Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–III (NEW) EXAMINATION – WINTER 2020

Subject Code:3131101 **Date:10/03/2021**

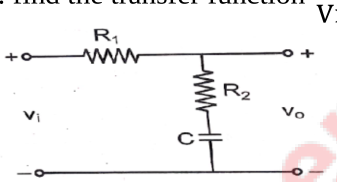
Subject Name: Control Systems

Time: 10:30 AM TO 12:30 PM **Total Marks:56**

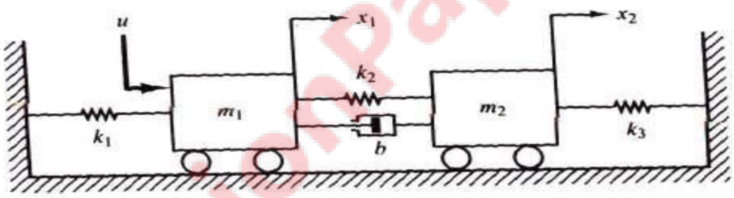
Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

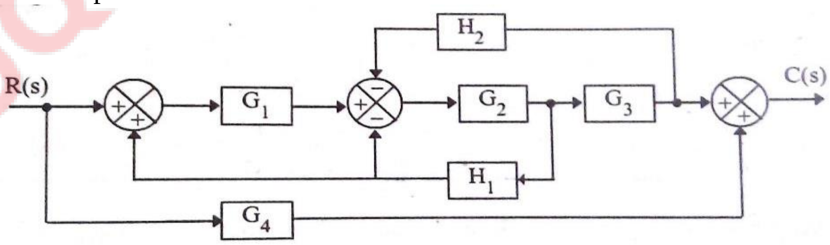
			Marks
Q.1	**(a)**	Compare open-loop and Closed-loop system.	**3**
	(b)	For the network of Fig. find the transfer function $\frac{Vo(S)}{Vi(S)}$	**4**



	(c)	Find the transfer function $\frac{X2(S)}{U(S)}$ of the mechanical system shown in Fig.	**7**



Q.2	**(a)**	List properties of the Transfer Function.	**3**
	(b)	Conclude Usefulness of analogues system and explain Force (Torque)-Voltage Analogy.	**4**
	(c)	For the system represented by the block diagram shown in Fig. evaluate the closed-loop transfer function.	**7**



Q.3	**(a)**	Discuss Unit-Ramp response of First-Order systems.	**3**
	(b)	Define: (1) Delay time (2) Rise time (3) Peak time (4) Settling time	**4**
	(c)	Discuss Unit-step time response of Second-order systems for $\xi > 0$.	**7**
Q.4	**(a)**	Discuss Static error constants and steady state errors for various inputs and systems.	**3**

	(b)	The characteristic equation of a system is given by $S^4 + 8S^3 + 18S^2 + 16S + 4 = 0$. Investigate the stability of a system by means of Hurwitz criterion.	**4**
	(c)	The open-loop transfer function of a feedback control system is $G(S).H(S) = \frac{K}{S(S+4)(S^2+4S+20)}$. Construct the root locus.	**7**
Q.5	**(a)**	Discuss following terms with respect to Frequency response analysis. (i) Resonant Peak (ii) Resonant Frequency (iii) Bandwidth	**3**
	(b)	Develop the Polar plot of $G(S) = \frac{10}{S(S+1)}$.	**4**
	(c)	Develop the Bode plots for the transfer function given below: $G(S).H(S) = \frac{10}{S(0.1S+1)(0.05S+1)}$. Find the gain margin and Phase margin.	**7**
Q.6	**(a)**	Discuss Nyquist stability criterion.	**3**
	(b)	List properties of M-circles.	**4**
	(c)	The open-loop transfer function of a unity feedback control system is given as $G(S).H(S) = \frac{S+2}{(S+1)(S-1)}$. Investigate the closed-loop stability by applying Nyquist criterion.	**7**
Q.7	**(a)**	Justify: Compensation is required.	**3**
	(b)	Discuss Lag compensator. Obtain the transfer function of a Lag Compensator.	**4**
	(c)	Design a lead compensator for a unity feedback system with an open-loop transfer function $G(S) = \frac{K}{S(S+1)}$ for the specifications of (i) static velocity error constant $K_v = 10\ sec^{-1}$ and (ii) phase margin= 35°.	**7**
Q.8	**(a)**	Define: (i) State (ii) State Variable (iii) State Vector	**3**
	(b)	List Advantages of State variable analysis.	**4**
	(c)	Construct the transfer function of	**7**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} r(t) \qquad Y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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