Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – WINTER • 2014

Subject code: 710703N **Date: 03-12-2014**

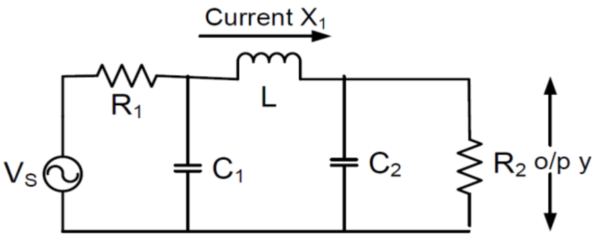
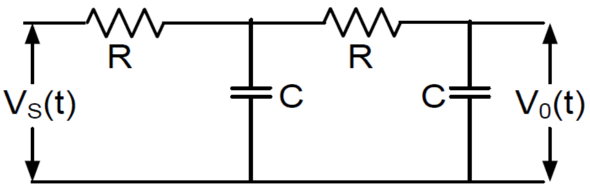
Subject Name: Modern Control System

Time: 10:30 am - 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1	**(a)**	Answer the most appropriate option 1) System state model have transmission matrix D with non-zero value when______. A) Pole and zero of a T.F. have same value B) Pole and zero of a T.F. have different value C) When zero of a T.F. is absent D) none of these 2) Output equation of a state model is also known as ______. A) Read out function B) Quadruplet C) Transmission function D) Rational function 3) Phase variable and Dual phase variable form are also known as _______. A) Bush form B) Companion form C) Rational form D) Canonical from 4) Diagonalization of system matrix means________. A) Inverse of matrix B) Decoupling state equation C) Transformation of system matrix D) none of these 5) Find incorrect option A) State space model can be obtained for a linear system only B) Eigen values of the system represents roots of characteristic equation C) x(t) represents the state vector d) a and c 6) Which is not the property of State Transition Matrix A) $\varphi(t_1/t_2) = \varphi(t_1).\varphi^{-1}(t_2)$ B) $\varphi(-t) = \varphi^{-1}(t)$ C) $\varphi(t_1-t_2) = \varphi(-t_2).\varphi(t_1)$ D) None of these	**06**
	(b)	Answer the following 1) Explain for matrix: a) Rank b) co-factor c) Adjoint d) Symmetry e) Eigen value f) Eigen vector 2) Mention the properties of determinant of a matrix.	**08**
Q.2	**(a)**	Obtain the state space model for MIMO type of system and discuss in detail about the advantages and limitations of the model as far as control system analysis is concern.	**07**
	(b)	What is transfer function decomposition? How it is useful? Explain any one of the method to obtain it.	**07**
		OR	
	(b)	Determine the state space model using direct decomposition for the system given as T.F. $$\frac{Y(s)}{U(s)} = \frac{S^2+3s+2}{s^3+9s^2+26s+24}$$	**07**
Q.3	**(a)**	Define STM. Mention and prove the properties of the same.	**07**
	(b)	What is decoupling of state equation? Obtain the decoupled state equation for the system given as:	**07**

		$\begin{bmatrix}\dot{X}1\\ \dot{X}2\end{bmatrix} = \begin{bmatrix}-6 & 1\\ -5 & 0\end{bmatrix}\begin{bmatrix}X1\\ X2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}U$ $Y = \begin{bmatrix}1 & -2\end{bmatrix}\begin{bmatrix}X1\\ X2\end{bmatrix}$	
		OR	
Q.3	**(a)**	Discuss the concept of Kalman's controllability and observability test in detail.	**07**
	(b)	Obtain state space model for the electrical system given in Fig.1 below  Fig.1	**07**
Q.4	**(a)**	Discuss the causes of uncontrollability and/or unobservability with the help of examples.	**07**
	(b)	Develop state space model and investigate for complete controllability and complete observability for system given in Fig.2  R=1MΩ and C=4.7μF Fig.2	**07**
		OR	
Q.4	**(a)**	Discuss the stability in the sense of Lyapunov. Explain asymptotic and uniform stability with the help of appropriate diagram and relevant equations.	**07**
Q.4	**(b)**	Investigate the system's stability by Lyapunov's method using the Lyapunov's function in which $X=X_1^2+X_2^2$ for the following two systems given as: (i) $\dot{X}_1 = X_2$, $\dot{X}_2 = -X_1 - X_2^3$ (ii) $\begin{bmatrix}\dot{X}1\\ \dot{X}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -1 & 1\end{bmatrix}\begin{bmatrix}X1\\ X_2\end{bmatrix}$	**07**
Q.5	**(a)**	Discuss the state feedback and pole placement at desired location in state space design for the controlled dynamic behaviour of a closed loop system.	**07**
	(b)	For the given state model here obtain the solution for gain elements desiring that the systems poles be located at s= -3, s= -4, and s= -5.	**07**

		$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -6 & -7 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$ $$y = \begin{bmatrix} 2 & 0 & -1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$	
		OR	
Q.5	**(a)**	Define (i) Full order state observer (ii) reduced order state observer (iii) observer gain, related with observer design and also define (iv) Positive definiteness (v) negative definiteness (vi) Sylvestor's theorem explaining definiteness.	**07**
	(b)	Obtain the observer design for the system given below in which it is desired that the observer eigen values are placed at (-50, -50). $$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} -2 & -4 \\ 1 & -4 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 0 \end{bmatrix} u$$ $$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$$	**07**

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