Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3131101 **Date:19-02-2022**

Subject Name:Control Systems

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.**

Q.1	**(a)**	Compare open-loop and closed-loop control system.	**03**
	(b)	What is transfer function? Discuss properties, advantages and disadvantages of it.	**04**
	(c)	Explain rules for block-diagram reduction technique.	**07**
Q.2	**(a)**	Define following terms. 1) Time response 2) Order of the system 3) Steady state error	**03**
	(b)	Compare block-diagram and signal flow graph method.	**04**
	(c)	Draw the equivalent mechanical system of the system shown in figure.1. Write the set of equilibrium equations for it and obtain electrical analogous circuits using i) F-V analogy ii) F-I analogy	**07**
		OR	
+	**(c)**	For the block diagram of figure.2, derive the open-loop and closed-loop transfer function by block diagram reduction technique.	**07**
Q.3	**(a)**	Define following terms. 1) Rise time 2) Settling time 3) Peak time	**03**
	(b)	The open loop transfer function of a unity feedback system is, $\boldsymbol{G(s) = \frac{k}{s(1+Ts)}}$ i) Find by what factor the gain k be reduced so that the overshoot is reduced from 60% to 15%. ii) Find by what factor gain k should be reduced so that the damping ratio ξ is increased from 0.1 to 0.6.	**04**
	(c)	Determine the transfer function of the system with signal flow graph shown in figure.3.	**07**
		OR	
Q.3	**(a)**	Derive an expression for the Peak Overshoot for a second order control system subjected to a unit step input.	**03**
	(b)	Discuss standard Test signals used in control system.	**04**
	(c)	Close loop transfer function of control system is given by $\frac{C(s)}{R(s)} = \frac{k}{s^4+6s^3+30s^2+60s+k}$ (1) Determine the range of k must be lie for the system to be stable. (2) What should be upper limit of k is all the close loop pole are required to be the left side of the line (σ = -1).	**07**
Q.4	**(a)**	Explain the frequency response, state its application with possible limitations.	**03**
	(b)	An open loop transfer function of a system is given by $\boldsymbol{G(s)H(s) = \frac{k}{(s+1)(2s+1)}}$ Prepare Nyquist plot for it.	**04**
	(c)	Explain rules for construction of root locus.	**07**

OR

Q.4 **(a)** Discuss Nyquist criteria for stability. **03**

(b) Write a short note on state space representation of a control system. **04**

(c) Draw the approximate root-locus diagram for close loop system whose transfer function is given by $\boldsymbol{G(s)H(s) = \frac{k}{s(s+5)(s+10)}}$ **07**

Q.5 **(a)** Derive sensitivity $\boldsymbol{S_G^T}$ of open loop and close loop control system **03**

(b) Define the following terms **04**

1) Gain cross over frequency
2) Phase cross over frequency
3) Gain Margin
4) Phase Margin

(c) Draw the bode plot for $\boldsymbol{G(s) = \frac{10\, e^{-0.1s}}{s(1+10s)(1+4s)}}$ **07**

Also find phase and gain margin.

OR

Q.5 **(a)** Define following terms. 1) State 2) State variable 3) State space. **03**

(b) Derive the expression for peak time $\mathbf{T_p}$ for a second order control system subjected to a unit step input. **04**

(c) Derive the state variable equation $X = AX + BU$ and $Y + CX + DU$. Also draw the block diagram. **07**

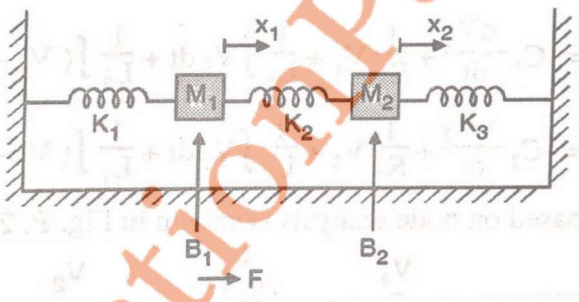

Figure.1

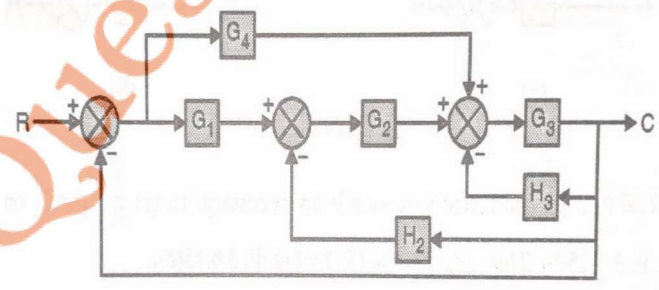

Figure.2

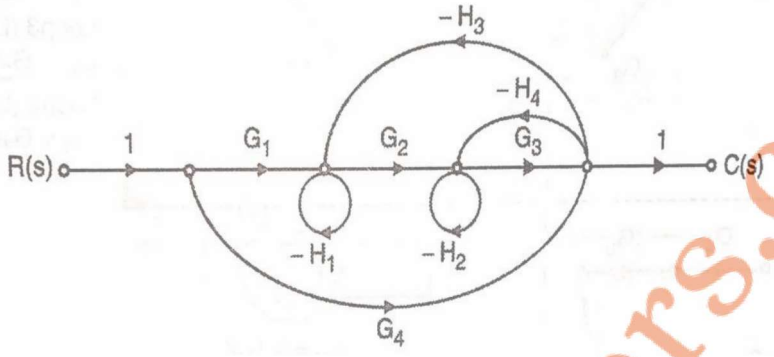

Figure.3

****