U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. | **Semester: VI**

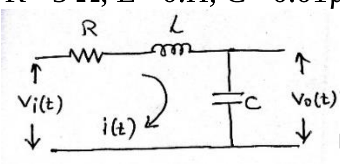
Branch: ELECTRICAL & ELECTRONICS ENGG. | **Duration: 3 hrs.**

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.

		UNIT - I	*CO*	*PO*	**Marks**
1	a)	List the limitations of classical control theory and state how it is overcome in state space analysis.	*CO1*	*PO1*	**06**
	b)	Obtain the state space model of an armature-controlled DC motor	*CO1*	*PO1*	**08**
	c)	Determine the state model of the given electrical system. Given R= 5 Ω, L= 0.H, C= 0.01µF. 	*CO1*	*PO2*	**06**
		OR			
2	a)	Explain linearization of state equations.	*CO1*	*PO1*	**08**
	b)	Obtain the canonical state model for the given transfer function $\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$	*CO1*	*PO2*	**08**
	c)	Define: State, state variable, state space and state vector.	*CO1*	*PO1*	**04**
		UNIT - II			
3	a)	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.	*CO1*	*PO2*	**10**

		b)	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.	*CO1*	*PO2*	**10**
			OR			
	4	a)	Find e^{At} for $A=\begin{bmatrix}0 & 1\\-6 & -5\end{bmatrix}$ using (i) Cayley- Hamilton theorem (ii) Laplace Transform method	*CO1*	*PO2*	**10**
		b)	Compute the solution of the following state equation: $$\dot{X}=\begin{bmatrix}0 & 0 & -2\\0 & 1 & 0\\1 & 0 & 3\end{bmatrix}X;\ X(0)=\begin{bmatrix}0\\1\\0\end{bmatrix}$$	*CO1*	*PO2*	**10**
			UNIT - III			
	5	a)	Define controllability and observability. Discuss the duality Principle of controllability and observability.	*CO2*	*PO1*	**10**
		b)	Evaluate controllability and observability of the state model: $A=\begin{bmatrix}0 & 0 & 0\\1 & 0 & -3\\0 & 1 & -4\end{bmatrix}$, $B=\begin{bmatrix}40\\10\\0\end{bmatrix}$, $C=\begin{bmatrix}0 & 0 & 1\end{bmatrix}$	*CO2*	*PO2*	**10**
			OR			
	6	a)	Determine controllability of the given system using Kalmans test and Gilberts test. $$\begin{bmatrix}\dot{X}_1\\\dot{X}_2\\\dot{X}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\-6 & -11 & -6\end{bmatrix}\begin{bmatrix}X_1\\X_2\\X_3\end{bmatrix}+\begin{bmatrix}0\\0\\1\end{bmatrix}U$$	*CO2*	*PO2*	**10**
		b)	Find whether the system given below is observable or not using Kalman's and Gilberts test for the system given below: $$A=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\0 & -2 & -3\end{bmatrix},\ B=\begin{bmatrix}0\\0\\1\end{bmatrix}\ and\ C=[3\ \ 4\ \ 1]$$	*CO2*	*PO2*	**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	*CO2*	*PO2*	**10**

		b)	What is pole placement by state feedback? Explain. Also define the necessary and sufficient condition for arbitrary pole placement.	*CO2*	*PO1*	**10**
			OR			
	8	a)	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.	*CO2*	*PO2*	**10**
		b)	Explain the different methods of pole placement.	*CO2*	*PO1*	**10**
			UNIT - V			
	9	a)	What is intentional nonlinearity? Why is it used? Compare intentional nonlinearity with inherent nonlinearity.	*CO3*	*PO1*	**10**
		b)	Explain the following phenomena with examples, in a non-linear system. (i) Saturation (ii) Friction (iii) Backlash (iv) Deadzone (v) Relay	*CO3*	*PO1*	**10**
			OR			
	10	a)	What are singular points? Explain the different singular points w.r.t. the stability of a nonlinear system.	*CO3*	*PO1*	**10**
		b)	What are phase trajectories, Explain the method of constructing the same using Delta method	*CO3*	*PO1*	**10**

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