BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Hyderabad campus

First Semester 2023-2024

Course Handout (Part II)

Date: 11/8/2023

In addition to part I (General Handout for the course appends to the time table) this portion gives further specific details regarding course.

Course No. : BITS F316
Course title : Nonlinear dynamics and Chaos
Instructor-in-charge : P.K.THIRUVIKRAMAN

I. Scope and Objective of the course

This course introduces the basic concepts of nonlinear dynamics and chaos. Through graphical and analytical techniques, ordinary differential equations, especially those which are not exactly solvable, are qualitatively analyzed to understand the stability of systems. These ordinary differential equations represent dynamics in a wide range of systems that include buckling beams, turbulent flow of fluids, growth of insect population, progress of chemical reactions, love affairs, propagation of nerve impulses, and oscillation of electronic circuits.

II. Learning outcomes

A. Classifying fixed points in one-and two-dimensional phase space.
B. Breaking down higher order differential equations into first order differential equations to analyze the stability of systems.
C. Solving differential equations using computer.
D. Analyzing logistic maps.
E. Applying bifurcation analysis to study practical systems.
F. Identifying the conditions for a system to be chaotic.

III. Textbook

1. Steven H. Strogatz, “Nonlinear dynamics and Chaos” West view Press, 2000

Reference Books

1. Robert C. Hilborn, “ Chaos and Nonlinear dynamics – An introduction for scientists and engineers” Oxford University Press
2. Edward Ott, “Chaos in dynamical systems” Cambridge university press
3. James Gleick, “Chaos: Making of a new science” Penguin

IV. Course Plan

Lecture Number.	**Topics to be covered**	**References** from Strogatz
1-4	History and importance of non-linear dynamics, fractals and chaos, autonomous and non-autonomous systems, map of degrees of freedom and non-linearity, introduction to logistic maps	Chap 1, 10.0-10.5
4-8	Phase space flows on the line, Linear stability analysis, Fixed points, phase space trajectory	Sec. 2.0-2.6, 2.8

9-13	Phase space flows on the circle	Chap. 4
14-19	Bifurcations – Saddle-node, transcriticial, and pitchfork bifurcations	Chap. 3
20-23	Phase space flows in two dimensions	Chap.5
24-29	Phase portraits, Existence and Uniqueness, fixed points, conservative systems	Sec. 6.0-6.7
30-32	Limit cycles, Poincare-Bendixson theorem	Sec. 7.0, 7.1,7.3-7.5
33-35	Bifurcations in two dimensional phase space	Sec. 8.0-8.3, 8.6
35-38	Chaotic Dynamics	Sec. 9.0-9.5
38-40	Conclusion and outlook	

V. Evaluation Scheme

EC No.	Evaluation component	Duration	Weightage	Date, time and venue	Nature of component
1	Mid-semester test	90 min	35 %	13/10 - 4.00 - 5.30PM	Open book
2	Assignment	-	20 %		Open Book
3	Comprehensive exam	3 hours	45 %	19/12 AN	Closed Book

VI. Chamber consultation Hours: To be announced in the class

VII. Make-up policy: Make up request should be forwarded by the Chief Warden.

VIII. Notices will be displayed onlyon the course management system website.

IX. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester. Any form of academic dishonesty would lead to serious actions.

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