Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– III (New) EXAMINATION – WINTER 2019

Subject Code: 3131101 Date: 28/11/2019

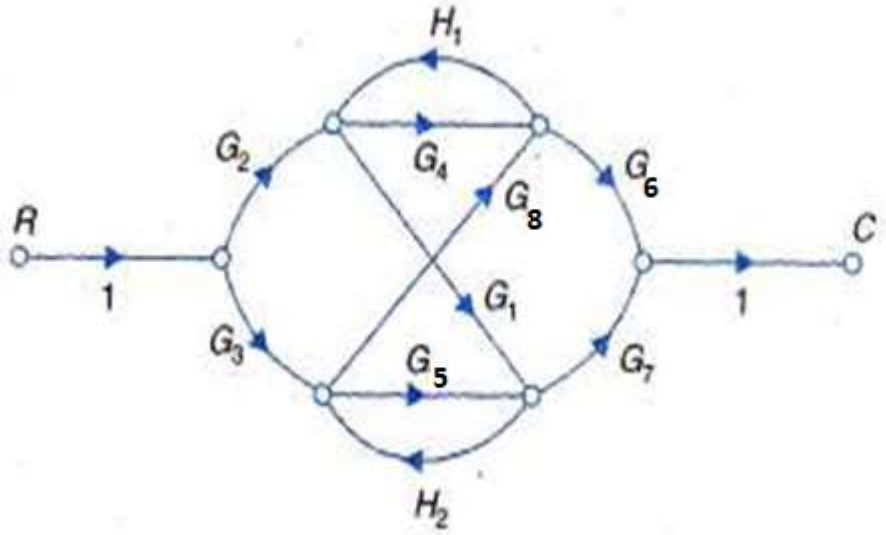
Subject Name: Control Systems

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.**

			Marks
Q.1	**(a)**	Explain Open loop and Closed loop control system with example.	**03**
	(b)	Define: Transfer function, Self loop, Steady-state error,	**04**
	(c)	Obtain the overall transfer function C/R of the system whose signal flow graph shown in following figure.	**07**



Q.2	**(a)**	Explain the conditions for Stable, Marginally stable and Unstable systems.	**03**
	(b)	Derive the expressions for error constants K_p, K_v and K_a corresponding to step, ramp and parabolic input respectively.	**04**
	(c)	Consider the feedback system with $G(s) = 4/s(s + 0.2)$ and $H(s) = 1 + as$. Determine the value of *'a'* such that the damping ratio is 0.5. Also obtain the values of rise time t_r and peak overshoot M_p for its step response.	**07**
		OR	
	(c)	Derive expressions of (i) Rise time, t_r (ii) Peak time, t_p and (ii) Peak overshoot, M_p for a second order control system subjected to a unit step input.	**07**
Q.3	**(a)**	Explain: Frequency response, Root locus, Centroid	**03**
	(b)	The characteristic equation of the system is: $4s^4 + 2s^3 + Ks^2 + 2s + 1 = 0$. Find K_{mar} and ω_{mar}.	**04**
	(c)	Using Routh's criterion check the stability of a system whose characteristic equation is given by $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$	**07**
		OR	
Q.3	**(a)**	Explain concept of Relative stability.	**03**

(b) Write short note on PID controller. **04**

(c) Using Routh array determine the range of K for a unity feedback system whose open loop transfer function is given by **07**

$$G(s) = \frac{K}{s(s+1)(s+3)(s+5)}$$

Q.4 **(a)** Explain: State, State variable, state trajectory **03**

(b) Draw the polar plot considering a unity feedback system with open loop transfer function **04**

$$G(s) = \frac{10}{s(s+2)(s+5)}$$

(c) A unity feedback system has the loop transfer function **07**

$$\mathrm{G(s)} = \frac{\mathrm{K}}{(\mathrm{s}+1)(\mathrm{s}+3)(\mathrm{s}+5)}$$

a) Find Centroid and Breakaway point.

b) Sketch the Root Locus.

OR

Q.4 **(a)** Explain: Gain margin, Phase margin, Polar plot **03**

(b) Write short note on Lag compensator. **04**

(c) A unity feedback system with open loop transfer function $\mathrm{G(s)} = \frac{\mathrm{K}}{\mathrm{s(s+2)}}$ is to be compensated to meet the following specifications: **07**

- Damping ration $\xi = 0.5$
- Damped natural frequency $\omega_n = 4\ rad/sec$

Design the lead compensator to meet the given specifications.

Q.5 **(a)** Derive Correlation Between Transfer Functions and State-Space Equations. **03**

(b) Determine the transfer function for the following system. **04**

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 3 \\ -2 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} u$$

and $$y = \begin{bmatrix} 2 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

(c) The feed forward transfer function of a close loop system is $G(s) = 1/s(s+1)$ and feedback transfer function is $H(s) = 1/(s+2)$. **07**

(i) Draw the polar plot of $G(s)H(s)$.

(ii) Find ω corresponding to $\angle G(j\omega)H(j\omega) = 180^{\circ}$.

(iii)Find $|G(j\omega)H(j\omega)|$ corresponding to frequency obtain in (ii).

OR

Q.5 **(a)** Explain standard test signals. **03**

(b) Discuss Nyquist stability criterion. **04**

(c) Draw the Nyquit plot for unity feedback system having $G(s) = 10\ /\ (s+1)(s+2)$. Also, comment on system stability. **07**

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