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ME (Sem-I) (Electrical)

MODERN CONTROL SYSTEM

Date- 19/01/2013 **Max. Marks: 70**

Time: 3 Hrs.

Instructions: (1) Answer each section in separate Answer sheet.
(2) Use of scientific calculator is permitted.

Section – I

Each carries equal marks.

Q.1 (a) Define Rank. Find the Rank of a Matrix. **[05]**

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

(b) 1. Define: (1) State (2) State Variable (3) State Vector (4) State space **[05]**
2. Mentation the condition for selecting the state variable for the system.

(c) 1. Define State Equation and State Transition Equation. **[05]**
2. Write and prove the properties of the State Transition Matrix (STM).

OR

(c) Obtain the State-transition matrix Q(t) of the following. **[05]**

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

Q-2 (a) 1. What are the advantages of state space modeling technique over the transfer function modeling technique in control system analysis? **[05]**
2. Obtain co-relation between the state space equation and transfer function.

(b) Obtain the state model of the electrical system shown in fig. 1. Consider the state variable as i_1, i_2, and v_c. **[05]**

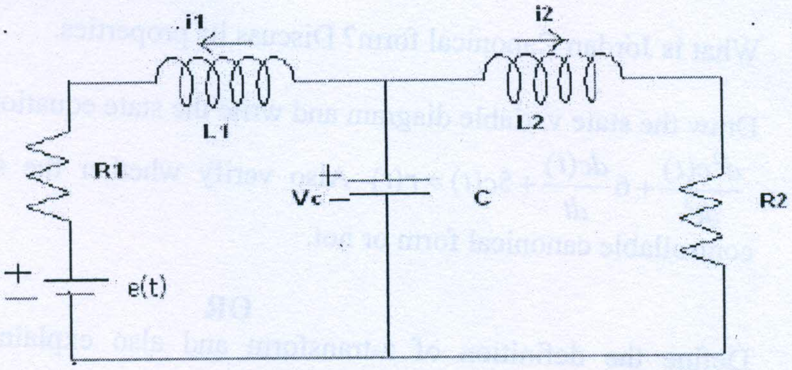

Fig. 1

OR

Q-2 (a) A discrete-time system has state equation given by [5]

$x(k+1) = \begin{bmatrix} 0 & 1 \\ -10 & -7 \end{bmatrix} x(k)$ Use Caylay-Hamilton approach to find out its state transition matrix.

(b) Represent the following differential equation in state transition variable form [5]

$\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = u(t)$ Draw the state diagram and find STM.

Q-3 (a) What is Decomposition of transfer function? Explain the process to obtain direct decomposition of transfer function to controllable canonical form. [5]

(b) Examine the observability of the system given below. [5]

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = [3 \quad 4 \quad 1] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = Cx$$

OR [5]

Q-3 (a) Check the controllability of the system given with state matrices as [5]

$$A = \begin{bmatrix} 1 & 1 & 0 \\ 3 & 0 & 1 \\ -6 & 11 & 5 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, C = [1 \quad 9 \quad 2]$$

(b) Give the relationship between Controllability, Observability and Transfer function. [5]

Section - II

Each carries equal marks.

Q.4 (a) Explain in brief concepts and definition of Controllability and Observability. [05]

(b) What is Jordan Canonical form? Discuss its properties. [05]

(c) Draw the state variable diagram and write the state equation for [05]

$\frac{d^2c(t)}{dt^2} + 6\frac{dc(t)}{dt} + 5c(t) = r(t)$ Also verify whether the state equations are in controllable canonical form or not.

OR

(c) Define the definition of z-transform and also explain the properties of z-transform. [05]

Q-5 (a) Find the inverse z-transform for the following function. [05]

1. $F(z)=\dfrac{0.632z}{z^2-1.368z+0.368}$

2. $F(z)=\dfrac{z}{z^2-z+0.5}$

(b) Determine the stability of a sampled data control system having following characteristics polynomial using Jury's stability test. **[05]**

$2z^4+7z^3+10z^2+4z+1=0$

OR

Q-5 (a) Simplify formula for PID or Three mode controller. **[5]**

(b) Find the response of the system shown in fig. 2 to a unit impulse input. **[5]**

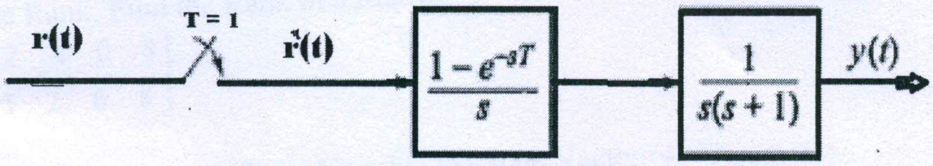

Fig. 2

Q-6 (a) Compare the stability properties of the system shown in the fig.3 with and without sample-and-hold on the error signal. **[5]**

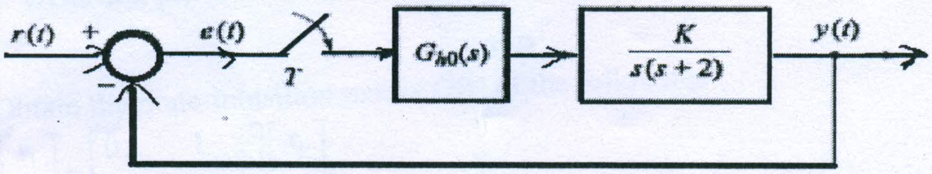

Fig. 3

(b) Short notes on Tunable PID controllers. **[5]**

OR **[5]**

Q-6 (a) Enlist and describe common nonlinearities encountered in the systems. **[5]**

(b) Find out describing function of saturation. **[5]**