Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS / M.TECH (EE) / SEM-1 / CAM-103B / 2010-11

2010-11

MODELLING AND SIMULATION OF DYNAMIC SYSTEMS

*Time Allotted* : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words

as far as practicable.

Answer any *five* of the following. $5 \times 14 = 70$

1. a)   What are the advantages of state space model over transfer function model ?

    b)   For the electrical network shown below, obtain a state space model. Also draw the relevant state diagram.
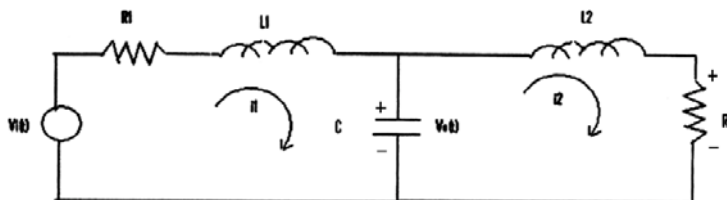
                                                      4 + 10

40170   [Turn over]

2. The state equation of a system is given by

$$\dot{X} = AX + BU \text{ where } \dot{X} = \begin{bmatrix} \dot{X}1 \\ \dot{X}2 \end{bmatrix}$$

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

    a) Find the transfer function of the system

    b) Find state transition matrix

    c) Determine unit step response when initial conditions are zero.   4 + 4 + 6

3. a) Consider the system state equation

$$\begin{bmatrix} \dot{X}1 \\ \dot{X}2 \\ \dot{X}3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 1 \\ -6 & -11 & -6 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

    Compute :

       i) Controllability by Gilbert's method

       ii) Controllability by Kalman test.

    b) State the properties of state transition matrix.   12 + 2

4. Find the bond graph model of the following network :

    a) Series R-L-C circuit excited by voltage source

    b) Parallel R-L-C circuit excited by current source.

c)
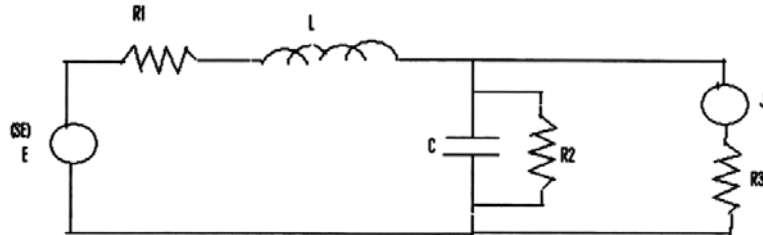
5. a) Define the terms 'modelling' and 'simulation'. Describe the advantages and disadvantages of modelling and simulation.

b) Why do time delays occur in a system ? Obtain the transfer function of a pure time delay. Also obtain its 1st order Pade approximation. 7 + 7

6. a) A continuous-time LTI system is described by the following state space model :

$$\dot{X} = \begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix} X + \begin{pmatrix} 0 \\ 1 \end{pmatrix} U$$

$$Y = (0 \;\; 1)X$$

Obtain a discrete-time state space model of the system assuming the sampling interval to be 0·1 sec.

b) Consider a nonlinear unforced system given by,

$$x_1 = -x_1 + 2x_1^3 + x_2$$

$$x_2 = x_1^2 - x_2 .$$

Obtain the equilibrium points of the system and linearized state equations around each of the equilibrium points. 6 + 8

7. a) The state space model of a system is given by,

$$\dot{X} = \begin{pmatrix} 0 & -2 \\ 1 & -3 \end{pmatrix} X + \begin{pmatrix} 1 \\ 0 \end{pmatrix} U$$

$$Y = \begin{pmatrix} 0 & 1 \end{pmatrix} X$$

Design an observer based state feedback controller such that the closed loop system poles are five times faster than the open loop system poles and the observer poles are five times faster than the closed loop system poles.

b) Obtain a transfer function representation of an observer based state feedback controller. Use standard notations.

10 + 4

8. a) Show that the system zeros remain invariant under linear state feedback control.

b) Using standard notations, derive the partial differential equation of heat flow through a one-dimensional rod.

5 + 9

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