

(3 Hours)

[Total Marks: 80]

- Note:- (1) Q no. 1 is compulsory
 (2) Solve any three questions from Q. No. 2 to Q.no. 6.
 (3) Assume suitable data whenever necessary.

Q NO.1 Solve any four.

- (a) What are the time domain specifications needed to design a control system? **05**
 (b) What is compensation? What are types? **05**
 (c) Compare the analog and digital controller. **05**
 (d) What is zero order hold circuit? **05**
 (e) State the conditions for stability of system in Z-plane. **05**

Q. NO.2(a) A linear time-invariant system is described by the following differential equations:- **10**

$$dx_1(t)/dt = -2.x_1(t) + 4.x_2(t).$$

$$dx_2(t)/dt = -2.x_1(t) - x_2(t) + u(t).$$

Comment on the controllability and stability.

Q.NO.2(b) Obtain the state transition matrix (STM) for the state model whose matrix (A) is given by:- **10**

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

Q.NO.3(a) Obtain the transfer function for a system having state model:- **10**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 3 \\ 5 \end{bmatrix} u$$

$$Y = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \text{ and } D = \begin{bmatrix} 0 \end{bmatrix}$$

Q.No.3(b) Construct a state model for a system by the characterized differential equation, by phase variable method:- **10**

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 6y + u = 0$$

Q.No.4(a) A linear time invariant system is characterized by the homogenous state equation **10**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Compute the solution of homogeneous equation, assuming the initial state vector = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$

Q.No.4(b) A single input system is described by the following state equation 10

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 1 & -2 & 0 \\ 2 & 1 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 10 \\ 1 \\ 0 \end{bmatrix} u$$

Design a state feedback controller which will give closed loop poles at $-1 \pm j2, -6$. Use Ackermann's method.

Q.No.5(a) Consider a system described by the state model: 10

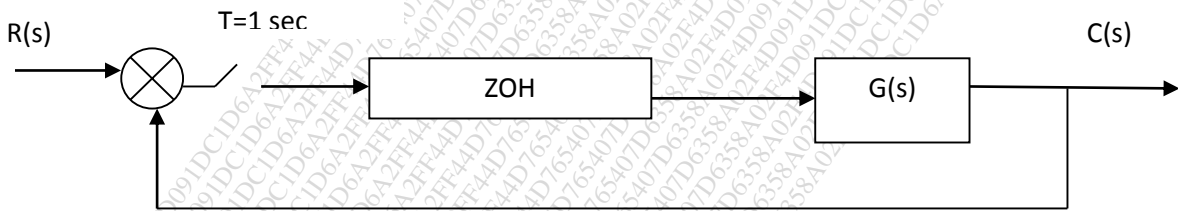
$$\dot{x} = [A]x \text{ and } [y] = [C]x$$

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

Design a full order state observer. The desired eigen values for the observer matrix are $-5, -5$. Use Ackermann's method.

Q.No.5(b) Find the response of the unit step input where 10

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



Q.No.6(a) Explain the design procedure of Lag-Lead Compensator. 10

Q.No.6(b) Explain the stability of digital control system in Z-plane. 10