Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2019-2020
Course Handout Part II

01-08-2019

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

Course No. : BITS F316
Course Title : Nonlinear dynamics and Chaos
Instructor-in-Charge : ARAVINDA RAGHAVAN

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, war between nations, propagation of nerve impulses, and oscillation of electronic circuits.

Textbooks:

1. Steven H. Strogatz, "Nonlinear dynamics and Chaos" West view Press

Reference books

1. Robert C. Hilborn, " Chaos and Nonlinear dynamics – An introduction for scientists and engineers" Oxford University Press
2. M Lakshmanan and S. Rajasekar "Non Linear Dynamics" Springer
3. G. L. Baker and J. P. Gollub, "Chaotic dynamics – an introduction", Cambridge university press
4. Edward Ott, "Chaos in dynamical systems" Cambridge university press
5. James Gleick, "Chaos: Making of a new Science" Penguin

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1-2	To trace the history and significance of non-linear dynamical systems	History and importance of non-linear dynamics, fractals and chaos, autonomous and non-autonomous systems, map of degrees of freedom and non-linearity	Chap. 1
3-4	To illustrate non-linearity and chaos through logistic maps	Introduction to logistic maps	10.0-10.5
4-8	To introduce the phase space and graphically analyze the stability of one-dimensional systems	Phase space flows on the line, Linear stability analysis, Fixed points, phase space trajectory	Chap 2

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9-14	To apply bifurcation analysis to study practical 1D systems.	Bifucrcations – Saddle-node, transcriticial, and pitchfork bifurcations	Chap.3
15-19	To transpose the problem of non-uniform oscillation to phase space dynamics on a circle.	Phase space flows on the circle	Chap.4
20-23	To break down higher order differential equations into first order differential equations to analyze the stability of 2Dsystems	Phase space flows in two dimensions	Chap.5
24-29	To investigate and classify fixed points in 2D	Phase portraits, Existence and Uniqueness, fixed points, conservative systems	Sec. 6.0-6.7
30-32	To study the unique fixed point in 2D – Limit cycles	Limit cycles, Poincare-Bendixson theorem	Sec. 7.0, 7.1,7.3-7.5
33-35	To apply bifurcation analysis to study practical 2D systems.	Bifurcations in two dimensional phase space	Sec. 8.0-8.3, 8.6
35-38	To apply concepts of non-linear dynamics to chaotic systems and identify the characteristics of chaotic dynamics	Chaotic Dynamics	Sec. 9.0-9.5
38-40	To analysis student projects	Conclusion and outlook	

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid-semester exam	1.5 hours	25 %	4/10 (3.30-5.00 PM)	Closed book
Quiz		15 %		Open Book
Project work		20 %		Open Book
Comprehensive exam	3 hours	40 %	12/12 (2.00 – 5.00 PM)	Closed Book

Chamber Consultation Hour: To be announced in the class

Notices: Notices will be displayed either on the Physics department notice board and the course management system.

Make-up Policy: It is applicable to the following two cases and it is permissible on production of evidential documents.

(i) Debilitating illness.

(ii) Out of station with prior permission from the Institute.

11. **Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

INSTRUCTOR-IN-CHARGE