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B. TECH.

THEORY EXAMINATION (SEM-VIII) 2016-17

NON-LINEAR DYNAMICS SYSTEM

Time : 3 Hours

Note : Be precise in your answer. In case of numerical problem assume data wherever not provided.

SECTION-A

 $(10 \times 2 = 20)$

Max. Marks : 100

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1. Attempt all parts of the following-

- **a.** What is a dynamical system?
- **b.** What is a Strange Attractor?
- c. What are simple experiments to demonstrate chaos?
- **d.** What is a Cantor set?
- e. What is an attractor?
- f. How do I know if my data are deterministic?
- g. What is quantum chaos?
- **h.** What are cellular automata?
- i. What are solitons?
- j. What is spatio-temporal chaos?

SECTION-B

2. Attempt any five of the following:

- State and explain Liapunov's theorems on (i) stability, (ii) asymptotic stability (iii) global a) asymptotic stability and (iv) instability.
- Consider the linear autonomous system b)

X

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

Using direct method of Lyapunov, determine the stability of the equilibrium state.

- Explain Peano's theorem? **c**)
- What is the normal form theory and application to non-linear system? d)
- What is a Bifurcation? e)
- What is a degree of freedom? How are maps related to flows (differential equation)? f)
- Explain the control of chaos? g)
- Describe the different types of solutions. h)

SECTION-C

Attempt any two of the following:

For $x^{*} = x^{4} - x^{2} + \alpha$, 3.

- **a**) Sketch the phase portrait for $\alpha = 0$.
- **b**) How many bifurcations are taking place in this system as a function of α .
- c) In each case, determine the type of bifurcation by reducing to normal form
- **d**) Draw the bifurcation diagram.
- for the nonlinear system given by: $\mathbf{x} = \sin \mathbf{y}, \mathbf{y} = \mathbf{x}(1 \mathbf{x}^2)$, 4.
 - Answer the following questions:
 - a) How many fixed points does it have. Determine the fixed points of this system.
 - b) Determine the Jacobian matrix for this system for any arbitrary fixed point (x *, y*).
 - c) For the fixed points on x = 0 line, determine the type of fixed points.
 - **d**) Draw the phase portrait ONLY around the fixed points lying on x = 0 line.
- What is Generic? What is the minimum phase space dimension for chaos?

5.

$(10 \times 5 = 50)$

 $(15 \times 2 = 30)$