Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3130905 Date:27-02-2023

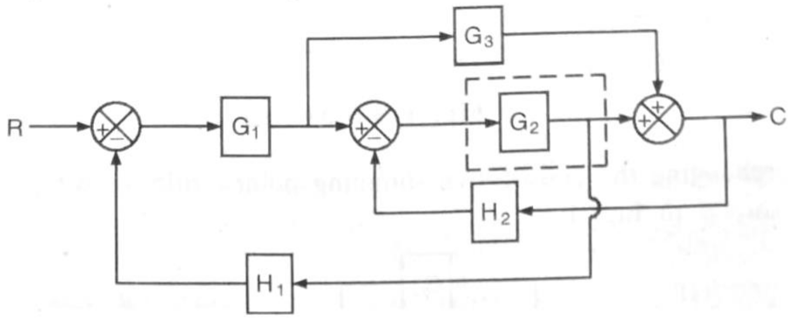
Subject Name:Control System Theory

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

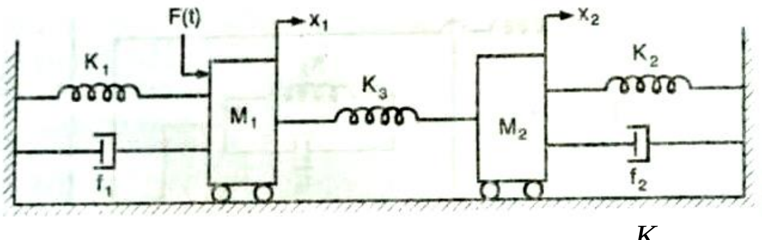
Instructions:

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.