Name : .....

Roll No. : .....

Invigilator's Signature : .....

2011

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* questions of the following

1. a) What do you mean by modelling and simulation ? Briefly discuss their advantages and disadvantages.

   b) Obtain block diagram representations of

      i) the predator-prey dynamics given by,

      $x(k+1) = \alpha x(k) - \beta x(k) y(k)$ and

      $y(k+1) = -\gamma y(k) + \delta x(k) y(k)$ where $\alpha,\beta,\gamma,\delta$ are constants

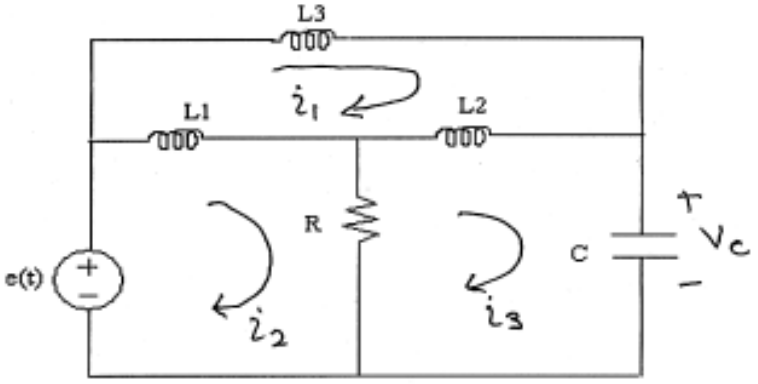
      ii) Van-der Pol oscillator given by,

      $\ddot{x} - 1{\cdot}5\dot{x}(1-x^2) + x = 0$ with $x(0) = 0$ and $\dot{x}(0) = -1$. 7 + 7

2. a) How does a pure time delay affect the behaviour of a closed loop system ? Obtain the 2nd order Pade approximation of a pure time delay.

   b) What are Zero and First Order Hold devices ? Obtain their transfer functions. 8 + 6

3. Obtain a state space model of the following electrical network. Choose i_3 and v_c as the output variables.



4. a) Consider a 5th order transfer function $G(s) = \dfrac{3s^4 + 2s^3 + s^2 + 4s + 2}{3s^5 + 5s^4 + s^3 + 2s^2 + 2s + 1}$.

   Determine a Pade approximant of G(s) having three poles and one zero.

   b) Using Modal Truncation method, obtain a 1st order state space model for the following 2nd order system –

   $\dot{X} = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$ and $Y = [1\ 0]\, X$ 8 + 6

5. Derive Lagrange's energy equation. 14

6. a) Obtain the Bond graph models for series R-L-C and parallel R-L-C circuits.

   b) Obtain the state transition matrix and its inverse for the following system –

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

   7 + 7

7. Write short notes on any *two* of the following 7 + 7

   a) 4th order Runge-Kutta method for solution of ODEs

   b) Finite Difference method for solution of PDEs.

   c) Separation principle

   d) Discretization of state equation.