Duration 3 Hours **[Maximum Marks 80]**

NOTE: 1) Question 1 is **compulsory**
2) Solve **any three** from the remaining five questions
3) Assume suitable data if necessary.
4) Figures to the right indicate full marks

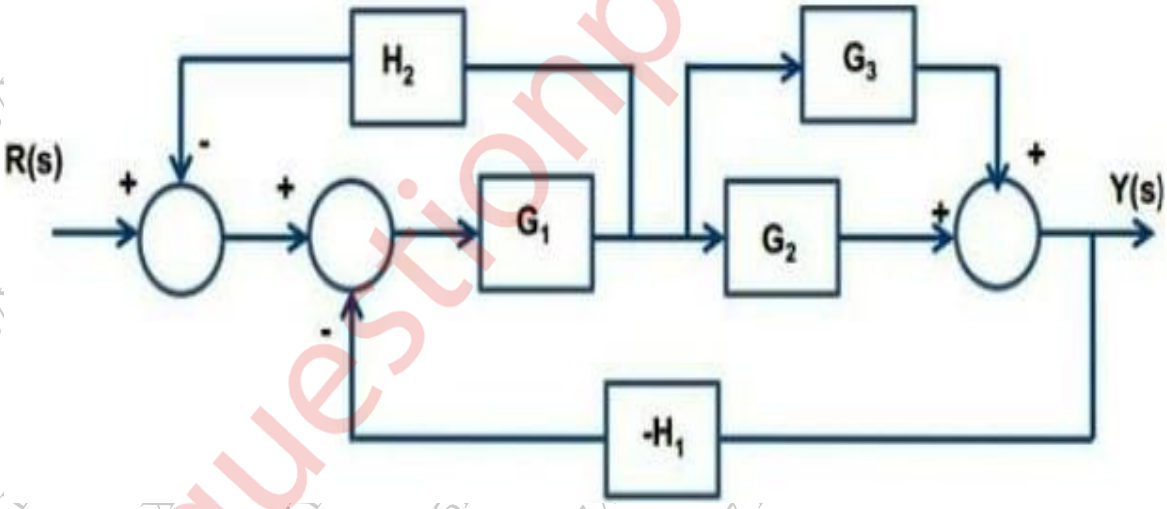
Q.1. a Explain any five rules of Root locus method. **5**

b. Define the following terms related to stability analysis using bode plot. **5**
(i) Gain Crossover Frequency
(ii) Gain Crossover Frequency
(iii) Gain Margin
(iv) Phase Margin

c. Compare open loop transfer function and closed loop transfer function with proper block diagram and Example. **5**

d. Explain Mason Gain's formula with its need. **5**

Q.2. a. Find the overall transfer function of the given system using block diagram reduction method. **10**



b. The characteristic equation of a system is, determine range of K for stability. **10**

$S^4 + 7S^3 + 10S^2 + 2KS + K = 0$.

Q3. a. A second order system is given by: **10**

$$\frac{C(S)}{R(S)} = \frac{25}{(S^2+6s+25)}$$

Find damping ratio, natural frequency, delay time, peak time, peak-overshoot, settling time if subjected to step input.

b. Draw polar plot of **G(s) H(s)** = $\frac{K}{(1+2S)\,(1+3S)}$ **10**

Q.4.a. Sketch the Root locus for given open loop transfer function and comment on the stability. **10**

$$G(s)\,H(s) = \frac{K}{s(S+5)(S+10)}$$

b. Check the controllability and observability of the following state model **10**

$\dot{x} = Ax + Bu$

Y= Cx

where x is the state vector, u is input and y is output and

$$A = \begin{bmatrix} -2 & 4 \\ 2 & 1 \end{bmatrix} B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} and\ C = [1 \quad 0]$$

Q.5. a. Draw the Nyquist plot for the given open loop transfer function and test the stability. **10**

$$G(s)\,H(s) = \frac{1}{S^2(1+s)\,(1+2s)}$$

b. Obtain the state model for the system with given transfer function. **10**

$$\frac{Y(s)}{U(s)} = \frac{24}{s^3+9s^2+26s+24}$$

Q.6. Short note on (Any 2) **20**

a. Pole Placement method

b. Lag-lead compensator

c. Explain the Time domain specifications for second order under damped system.

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