U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

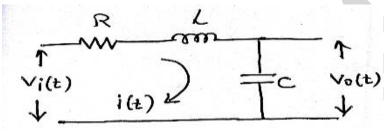
Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

Programme: B.E. | **Semester: V**
Branch: Electrical and Electronics Engineering | **Duration: 3 hrs.**
Course Code: 22EE5PCMCT | **Max Marks: 100**
Course: Modern Control Theory

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			CO	*PO*	Marks
		UNIT - I			
1	a)	Define the concept of i) State ii) State variables iii) State vector with an example.	*CO1*	-	**06**
	b)	Determine the state model of the given electrical system 	*CO2*	*PO1*	**07**
	c)	Derive the state model in canonical form of a system whose transfer function is $T(s) = \frac{8S^2+17S+8}{(S+1)\ (S^2+8S+15)}$	*CO2*	*PO1*	**07**
		UNIT - II			
2	a)	Define Homogeneous state equation and Non-homogeneous state equation.	*CO1*	-	**04**
	b)	Determine the State transition matrix using Cayley – Hamilton method. $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$	*CO2*	*PO1*	**06**
	c)	Consider a state model with matrix $A = \begin{bmatrix} 0 & 2 & 0 \\ 4 & 0 & 1 \\ -48 & -34 & -9 \end{bmatrix}$ Determine a) Characteristic equation b) Eigen Values and c) Modal matrix. Also prove that the transformation $M^{-1}AM$ results in a diagonal matrix.	*CO2*	*PO1*	**10**
		OR			
3	a)	State the various properties of state transition matrix.	*CO1*	-	**05**

		b)	Reduce the given state model into its canonical form by diagonalizing matrix A: $\dot{X}(t) = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U(t)$ and $Y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} X(t)$.	*CO2*	*PO1*	**08**
		c)	Derive the transfer function from state model.	*CO2*	*PO1*	**07**
			UNIT - III			
	4	a)	Use controllability and observability matrices to determine whether the system given below is completely controllable and completely observable. $A = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix}, \quad B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}, \quad C = [0 \;\; 0 \;\; 1]$	*CO3*	*PO2*	**10**
		b)	Define controllability and observability. Explain how to determine the same using any one method. Discuss the duality of controllability and observability.	*CO3*	*PO2*	**10**
			UNIT - IV			
	5	a)	Consider the system defined by $\dot{X}$=AX+BU where $A = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & 1 \\ 0 & 2 & 0 \end{bmatrix}, B = \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$ Design an observer such that the eigen values are placed at S = -3±j1, s= -4. Determine the state observer gain matrix using Ackerman's formula	*CO4*	*PO3*	**10**
		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 the state feedback control u = -kx, it is desired to have the closed loop poles at s = -2 ± j4, s = -10. Determine the state feedback gain matrix K using transformation matrix.	*CO4*	*PO3*	**10**
			UNIT - V			
	6	a)	Draw the input-output characteristics of the following non linearities and explain: i) Dead zone ii) On-off with dead zone iii) Saturation iv) On –off with hysteresis.	*CO1*	-	**08**
		b)	Classify singular points based on the location of eigen values of the system.	*CO2*	*PO1*	**08**
		c)	What are the characteristics of nonlinear system?	*CO1*	-	**04**
			OR			
	7	a)	What is intentional nonlinearity? Why is it used? Give one example. Compare intentional nonlinearity with inherent nonlinearity.	*CO1*	-	**06**

		b)	With reference to a nonlinear system explain: i) Jump response ii) Limit cycles.	*CO1*	-	**06**
		c)	For a nonlinear system given by: $\ddot{y} + 0.5\dot{y} + 2y + y^2 = 0$, find the singularities and classify the singular points.	*CO2*	*PO1*	**08**

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