(3 Hours) [Total Marks:80]

**N.B.** (1) Question number 1 is compulsory.

(2) Attempt any 3 questions from remaining.

(3) Assume suitable data if required.

(4) Figure to the right indicates full marks.

Q1. Attempt any four questions in Q1. [20]

a) Explain lead and lag compensator.

b) What are the properties of state transition matrix?

c) Explain Controllability and Observability with necessary condition for stability.

d) Explain Mason Gains' Formula with its need.

e) Explain the effect of addition of pole and zero to a system.

Q2. A) Find the transfer function C(s)/R(s) of the following system using block diagram technique.
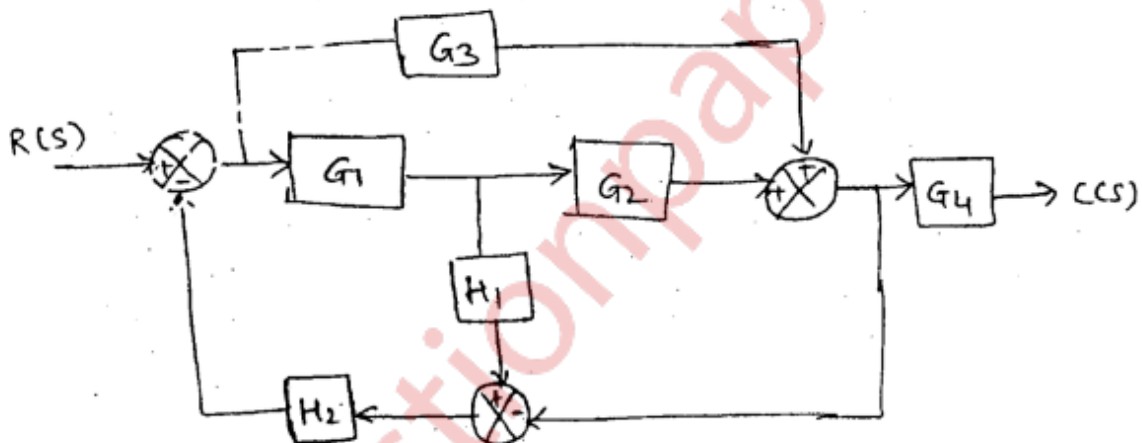
[10]

Q2. B) Consider Unity feedback control system with open loop transfer function given as [10]

$$G(s)H(s) = \frac{k(s+1)(s+2)}{(s+3)(s-3)}$$

Plot the Root Locus and find the gain at which system is critically damped.

Q3. A) Write a note on advances in control system. [10]

Q3. B) Obtain the state variable model of the transfer function – [10]

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

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Q4. A) Check controllability and observability for the system described by **[10]**

$$\dot{x} = \begin{vmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{vmatrix} x + \begin{vmatrix} 0 \\ 1 \\ 2 \end{vmatrix} u$$

$$Y = [1 \quad 2 \quad 3]\, x$$

Q4. B) Determine the stability of the system having characteristic equation **[10]**

$$s^8 + 5s^6 + 2s^4 + 3s^2 + 1 = 0$$

Q5. A) Construct the Bode Plot for the following transfer function. Comment on stability. **[10]**

$$G(s)H(s) = \frac{10}{s(s+1)(s+5)}$$

Q5. B) List the performance specifications of Time Response Analysis and derive any four of them.

[10]

Q6. A) Explain Adaptive Control System. **[20]**

Q6. B) Explain PID Controller.

Q6. C) Find the range of K for the system to be stable

$$S^4 + 7s^3 + 10s^2 + 2ks + k = 0.$$

Q6. D) Draw polar plot for the transfer function given by

$$G(s) = \frac{12}{s(1+s)}$$

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