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

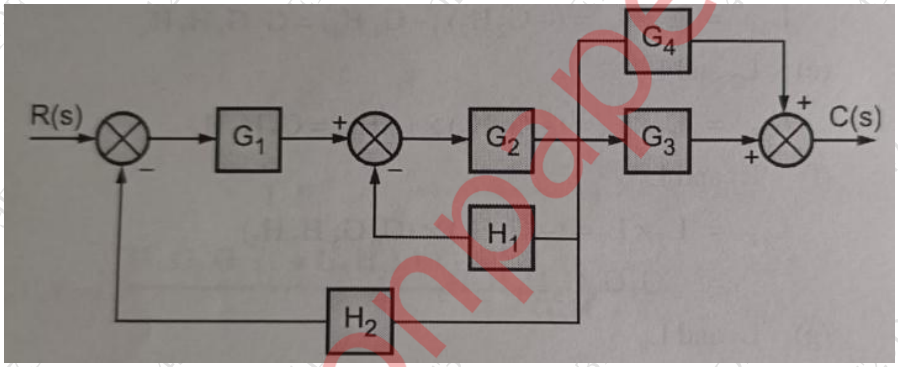
Q.1. a. Differentiate between closed loop and open loop control system **5**

b. Explain type and order of control system. **5**

c. Explain how to find gain margin and phase margin from Bode plot? **5**

d. Explain any rules in order to plot root locus. **5**

Q.2. a. Find transfer function using Mason's gain formula for shown figure below **10**



b. If peak overshoot is 18.3 % and peak time is 0.3023 seconds, **10**
Find Damping factor, Undamped natural frequency and Settling time

Q.3. a. For unity feedback system with open loop transfer function **10**

$$G(s) = \frac{100\,(s+4)}{s^2\,(s+2)\,(s+10)}$$

Determine type of system, k_p, k_v, k_a. Find e_{ss} for input $4 + 8t + 2t^2$

b. For unity feedback system with open loop transfer function **10**

$$G(s) = \frac{100}{s\,(s+8)}$$

Determine damping factor, undamped natural frequency, resonant peak and resonant frequency.

Q.4. a. Explain Lead Compensator design using root locus. **10**

b. Obtain state variable model of transfer function **10**

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

Q.5. a. The open loop transfer function of the system **10**

$$G(s)\,H(s) = \frac{4s+1}{s^2\,(s+1)\,(2s+1)}$$

Using Nyquist criterion, examine closed loop stability of the system.

b. Sketch the root locus for open loop transfer function of the system. **10**

$$G(s)\,H(s) = \frac{k}{s\,(s+2)\,(s^2+6s+25)}$$

Q.6.a. Sketch the Bode plot for open loop transfer function of the system **10**

$$G(s)\,H(s) = \frac{0.4\,(1+6s)}{s^2\,(1+0.5s)}$$

Also comment on stability.

b. Find the solution of following stste equation **10**

$$\dot{x} = \begin{bmatrix} -5 & -6 \\ 1 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$y = [\,1 \quad 1\,]\,x$$

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