U.S.N.										

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

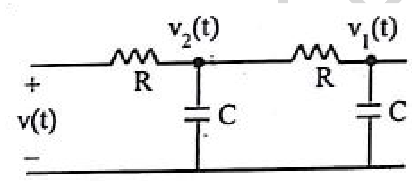
Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**
Branch: Electrical and Electronics Engineering **Duration: 3 hrs.**
Course Code: 19EE6PCMCT **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)	Explain the following with an example: State, State variables, State vector, State space,	*CO2*	*PO2*	**08**
	b)	Obtain state model for the electrical system shown: 	*CO1*	*PO1*	**07**
	c)	List the advantages of state space analysis.	*CO1*	*PO1*	**05**
		OR			
2	a)	Determine the canonical state model of the system given by $$T(s) = \frac{2(s+5)}{(s+2)(s+3)(s+4)}$$	*CO1*	*PO1*	**10**
	b)	A feedback system has a closed-loop transfer function $$\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s+1}$$ Construct the state model for this system.	*CO2*	*PO3*	**10**
		UNIT - II			
3	a)	Derive the expression for transfer function from the state model and hence obtain the transfer function for the system with state model given as:	*CO2*	*PO3*	**10**

			$\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}-5 & -1\\ 3 & -1\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}2\\ 5\end{bmatrix}U$ $y=\begin{bmatrix}1 & 2\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}$			
		b)	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*	*PO3*	**10**
			OR			
	4	a)	Find the solution of $\dot{X}=\begin{bmatrix}0 & 1\\ 0 & -2\end{bmatrix}X(t)+\begin{bmatrix}1\\ 0\end{bmatrix}U(t)$ and $Y(t)=\begin{bmatrix}1 & 0\end{bmatrix}X(t)$ if $X(0)=\begin{bmatrix}1\\ 0\end{bmatrix}$ and system is subjected to unit step input.	*CO2*	*PO3*	**10**
		b)	Find state transition matrix for $A=\begin{bmatrix}0 & 1\\ 0 & -2\end{bmatrix}$ using (i) Cayley Hamilton theorem (ii) Laplace Transform method.	*CO2*	*PO3*	**10**
			UNIT - III			
	5	a)	Define controllability and observability. Explain the Kalman's method of determining the same.	*CO3*	*PO1*	**10**
		b)	Check observability using Kalman's and Gilberts test for the system given below: $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\\ \dot{X}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}U$	*CO3*	*3*	**10**
			OR			
	6	a)	Find whether the system given below is controllable or not using Kalman's and Gilberts test for the system given below: $A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}, B=\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$ *and* $C=\begin{bmatrix}3 & 4 & 1\end{bmatrix}$	*CO3*	*PO1*	**10**
		b)	Define the duality of the system between controllability and observability concept? Develop the expression by Kalman's Method.	*CO3*	*PO3*	**10**

			UNIT - IV			
	7	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)	Explain the concept of state controller and observer.	*CO4*	*PO3*	**10**
			OR			
	8	a)	Explain the different methods of pole placement.	*CO1*	*PO1*	**10**
		b)	Design a full order state observer using (i) Direct substitution method (ii) Ackermann's method. Assume that the desired eigenvalues of the observer matrix are -5, -5 for the system given as $\dot{X}= \begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix} X(t)+ \begin{bmatrix} 1 \\ 0 \end{bmatrix} U(t)$ and $Y(t)=\begin{bmatrix} 1 & 0 \end{bmatrix} X(t)$	*CO3*	*PO3*	**10**
			UNIT - V			
	9	a)	Explain the following phenomena with examples, in a non-linear system. (i) Saturation (ii) Friction (iii) Backlash (iv) Deadzone (v) Relay	*CO1*	*PO1*	**10**
		b)	Explain different types of singular points.	*CO2*	*PO1*	**10**
			OR			
	10	a)	What is intentional nonlinearity? Why is it used? Give one example. Compare intentional nonlinearity with inherent nonlinearity.	*CO1*	*PO1*	**10**
		b)	Explain the phase plane method of stability analysis of nonlinear systems.	*CO1*	*PO1*	**10**

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