

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)

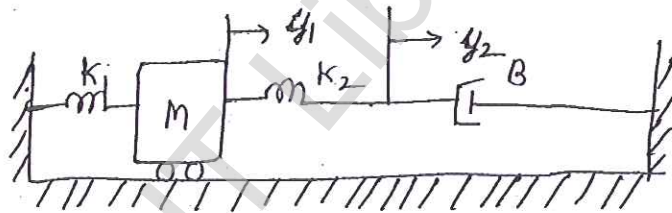


Fig. Q2 (b)

- 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)

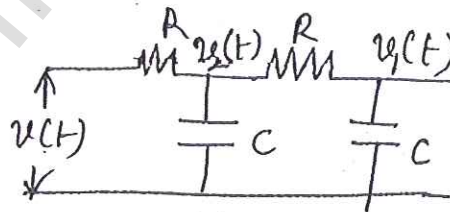


Fig. Q2 (c)

- 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
 $A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$; $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$; $C = [1 \ 0]$ (10 Marks)
 c. Check controllability and observability of the following model:
 $A = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix}$, $B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}$, $C = [0 \ 0 \ 1]$ (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 $\ddot{x} + 4\dot{x} + 4x = 0$. 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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