USN | | | | | | | | | | |  **10EE55**

# Fifth Semester B.E. Degree Examination, Dec.2016/Jan.2017
# Modern Control Theory

Time: 3 hrs. Max. Marks:100

**Note:** ***Answer FIVE full questions, selecting at least TWO questions from each part.***



## PART – A

1 a. Obtain the state model of the system whose transfer function is given by,

$$G(s) = \frac{s^2 + 2s + 1}{s^3 + 3s^2 + 4s + 5}$$

**(06 Marks)**

b. Obtain the state model of armature controlled DC motor. **(10 Marks)**

c. Mention the advantages of modern control theory. **(04 Marks)**

2 a. A system is described by the, $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix}$. Find eigen values, eigen vector and modal matrix. **(08 Marks)**

b. Obtain the state model of mechanical system shown in Fig. Q2 (b) by using minimum number of state variables. **(06 Marks)**

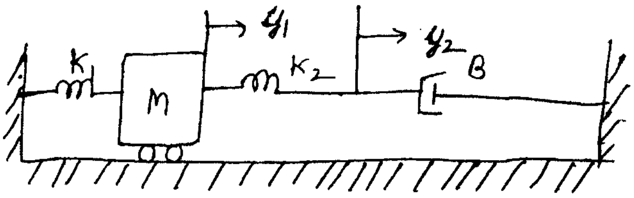


Fig. Q2 (b)

c. Obtain the state model of the electrical network shown in Fig. Q2 (c) by choosing $v_1(t)$ and $v_2(t)$ as state variables. **(06 Marks)**

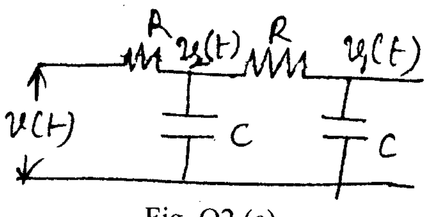


Fig. Q2 (c)

3 a. What are the properties of state transition matrix? **(04 Marks)**

b. Obtain state transition matrix for the system described by $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} x(t)$ by,

(i) L.T. method (ii) C-H technique. **(10 Marks)**

c. Obtain the transfer function of the following system:

$$A = \begin{bmatrix} -1 & 0 & 1 \\ 1 & -2 & 0 \\ 0 & 0 & 3 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix},\ C = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}^T$$

**(06 Marks)**

4 a. Define controllability and observability. **(04 Marks)**

b. Find the step-response for the system represented by state equation,

$\dot{X} = AX + BU$ and $Y = CX$ where

$A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$; $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$; $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$ **(10 Marks)**

c. Check controllability and observability of the following model:

$A = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix}$, $B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}$, $C = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$ **(06 Marks)**

## PART – B

5 a. Explain the following:

(i) P + D controller (ii) P + I controller (iii) P + I + D controller **(06 Marks)**

b. Consider the system defined by,

$\dot{x} = Ax + Bu$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$. By using state feedback control $u = -Kx$ it is desired to have closed loop poles at $s = -1 \pm j1$, $s = -10$. Determine the state feedback gain matrix K. **(08 Marks)**

c. Design full order state observer with the block diagram. **(06 Marks)**

6 a. What is non-linear system? What are the properties of non-linear system? Explain them. **(08 Marks)**

b. Explain the following non linearities :

(i) Relay with dead zone (ii) Backlash (iii) Saturation (iv) Friction. **(12 Marks)**

7 a. What are singular points? Explain them. **(06 Marks)**

b. Explain isoclines method of sending phase trajectories. **(06 Marks)**

c. Construct phase trajectory by delta method for non linear system represented by differential equation $\ddot{x} + 4|\dot{x}|\dot{x} + 4x = 0$. Choose initial conditions as x(0) = 1.0 and $\dot{x}(0) = 0$. **(08 Marks)**

8 a. Define (i) Positive definiteness (ii) Negative definiteness (iii) Indefiniteness **(06 Marks)**

b. Explain Liapunov stability theorem. **(06 Marks)**

c. Use Krasookii's method to show that the equilibrium state x = 0 of the system described by,

$\dot{x}_1 = -3x_1 + x_2$

$\dot{x}_2 = x_1 - x_2 - x_2^3$

is asymptotically stable in large. **(08 Marks)**

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