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. Answer any Four of the following

a. Explain with appropriate examples, open loop and closed loop systems. **5**

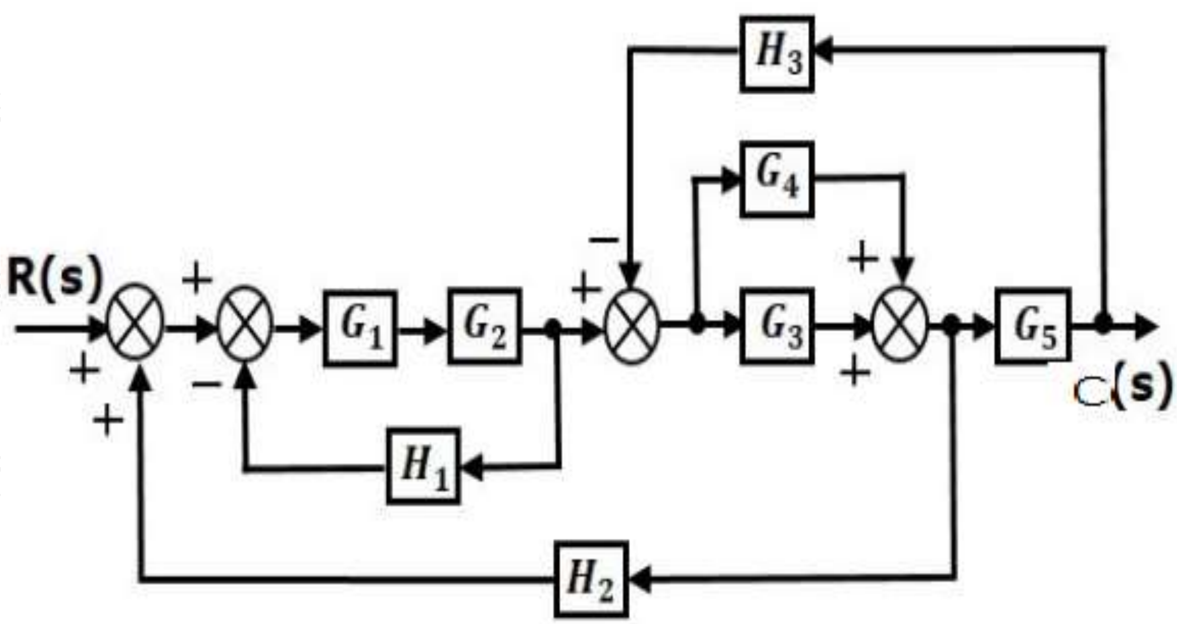
b. Explain the Mason's gain formula with reference to SFG Technique**.** **5**

c. With an example, determine the relative stability of a system using Routh stability criterion. **5**

d. Define gain margin and phase margin. Explain how to find them from magnitude versus phase plot. **5**

e. What is the Nyquist **C**riterion. **5**

Q.2. a. Find the transfer function of the block diagram shown in figure by using block diagram reduction method. **10**



b. Determine the stability of the control system having characteristic equation **10**

$$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$$

Q3. a. A unity feedback system is characterized by a loop transfer function **10**

$$G(s) = \frac{k}{s\,(s+10)}$$

Determine gain k, so that the system will have a damping ratio of 0.5.
For this value of k, determine T_s, M_p, T_p for a unit step.

b. Sketch the polar plot for the system having transfer function **G(s)** = $\frac{1}{s\,(1+s)^2}$ **10**

Q.4.a. Draw the Root locus for the system. **10**

$$G(s)\,H(s) = \frac{K}{s\,(s+3)(s+6)}$$

Determine the value of k for marginal stability and critical damping.

b. A feedback control system has **G(s) H(s)** = $\frac{100(s+3)}{s\,(s+1)(s+5)}$ **10**

Draw Bode plot and comment on stability.

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

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

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

$$\frac{Y(s)}{U(s)} = \frac{3S+4}{s^2+5s+2}$$

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

a. Frequency domain specifications for second order under damped system

b. Special cases with Routh Criterion

c. Concept of Controllability

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