

MEIC-102**M.E./M.Tech. I Semester****Examination, December 2017****Linear Control Systems****Time : Three Hours****Maximum Marks : 70**

- Note:** i) Attempt any five questions.
ii) All questions carry equal marks.

1. a) Derive the expression for state transition matrix of continuous and discrete time control system.
b) Construct a state model for a system characterized by differential equation and obtain the different Canonical form.

$$\ddot{y} + 6\dot{y} + 11y + 6y = u$$

2. a) State and explain Lyapunov's stability theorem?
b) Find $x_1(t)$ and $x_2(t)$ of the system described by:

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

Where the initial condition

$$\begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

3. a) What is State Observer? Explain with suitable example.
b) A feedback system has a closed loop transfer function

$$\frac{10(s+4)}{s(s+1)(s+3)}$$

Construct state model and it's representation.

4. a) Explain various methods of evaluation of state transition matrix.

- b) Consider the linear autonomous system

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} x$$

using direct method of Lyapunov, determine the stability of the equilibrium state.

5. a) Explain the Jordan Canonical form realization with suitable example.
b) Consider the discrete time system with state and output equation is given by

$$X(k+1) = \begin{bmatrix} 1 & 0 \\ 0 & 0.5 \end{bmatrix} X(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$Y(k) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}^T X(k)$$

Determine the observability of the above system.

6. a) Using the Cayley Hamilton technique, find e^{At} for

i) $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$

ii) $A = \begin{bmatrix} 0 & 2 \\ -2 & -4 \end{bmatrix}$

b) Find the Eigen values and Eigen vectors for the following matrices?

i) $\begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix}$

ii) $\begin{bmatrix} -3 & 2 \\ -1 & 0 \end{bmatrix}$

7. a) Explain the stability of distributed parameter system.

b) Determine the Lyapunov function for the state representation given below:

$$\dot{x}_1 = 2x_2$$

$$\dot{x}_2 = -4x_1 - 6x_2$$

Use relation $V(x) = x^T p x$

8) Write short notes on any two of the following:

a) Generation of Lyapunov function

b) Controllability in continuous and discrete time

c) State transition matrix and solution of state equation
