Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E Sem-I Regular Examination January / February 2011

Subject code: 710703N

Subject Name: Modern Control System

Date: 02 /02 /2011 **Time: 02.30 pm – 05.00 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)** Define state space and state vector. Also discuss the advantages and limitations of state space techniques. **07**

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

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

Q.2 **(a)** Prove that $A(adjA) = (adjA)A = |A|I$. where **07**

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 3 & 5 \\ 1 & 5 & 12 \end{bmatrix}.$$

(b) Determine the $f(A) = e^{At}$ using Cayley-Hamilton Theorm for a given matrix A $= \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$. **07**

OR

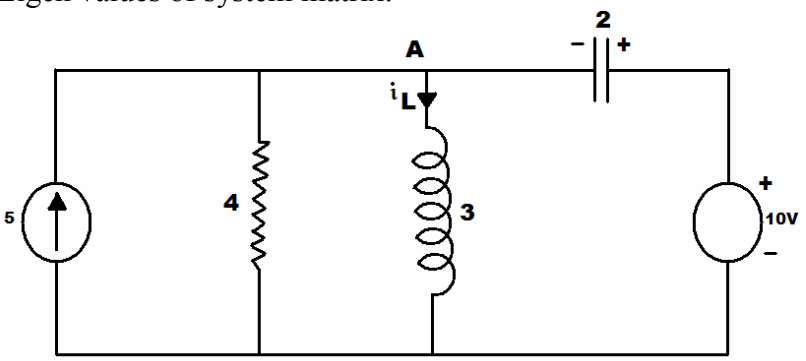
(b) Obtain time response of a system which is described by **07**

$$\dot{x}(t) = \begin{bmatrix} -1 & 1 \\ 0 & -2 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t), \quad x(0) = \begin{bmatrix} -1 \\ 0 \end{bmatrix},$$

$$u(t) = 1, \quad t > 0.$$

Q.3 **(a)** What is Jordan Canonical form ? Discuss its properties. **07**

(b) Write the state equations for the following circuit shown in fig. and also find Eigen values of system matrix. **07**



OR

Q.3 **(a)** What is State Transition matrix? How it is obtained? Discuss its properties. **07**

(b) A system is described by **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -4 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Obtain the transfer function of the system.

Q.4 **(a)** What is Decomposition of transfer function? Explain the processs to obtain direct decomposition of transfer function to controllable canonical form. **07**

(b) A SISO system is described by , **07**

$$\dot{x}(t) = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u(t) \ , \qquad and$$

$$y(t) = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix} x(t).$$

Test the system for controllability and observability.

OR

Q.4 **(a)** Prepare a technical note on "Application of Kalman's test" **07**

(b) Draw the state variable diagram and write the state equations for **07**

$$\frac{d^3c}{dt^3} + 6\frac{dc}{dt} + 5\,c(t) = r(t)$$

Also verify whether the state equations are in controllable canonical form or not.

Q.5 **(a)** Explain design of control system with observers. Briefly discuss both configurations i.e. observer controller in feedforward path and in feedback path. **07**

(b) Using Liapunov's direct method determine the stability of the system $\dot{x} = Ax$, **07**

where $A = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}$

OR

Q.5 **(a)** Explain variable gradient method to construct Liapunov function. **07**

(b) A regulator system is given by – **07**

$$\dot{x} = Ax + Bu \ ,$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}.$$

The system uses the state feedback control $u = -kx$.

The desired pole locations of close loop system are $s = -2 \pm j4 \ and \ s = -10.$ Using Ackermann's formula design a state feedback controller gain.

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