Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2013

Subject code: 710703N **Date: 13-06-2013**

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)** Express matrix A as a sum of symmetric and a skew symmetric matrix where, **07**

$$A = \begin{bmatrix} 2 & 3 & -3 \\ 5 & 6 & -6 \\ -7 & 0 & -9 \end{bmatrix}$$

(b) Define and discuss the concept of state, state variables, state vector and state space. **07**

Q.2 **(a)** Find the inverse and rank of matrix A, where **07**

$$A = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & -2 \\ 1 & 0 & -2 \end{bmatrix}$$

(b) Write a short note on limitations and advantages of state variable approach. **07**

OR

(b) Explain positive definite, positive semi definite and indefinite function. **07**

Q.3 **(a)** Explain in brief concepts and definition of Controllability and Observability. **07**

(b) Check for the controllability and the observability of the system given by **07**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \\ \dot{x_3} \end{bmatrix} = \begin{bmatrix} 3 & -1 & -1 \\ 1 & 0 & -1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u$$

$$[y_1] = [0 \quad 1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

OR

Q.3 **(a)** State the controllability and derive the condition for checking the same for a given system. **07**

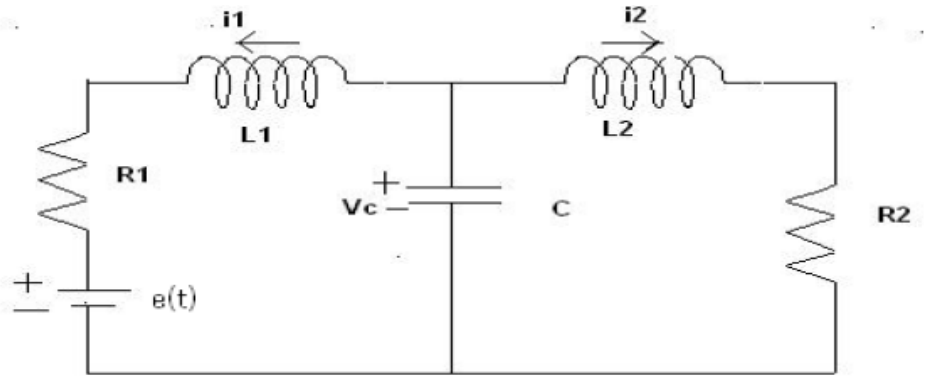
(b) Consider the system described by the following **07**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + u$$

Find whether it is state controllable, output controllable and observable

Q.4 **(a)** Write a set of state equations for the network shown in bellow Fig. Choose i_1, i_2, and v_c as state variables. **07**

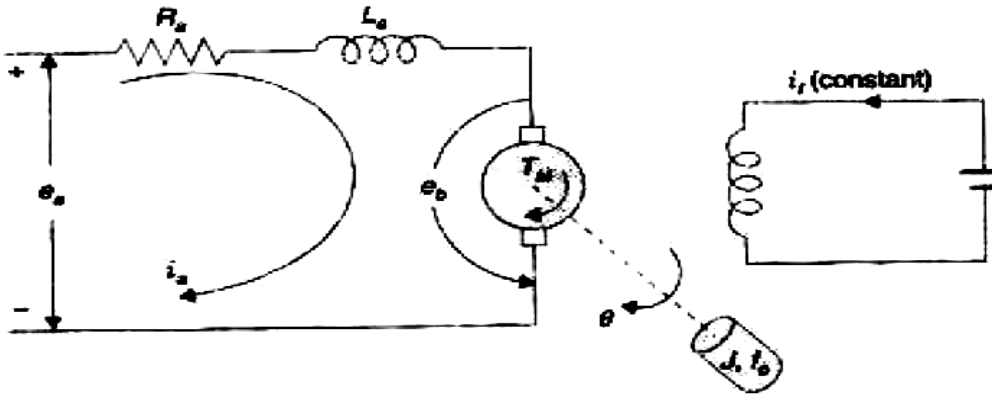


(b) Obtain state model by direct decomposition for the transfer function of the system, whose transfer function is, **07**

$$G(S) = \frac{S^2+5S+6}{S(S+1)(S^2+9S+20)}$$

OR

Q.4 **(a)** Obtain the state space representation for the armature controlled d.c. motor shown in Fig. below, given Moment of inertia of motor and load = J, Coefficient of friction of motor and load = f, Back emf constant = K_b and motor torque constant = K_T **07**



(b) Obtain the state model of system, whose transfer function is by parallel decomposition. **07**

$$G(S) = \frac{S^3+3S^2+2S}{S^3+12S^2+47S+60}$$

Q.5 **(a)** Explain the Liapunov stability criterion for the Linear Time Invariant System. **07**

(b) An autonomous system is given bellow Examine the stability using Liapunov theorem. **07**

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

OR

Q.5 **(a)** Explain Krasovskii method for the determination of stability. **07**

(b) Apply Krasovskii method to assess the stability of the equilibrium point x(0) of the system given below **07**

$$\dot{x_1} = -x_1$$
$$\dot{x_2} = x_1 - x_2 - (x_2^3)/3$$

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