Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject code: 710703
Subject Name: Modern Control System

Date: 02 /02 /2011 **Time: 02.30 pm – 05.00 pm**
Total Marks: 60

Instructions:

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

Q.1 (a) Find the inverse of the matrix. **04**

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

(b) Determine the rank of the matrix **04**

$$A = \begin{bmatrix} 2 & 4 & 0 & 8 \\ 1 & 2 & 6 & 8 \end{bmatrix}$$

(c) Obtain the State-transition matrix Q(t) of the following. **04**

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$$

Q.2 (a) Obtain the state model of the electrical system shown in fig. A **06**

(b) Obtain the state model of the mechanical system shown in fig. B **06**

OR

(b) (i) State the second method of Liapunov and Krasovki's theorem. **06**
(ii) use of Kalman's theorem on controllability and observability.

Q.3 (a) The state equation of a system is given. Also check for controllability **06**

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$$

(b) Explain in brief concepts and definition of Controllability and Observability. **06**

OR

Q.3 (a) Write the state equations of the system shown in fig. C in which X_1, X_1 and X_3 constitute the state vector. Determine whether the system is completely controllable and observable. **12**

Q.4 A feedback system has a closed loop transfer function. **12**

$$\frac{C(S)}{U(S)} = \frac{10(S+4)}{S(S+1)(S+3)}$$

Construct different state models for this system and give block diagram representation for each state model.

OR

Q.4 A linear time-invariant system is characterized by the homogeneous state equation **08**

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}$$

compute the solution of the homogeneous equation assuming initial state vector

$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

(i) by Laplace transfer method (ii) matrix exponential method.

Q.5 Explain in brief pole-placement design through state feedback control and state feedback design with integral control. **12**

OR

Q.5 (a) Explain with appropriate illustration the following terms Positive definite , Positive semi definite and in definite **06**

Using the Sylvester's theorem determine the definite of the following quadratic functions

(i) $V(x) = 5X_1^2 + 2X_1 X_2 + 20X_2^2 + 8X_1 X_3 + X_3^2$

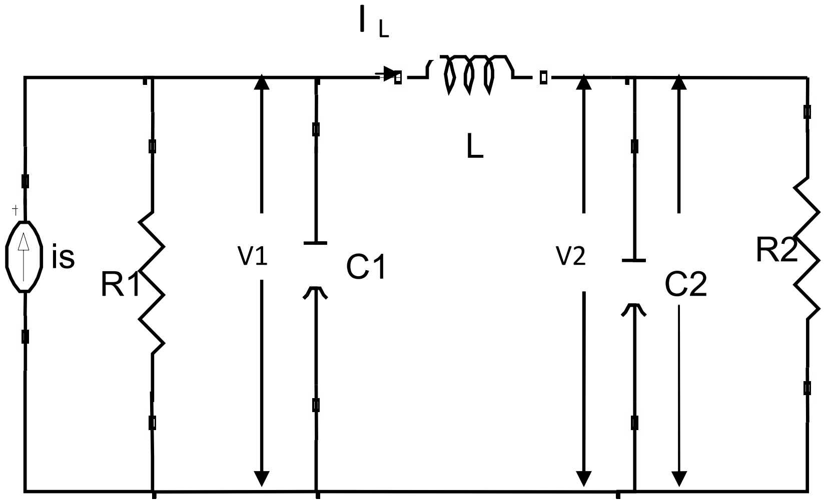
(ii) $V(x) = 23X_1^2 - 14X_1 X_2 + 11X_2^2$

(b) The state equation of the control system are given by **06**

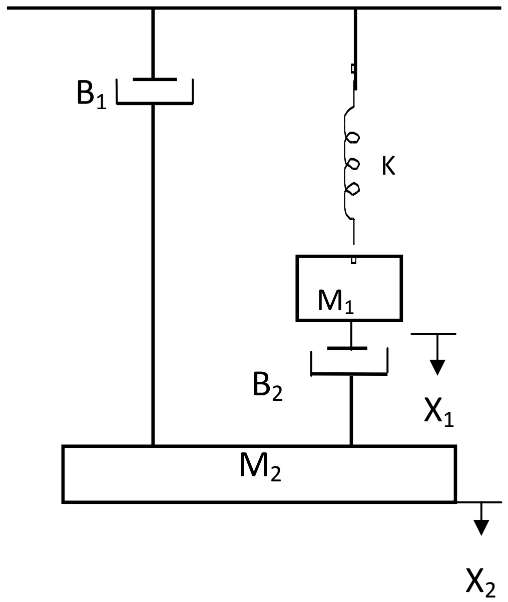
$$\dot{X}_1 = -X_1 + X_2 - X_1(X_1^2 + X_2^2)$$
$$\dot{X}_2 = -X_1 - X_2 - X_2(X_1^2 + X_2^2)$$

With $V = \frac{1}{2}(X_1^2 + X_2^2)$ Determine the stability of the system using the Liaponov's direct method.

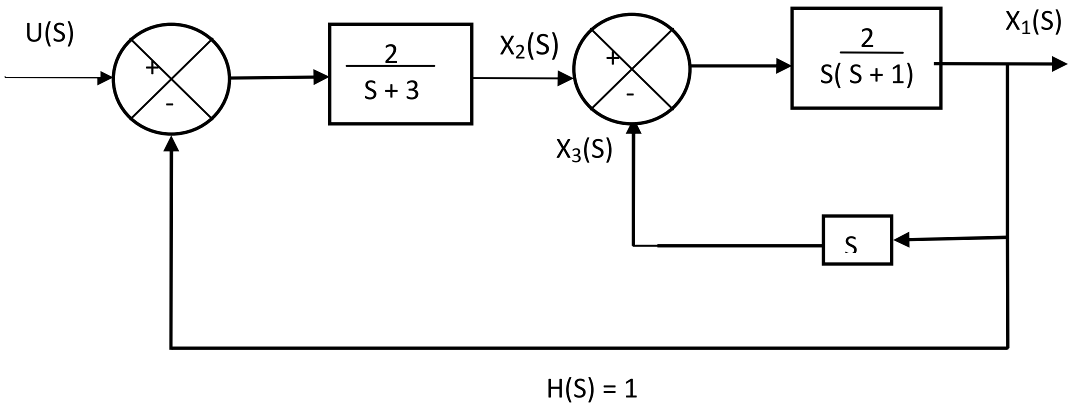
****



Q-2 (a) Fig - A



Q-2(b) Fig -B



Q-3 Fig-C