) Settling time.	**03**
	(b)	Obtain the transfer function $\frac{X_1(s)}{F(s)}$ and $\frac{X_2(s)}{F(s)}$ of the mechanical system shown in fig. below. 	**04**
	(c)	For the unity feedback control system with $G(s) = \frac{K}{s(s+1)(s+2)}$. Find the range of K for system that will cause the system to be stable, marginally stable and unstable. Make suitable comments.	**07**
		OR	
	(c)	Determine the stability of the system represented by the characteristic equation $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$ by means of the Routh criterion. Determine the number of roots of the characteristic equation lying in the right-half of s-plane.	**07**

Q.3 **(a)** Explain the terms with respect to root locus. (i) centroid (ii) angle of arrival and angle of departure (iii) breakaway and break in points. **03**

(b) State and explain nyquist stability criteria. **04**

(c) Sketch bode plot showing the magnitude in decibels and phase angle in degrees as a function of log frequency for the transfer function given below. Determine the gain cross over frequency. **07**

$$G(s) = \frac{10}{s(1+0.5s)(1+0.01s)}$$

OR

Q.3 **(a)** Describe the steps to construct the polar plot. **03**

(b) Explain relationship between time and frequency response. **04**

(c) Consider a unity feedback control system with an open-loop transfer function. **07**

$$G(s)H(s) = \frac{K(s+1)(s+2)}{(s+0.1)(s-1)}$$

Draw the root locus of the system with the gain K as a variable. Find from the root locus plot, the value of gain K for which a closed-loop system is critically damped.

Q.4 **(a)** Explain the effect of integral control action on system Performance. **03**

(b) What is compensation? What are the different types of compensations? **04**

(c) Draw the bode plot for phase-lead network and derive expression for the parameter α in terms of Φ_m. **07**

OR

Q.4 **(a)** State limitations and effects of Lag compensator. **03**

(b) State the limitations of a single stage phase lead compensation. **04**

(c) Explain step by step Procedure for Phase Lag Network. **07**

Q.5 **(a)** Explain the advantages of bode plot. **03**

(b) How will you define controllability and observability of the system? **04**

(c) Draw a series RLC circuit. Obtain its state space model considering current and capacitor voltage as state variables. **07**

OR

Q.5 **(a)** Define the following terms: Gain margin, phase margin, bandwidth, resonant peak **03**

(b) Explain the following terms: (i) State (ii) State Variables (iii) State Space (iv) State transition matrix **04**

(c) A linear time-invariant system is described by the following state variable model: **07**

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

$$y(t) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Comment on the controllability and observability of the system.