Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2018

Subject Code:2141004 **Date:05/12/2018**

Subject Name:Control System Engineering

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.**

Q.1	**(a)**	Compare Open loop control system and Closed loop control system.	**03**
	(b)	Discuss standard Test signals used in control system.	**04**
	(c)	Determine the overall transfer function of the system shown in Fig. 1 using block diagram reduction techniques.	**07**
Q.2	**(a)**	Define sensitivity of control system. Find S_G^T for open and closed loop systems.	**03**
	(b)	Discuss force current (F-I) analogous system with analogous quantity.	**04**
	(c)	Draw signal flow graph of the system shown in Fig. 1 and find out $C(s)/R(s)$ of the system using Mason's gain formula.	**07**
		OR	
	(c)	Draw the equivalent mechanical network for given system as shown in Fig. 2. Obtain differential equations describing the system and draw electrical network using force voltage (F-V) analogy.	**07**
Q.3	**(a)**	Discuss following transient response specification: Delay Time, Peak overshoot, Settling Time	**03**
	(b)	The overall transfer function of unity feedback control system is given by $\frac{C(s)}{R(s)} = \frac{10}{s^2+6s+10}$. Find: 1. Position error constant 2. Velocity error constant 3. Acceleration error constant	**04**
	(c)	The loop transfer function of the system is: $G(s)H(s) = \frac{K}{s(s+1)(s+3)}$. Sketch the root locus of the system and determine the value of K for marginal stability.	**07**
		OR	
Q.3	**(a)**	Define following terms: State, State variable, State space	**03**
	(b)	Obtain the state transition matrix for the state model whose system matrix is given by $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$.	**04**
	(c)	Derive the expression for unit step response of underdamped second order system.	**07**
Q.4	**(a)**	Discuss steady state error for a simple closed loop control system with negative feedback.	**03**
	(b)	Find the range of K to make the unity feedback system stable using Routh's criterion with $G(s) = \frac{K(s+20)}{s(s+2)(s+3)}$.	**04**
	(c)	The loop transfer function of the system is: $G(s)H(s) = \frac{50}{(s+1)(s+2)}$. Using Nyquist criterion, examine the closed loop stability of the system.	**07**
		OR	
Q.4	**(a)**	State the various advantages and disadvantages of feedback with respect to control system parameters.	**03**
	(b)	The characteristic equation of system is: $s^4 + s^3 + ks^2 + s + 1 = 0$. Find k_{mar} and ω at k_{mar}.	**04**

(c) The open loop transfer function of the system is: $G(s)H(s) = \frac{10}{s(s+1)(s+10)}$ **07**
Determine the stability of the system by plotting the Bode plot of the system.

Q.5 **(a)** Explain PI controller with the help of diagram. **03**
(b) Explain the Lead Compensator with its transfer function. **04**
(c) Derive the state variable equation $\dot{X} = AX + BU$ and $Y = CX + DU$. Also draw the state diagram. **07**

OR

Q.5 **(a)** Discuss Nyquist stability criterion. **03**
(b) Discuss following terms with respect to frequency response: Gain Margin, Phase Margin, Gain crossover frequency, Phase crossover frequency **04**
(c) Discuss steps to design a Lag Compensator using Bode plot method. **07**

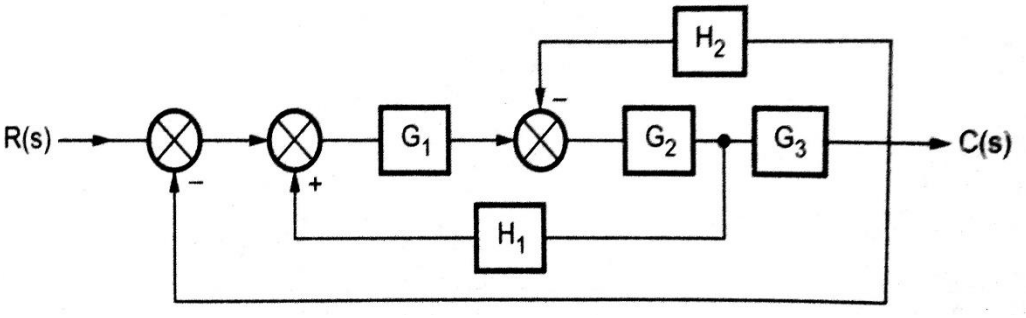

Fig. 1 ***(for Q.1 C & Q.2 C)***

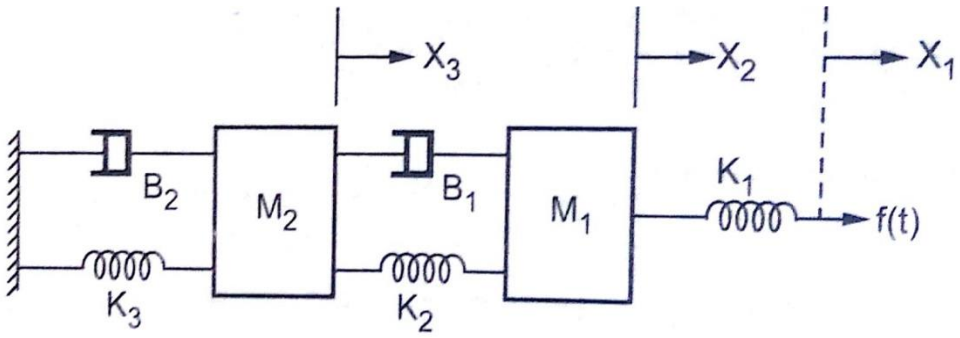

Fig. 2 ***(for Q.2 C OR)***

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