



Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech(EE-OLD)/SEM-2/PEM-205B/2013

2013

NONLINEAR PHENOMENA IN SWITCHING 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.

5 × 14 = 70

1. a) A dynamic system is given by the following :

$$\dot{x} = x - y$$

$$\dot{y} = x - xy$$

Find the fixed points and sketch the phase portraits.

2 + 5

- b) A dynamical system is given by

$$\ddot{x} = \left(x^2 - \dot{x}^2 - 1 \right) \dot{x} + x = 0$$

Draw the phase portrait and discuss about the dynamics.

7



2. The *van der pole* Equation is given by

$$\ddot{x} - \mu (1 - x^2) \dot{x} = 0$$

- Show that, at certain condition, it has a limit cycle
- Sketch the phase portrait.
- Find the amplitude and frequency of the periodic orbit.

6 + 2 + 3 + 3

3. The Lorenz equations are given by

$$\dot{x} = \sigma (y - x)$$

$$\dot{y} = rx - y - xz$$

$$\dot{z} = xy - bz$$

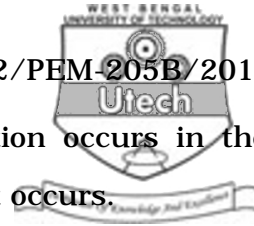
- Find the equilibrium points and comment on their existence.
- Check the stability of the equilibrium points.
- Discuss about the bifurcations occur as r is varied.

5 + 4 + 5

4. A dynamic system is represented by the map

$$x_{n+1} = ax_n (1 - x_n)$$

- Find the equilibrium points and conditions of their existence.



- b) Show that the saddle node bifurcation occurs in the system and the conditions at which it occurs.
- c) Find the condition at which period doubling bifurcation occurs in and explain the reason. $3 + 4 + 7$
5. Write the normal form of piecewise linear map without discontinuity. Suggest different types of bifurcations occurred in the system.
6. a) Draw the schematic of a current controlled boost converter and write the dynamic equation.
- b) Find the equilibrium points and stability for them.
- c) Develop a piecewise linear map for the system. Hence show that the system is stable when $v_{out} = 2v_{in}$.
- d) Predict the dynamics around the equilibrium for the change in the parameter value. $3 + 3 + 5 + 3$
7. For a voltage mode control DC Drive
- a) Draw the schematic and write the state equations.
- b) Find the equilibrium points and discuss the dynamics of the system.
- c) Predict the nonlinear phenomena occurred in the system due to variation of the parameters. $4 + 5 + 5$

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8. a) Write the state equation for Permanent magnet synchronous Motor Drive. 5 + 9
- b) Derive the equilibrium points and discuss the dynamics of the system with variation of parameters. 5 + 9
9. Write short notes on any *two* of the following : 2 × 7
- a) Pitch fork Bifurcation
- b) Homoclinic and heteroclinic orbit
- c) Time delay control of chaos
- d) Sliding model and switching surface control of chaos.
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