U.S.N.										

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

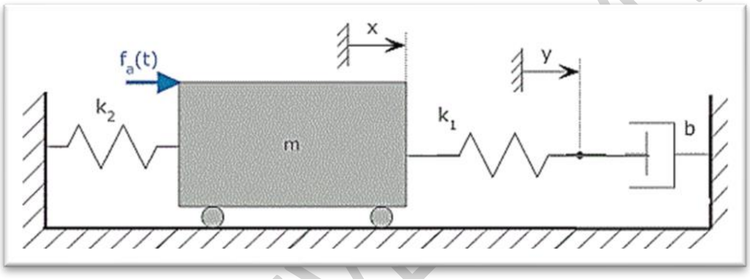
Autonomous Institute Affiliated to VTU

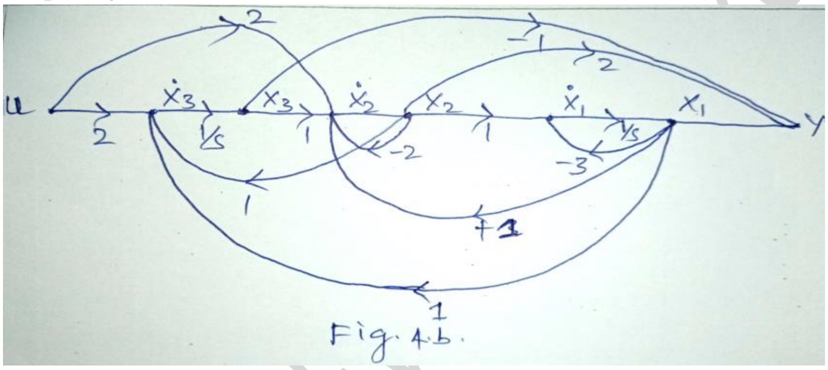
July 2023 Semester End Main Examinations

Programme: B.E. | **Semester: VI**
Branch: Electrical and Electronics Engineering | **Duration: 3 hrs.**
Course Code: 19EE6PCMCT | **Max Marks: 100**
Course: Modern Control Theory | **Date: 12.07.2023**

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 draw backs of the transfer function model.	CO1	PO1	**04**
	b)	 Fig 1b) Derive the state space model of the system shown in Fig 1b). The input is f_a and the output is y.	CO1	PO1	**06**
	c)	A feedback system has a closed loop transfer function given by $\frac{Y(S)}{U(S)} = \frac{(s+2)(s+3)}{s(S+1)(s^2+9s+20)}$. Obtain the state models for this system in (i) direct decomposition method. ii) Akermann's Formulae.	CO1	PO1	**10**
		UNIT - II			
2	a)	System matrix A is given as $\begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ -3 & 3 & 5 \end{bmatrix}$ Obtain the modal matrix, find M^{-1}AM and comment on its nature.	CO1	PO2	**10**
	b)	State any six properties of state transition matrix and also define Eigen Values, Eigen Vectors with an example.	CO1	PO2	**10**
		UNIT - III			
3	a)	Check the controllability and observability of the following representation using Kalman's test. $\dot{x}(t) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -1 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u \; ; \; y = [1 \quad 1 \quad 0]\, x(t).$	CO2	PO3	**10**

		b)	Consider a system defined by $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$ It is desired to place eigen values at s= -3 and s= -5 by using state feedback control u= -kx. Determine the feedback gain matrix K. Apply i) Direct substitution method ii) Ackermann's Formulae.	*CO2*	*PO3*	**10**
			OR			
	4	a)	Consider the system described by the transfer function $$\frac{Y(S)}{U(S)} = \frac{s+2}{s^3+9s^2+24s+20}$$ Obtain controllable canonical form and check its observability	*CO2*	*PO3*	**10**
		b)	Use Controllability and Observability matrices to determine whether the system represented by the signal flow graph in Fig.4.b is completely controllable and observable.  	*CO2*	*PO3*	**10**
			UNIT - IV			
	5	a)	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. $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$ $$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$	*CO2*	*PO3*	**10**
		b)	Prove that the necessary and sufficient condition for arbitrary pole placement in a system is completely state controllable.	*CO2*	*PO3*	**10**
			UNIT - V			
	6	a)	Discuss the following as applied to non linear systems: (i) Frequency amplitude dependence (ii) Jump resonance (iii) Limit cycles	*CO3*	*PO3*	**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			
	7	a)	Discuss the following as applied to physical systems: (i) Saturation (ii) Friction (iii) Backlash (iv) Relay nonlinearity	*CO3*	*PO3*	**12**
		b)	Describe in detail Isocline method for construction of Phase Trajectory with an example.	*CO3*	*PO3*	**08**

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