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**

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

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

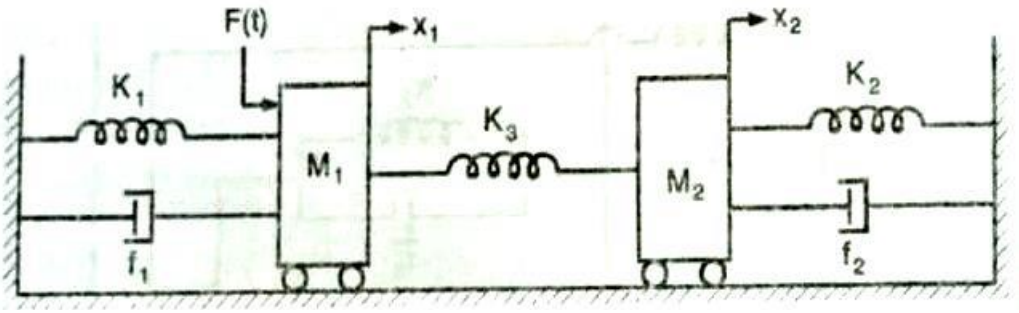

Fig. 1

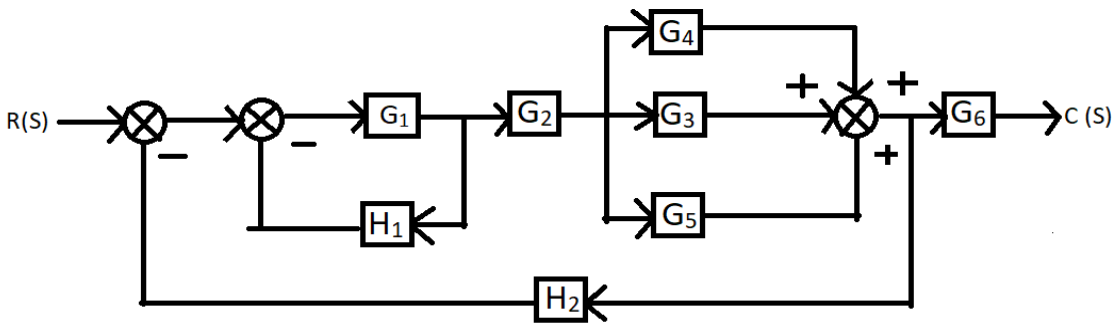

Fig.2