U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

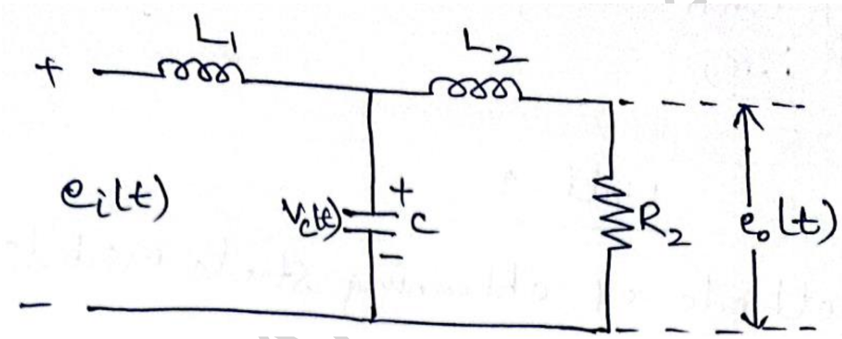
Programme: B.E. — **Semester: V**

Branch: Electrical and Electronics Engineering — **Duration: 3 hrs.**

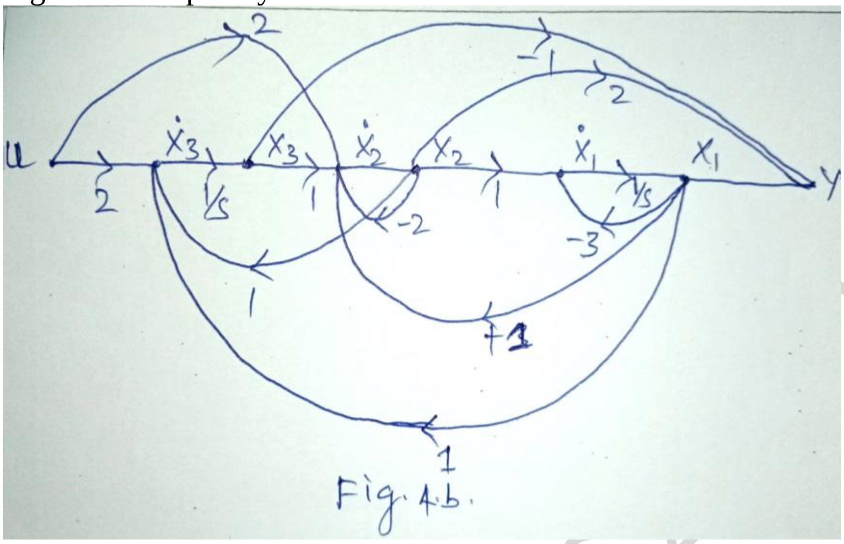
Course Code: 23EE5PCMCT — **Max Marks: 100**

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.

		UNIT - I	*CO*	*PO*	**Marks**
1	a)	Obtain the state model of the given electrical system in its standard form. 	*CO2*	*PO2*	**10**
	b)	For the given transfer function, obtain state model using direct decomposition method. $$T(s) = \frac{(S+2)\,(S+3)}{S(S+1)(s^2+9S+20)}$$	*CO2*	*PO2*	**10**
		OR			
2	a)	Construct the state model using phase variables. If the system is described by the differential equation: - $\frac{d^3y(t)}{dt^3}+4\frac{d^2y(t)}{dt^2}+7\frac{dy(t)}{dt}+2y(t)=5U(t)$	*CO2*	*PO2*	**10**
	b)	With an example, explain two methods of obtaining state model using transfer function.	*CO2*	*PO2*	**10**

			UNIT - II			
	3	a)	Derive an expression for the homogenous equation in the scalar form by classical method solution of state equation and also list out any three properties of state transition matrix.	*CO1*	*PO1*	**10**
		b)	Calculate the Eigen values, eigen vectors, modal matrix for $A = \begin{bmatrix} 0 & 0 & 1 \\ 2 & 0 & 0 \\ -8 & -2 & -5 \end{bmatrix}$	*CO2*	*PO2*	**10**
			OR			
	4	a)	With an example, explain Eigen Values, Eigen Vectors, Modal matrix(m) and Vander Monde matrix (V)	*CO1*	*PO1*	**10**
		b)	Determine the state Transition Matrix using Power Series Method for the given matrix $A = \begin{bmatrix} 0 & -1 \\ 2 & -3 \end{bmatrix}$ and discuss on Cayley Hamilton method.	*CO2*	*PO2*	**6+4=10**
			UNIT - III			
	5	a)	Define Controllability. Explain with an example both Kalman's test for Controllability and also Gilberts test for controllability.	*CO3*	*PO2*	**10**
		b)	A system represented by following state model is controllable but not observable. Show that non-observability is due to pole-zero cancellation. $\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$ $y(t) = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} x(t)$	*CO3*	*PO2*	**10**

			OR			
	6	a)	Define Observability. Explain with an example both Kalman's test for Observability and also Gilbert's test for Observability.	*CO3*	*PO2*	**10**
		b)	Use Controllability and Observability matrices to determine whether the system represented by the signal flow graph in Fig.6.b is completely controllable and observable.  	*CO3*	*PO2*	**10**
			UNIT - IV			
	7	a)	Design a state observer using direct substitution method so that the eigen values are at -4 & -3±j1. An observable system is described by $$\dot{x} = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & 1 \\ 0 & 2 & 0 \end{bmatrix} x + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u$$ $$y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} x$$	*CO4*	*PO3*	**10**
		b)	Consider the linear system described by transfer function $$\frac{Y(s)}{U(s)} = \frac{10}{s(s+1)(s+2)}$$ Design a feedback Controller with a state feedback so that the closed loop poles are placed at -2 , -1±j.	*CO4*	*PO3*	**10**
			OR			
	8	a)	Illustrate on state observer and explain the methods to find Ke.	*CO1*	*PO1*	**10**

		b)	It is desired to place the closed loop poles of the following system at S=-3 and S=-4 by a state feedback controller with the control u=-kx. Determine the state feedback gain matrix using all the methods. $\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$ $y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$	*CO4*	*PO3*	**10**
			UNIT - V			
	9	a)	Explain the following phenomena with examples, in a non-linear system (i) Saturation (ii) Friction (iii) Backlash (iv) dead zone (v) Relay.	*CO1*	*PO1*	**10**
		b)	Determine the kind of singularity for each of the following for each of the differential equations: (i) $\ddot{y}$ +3$\dot{y}$ +2y =0 (ii) $\ddot{x}$ +0.5$\dot{x}$ + 2x =0	*CO3*	*PO3*	**10**
			OR			
	10	a)	Describe in detail Isocline method for construction of Phase Trajectory with an example.	*CO1*	*PO1*	**10**
		b)	For a nonlinear system given by: $\ddot{y} + 0.5\dot{y} + 2y + y^2 = 0$, find the singularities and classify the singular points.	*CO3*	*PO3*	**10**

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