



Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech (EE)/SEM-1/CAM-103(B)/2012-13

2012

**MODELLING & 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.

1. a) What do you mean by static and dynamic systems ?
Enlist the various representations of a dynamic system.

- b) Consider the following unforced nonlinear system given
by,

$$\dot{x}_1 = -x_1 + 2x_1^3 + x_2$$

$$\& \quad \dot{x}_2 = x_1^2 - x_2$$

Obtain the equilibrium points of the system and a
linearized state space model about any one of the
equilibrium points. Also obtain the simulation block
diagram representation of the non-linear system. 5 + 9



2. Consider the “Inverted pendulum on Cart” system. Find the non-linear and linear differential equation modelling of the system by Euler-Lagrangian equation. Assume the following notations :

Pendulum angle from vertical = θ

Cart displacement = x

Control force applied to cart = F

Mass of stick = m

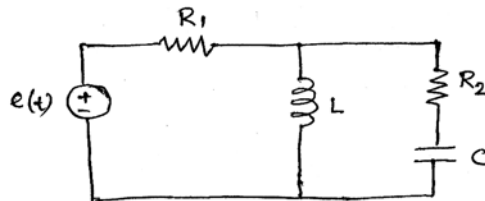
Mass of cart = M

Length of pendulum = $2l$

Moment of inertia of pendulum rod = I

Coefficient of friction of cart = b 14

3. a) Derive a state equation for the electric circuit as shown below. Assume the current through the inductor and the voltage across the capacitor as the state variables.



- b) What is state transition matrix and what is its significance ? 11 + 3
4. a) Discuss Gilbert’s test for controllability.
- b) Check whether the following system is controllable or not by Gilbert’s test :

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}. \quad 14$$



5. Consider a 4th order transfer function

$$G(s) = \frac{3s^3 + 3s^2 + 2s + 4}{s^4 + 8s^3 + 18s^2 + 16s + 1}$$

- a) Obtain its 2nd order Routh approximant.
 - b) Also find out its 2nd order Pade approximant having one zero. 7 + 7
6. a) What do you mean by Monte Carlo simulation technique ? Use this technique to determine the value of $\ln 2$.
- b) Use mixed congruential method to generate a sequence of ten random numbers in the interval $[0, 1]$ assuming $x_0 = 29$, $a = 5$, $b = 17$ and $m = 100$. 9 + 5
7. Write short notes on any *two* of the following : 2 × 7
- a) Euler's and improved Euler's methods for solution of ODEs
 - b) Finite difference method for solution of PDEs
 - c) Balanced truncation method
 - d) Bond graph modelling.

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