Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (NEW) EXAMINATION – WINTER 2021

Subject Code:3130905 Date:02-03-2022

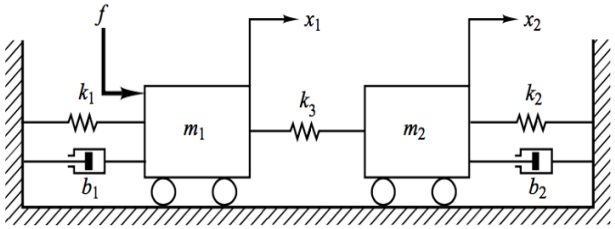
Subject Name:Control System Theory

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

Instructions:

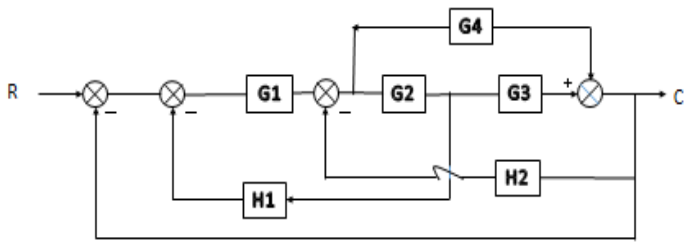
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	List out the difference between open loop and closed loop control system.	**03**
	(b)	The Characteristic equation of a feedback control system is $S^5+4S^4+8S^3+8S^2+7S+4=0$ Predict stability of system by following R-H criterion.	**04**
	(c)	Sketch the Root locus for the open loop transfer function of unity feedback control system given by G(s) =K/S(S^2+6S+25).Also determine centroid and angle of departure.	**07**
Q.2	**(a)**	Find the closed loop transfer function, undamped natural frequency & damping ratio of the system whose system response is given by C(t)=1+0.2 e^{-60t} -1.2 e^{-10t} subjected to a unit step input.	**03**
	(b)	Discuss steady state error constants of the Type-0 system for a Ramp input.	**04**
	(c)	Evaluate the differential equation for the given system and convert from F to V and F to I electrical equation form.	**07**



OR

	(c)	Evaluate overall transfer function for the system shown in Figure below.	**07**



Q.3	**(a)**	Define polar plot with a sketch of simple example.	**03**
	(b)	Summarize limitations of frequency domain approach.	**04**
	(c)	A unity feedback control system has G(s) = $\frac{80}{s(s+1)(s+20)}$.Make use of bode plot to measure gain margin and phase margin and identify stability of system.	**07**

OR

Q.3 **(a)** Define the following terms with respect to frequency response (i) Gain Margin (ii) Phase Margin (iii) Gain cross-over frequency. **03**

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

(c) The open loop transfer function of a system is, **07**

$$G(S) = 800(S+2)/(S^2(S+10)(S+40))$$

Sketch the bode plot and comment on stability.

Q.4 **(a)** Define compensation. List out different types of compensations. **03**

(b) Demonstrate transfer function of lead network. **04**

(c) Explain PID controller. **07**

OR

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

(b) Discuss advantages of frequency domain design. **04**

(c) Explain the design of lag lead compensator using root locus. **07**

Q.5 **(a)** List out different types of controller and need of controller. **03**

(b) Compute the state transition matrix for the state model whose matrix A is given by **04**

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

(c) Solve transfer function from the given state space model. **07**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$Y = [1 \;\; 2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

OR

Q.5 **(a)** Define Derivative controller. Mention two drawbacks of derivative action. **03**

(b) Discuss properties of state transition matrix. **04**

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

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

$$Y = [1 \;\; 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Test for Controllability and Observability of the system.

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