[This question paper contains 4 printed pages.]

Your Roll No. ....

3210 **J**

MEE

Paper – EE.551

SYSTEM THEORY

Time : 3 *Hours* *Maximum Marks* : 100

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any ***five*** *questions.*

Assume suitable missing data, if any.

1. (a) Explain the need of sampler and zero-order hold device in control system with the help of neat diagrams. 10

   (b) Check the stability of the following characteristic polynomial using Jury's Stability Test.

   $F(z) = 2Z^4 + 7Z^3 + 10Z^2 + 4Z + 1$ 10

2. (a) Find the response X(K) of the following system :

   $X(K + 2) - 3X(K+1) + 2X(K) = u(K)$

   where $X(K) = 0$ for $K \leq 0$

   $u(0) = 1$

   $u(K) = 0$ for $K < 0$, $K > 0$

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(b) Solve the difference equation :

$$C(K+2) + 3C(K+1) + 2C(K) = u(K);$$

$$C(0) = 1$$

$$C(K) = 0 \text{ for } K < 0$$

10

3. A discrete time system is described by the state equation.

$$Y(K+2) + 5.Y(K+1) + 6.Y(K) = u(K)$$

$$Y(0) = Y(1) = 0; \; T = 1 \text{ sec.}$$

(a) Determine a state model in Canonical form. 10

(b) Find the state transition matrix. 5

(c) For input $u(K) = 1$ for $K \geq 0$, find the output Y(K). 5

4. (a) Using Cascade method decompose the transfer function :

$$\frac{Y(s)}{U(s)} = \frac{1}{(s+1)(s+3)}$$

and obtain the state model. 10

(b) Discuss the advantages of state variable approach over classical approach in control systems. 10

5. (a) Derive the state variable formulation of a parallel RLC circuit driven by a current source I. 8

(b) Obtain the time response of the following system :

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

Where $u(t)$ is a unit step occurring at $t = 0$ and $X^T(0) = [1 \ 0]$. 12

6. (a) Obtain the resolvent matrix, STM, $\phi^{-1}(t)$ of the following system :

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$$ 10

(b) Explain the term state, state vector and state variables. Find the transfer function matrix from the data given below :

$$A = \begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \quad C = [1 \quad 1], D = 0$$ 10

7. (a) Construct the state model in Phase variable form for a system characterized by the differential equation :

$$\frac{d^3Y}{dt^3} + 6.\frac{d^2\,Y}{dt^2} + 11\,\frac{dY}{dt} + 6Y = u$$ 10

(b) For a system represented by the state equation :

$$\dot{X}(t) = AX(t)$$

the response of

$$X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$$

$$\text{and } X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}.$$

Determine system matrix A and the state transition matrix. 10

8. (a) Discuss the concept of control liability and observability in control systems. 8

(b) For the Sampled-data control system shown in Fig., find output Y(K) for $u(t)$ = unit step. 12