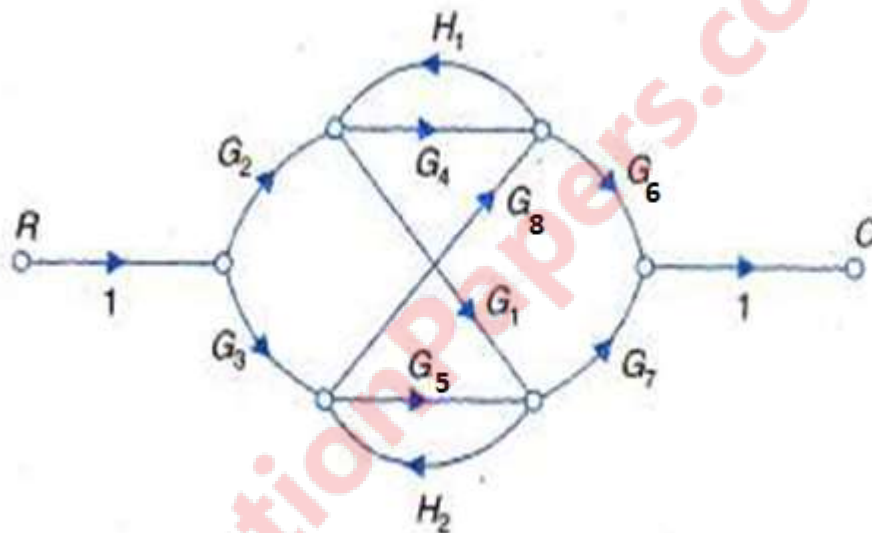


GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER- III (New) EXAMINATION – WINTER 2019****Subject Code: 3131101****Date: 28/11/2019****Subject Name: Control Systems****Time: 02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

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	07

$$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$$

OR

Q.3 (a) Explain concept of Relative stability.	03
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- (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

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

- 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 $G(s) = \frac{K}{s(s+2)}$ is 07

to be compensated to meet the following specifications:

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

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 Nyquist plot for unity feedback system having $G(s) = 10 / (s+1)(s+2)$. Also, comment on system stability. 07
