U.S.N.										

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

Autonomous Institute Affiliated to VTU

July / August 2024 Semester End Main Examinations

Programme: B.E.
Branch: Electrical and Electronics Engineering
Course Code: 19EE6PCMCT
Course: Modern Control Theory

Semester: VI
Duration: 3 hrs.
Max Marks: 100

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)	Explain the concept of (i) State (ii) State variables (iii) State space (iv) state vector (v) state trajectory of a linear system	*CO1*	*PO1*	**10**
	b)	Obtain the state space representation in phase variable form for the system represented by D^4y+20D^3y+45D^2y+18Dy+100y = 10D^2u+5Du+100u with y as output and u as input.	*CO1*	*PO1,2*	**10**
		UNIT - II			
2	a)	Determine the transfer matrix for the system $\begin{matrix}\dot{X}_1\\ \dot{X}_2\end{matrix} = \begin{bmatrix}-3 & 1\\ -2 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix} + \begin{bmatrix}4 & 6\\ -5 & 0\end{bmatrix}\begin{bmatrix}U_1\\ U_2\end{bmatrix}$ $\begin{bmatrix}Y_1\\ Y_2\end{bmatrix} = \begin{bmatrix}1 & -1\\ 8 & 1\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}$	*CO1*	*PO1,2*	**08**
	b)	Obtain the eigen values, eigen vectors, modal matrix for A= $\begin{bmatrix}4 & 1 & -2\\ 1 & 0 & 2\\ 1 & -1 & 3\end{bmatrix}$ and prove that $M^{-1}AM = \Lambda$ = Diagonal Matrix	*CO1*	*PO1,2*	**12**
		UNIT - III			
3	a)	State the conditions for complete controllability and complete observability. Determine the state controllability and observability of the system described by $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\\ \dot{X}_3\end{bmatrix} = \begin{bmatrix}0 & 0 & 1\\ -2 & -3 & 0\\ 0 & 2 & -3\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix} + \begin{bmatrix}0\\ 2\\ 0\end{bmatrix}$ u(t) and Y(t) = $\begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}X_1\\ X_2\\ X_3\end{bmatrix}$	*CO2*	*PO1,2*	**12**
	b)	Determine the controllability and observability of the following state model	*CO2*	*PO1,2*	**08**

			$\dot{X}=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\-6 & -11 & -6\end{bmatrix}[X]+\begin{bmatrix}1\\0\\1\end{bmatrix}u$ $y=\begin{bmatrix}10 & 5 & 1\end{bmatrix}X$			
		OR				
	4	a)	State the condition for complete observability using Gilbert's test. Determine the observability using Gilbert's test for the system described by $A=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\0 & -2 & -3\end{bmatrix}$ $B=\begin{bmatrix}0\\0\\1\end{bmatrix}$ $c=\begin{bmatrix}3 & 4 & 1\end{bmatrix}$	*CO2*	*PO1,2*	**10**
		b)	Define Controllability and Observability. Explain the principle of duality between controllability and observability.	*CO2*	*PO1*	**10**
			UNIT - IV			
	5	a)	Consider the system $\dot{X}$ =AX+Bu and Y= CX, 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 a state observer so that desired eigen values are at -3±j1 and – 4.	*CO3*	*PO1,2*	**10**
		b)	Determine the state feedback gain matrix 'K' for the system $\dot{X}$=AX+Bu where $A=\begin{bmatrix}0 & 1\\-1 & -3\end{bmatrix}$;B= $\begin{bmatrix}0\\2\end{bmatrix}$;C = $\begin{bmatrix}1 & 0\end{bmatrix}$ using state feedback control u = - Kx, it is desired to have the closed loop poles at s = -3 and s= -4.	*CO3*	*PO1,2*	**10**
			UNIT - V			
	6	a)	What are singular points? Explain the classification of singular points based on the location of eigen values of the system.	*CO3*	*PO1*	**10**
		b)	State the properties of non-linear system and write a short note on Jump Resonance.	*CO3*	*PO1*	**10**
			OR			
	7	a)	Obtain singular points for the following systems i) $\ddot{x}+0.5\dot{x}+2x=0$ ii) $\ddot{y}+3\dot{y}+2y=0$ iii) $\ddot{y}+3\dot{y}-10=0$	*CO3*	*PO1,2*	**12**
		b)	Discuss the basic features of the following non-linearities i. Non-linear friction ii. On-Off controllers iii. Backlash iv. Deadzone	*CO3*	*PO1*	**08**

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