(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) Sate 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**

dx1(t)/dt =-2.x1(t)+4.x2(t).

dx2(t)/dt=-2.x1(t)-x2(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= $\begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ 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**

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

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**

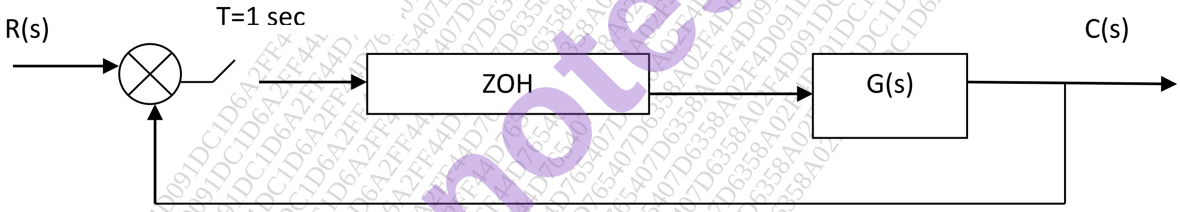
$[\dot{x}] = [A][x]$ and $[y] = [C][x]$

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**