Overview
This course is an introduction to the modern study of Chaos and Nonlinear Dynamics, an interdisciplinary field of Physics and Applied Mathematics that studies the evolution and predictability of general systems over time. Topics to be covered include phase space, dynamical systems, Hamiltonian systems, deterministic chaos, sensitivity to initial conditions and the butterfly effect, one-dimensional maps, bifurcations, strange attractors, fractals, universal properties in order-chaos transitions, and overview of complex systems.

Methodology
Lectures, supervised theoretical and computational exercises, tutorials.

Prerequisites
- Standard Basic Calculus.
- Standard Basic Physics (Mechanics)
- Basics of Differential Equations.
- Basic programming experience.

Level
Mid undergraduate in Sciences & Engineering.

Course Instructors
Professor’s Name: Luis Alberto Núñez, UIS.
Contact Info: lnunez@uis.edu.co

Professor’s Name: Mario Cosenza, Universidad Yachay Tech, Ecuador.
Contact Info: mcosenza@yachaytech.edu.ec

Lectures (daily/weekly)
Days of the week: Mon-Fri, 2 hours daily. From 10 am to 12 m.

Tutorials and Labs: (daily/weekly)
Days of the week: 4 hours per week.

Course Requirements
Problem Sets and Labs:
2 problem sets with theoretical and computational questions (40% each)
Final Evaluation: short project (20%)
Introduction to Chaos Theory.
Professors Luis Núñez and Mario Cosenza
June 17th – July 2nd, 2019
Summer Course

Total 100%

Detailed Curriculum

1. Dynamical Systems.

2. Introduction to Chaos.

3. One-dimensional maps as models of chaotic systems.

4. Transitions to chaos.
1. Period-doubling: quadratic and unimodal maps; scaling properties; Feigenbaum's universal constants; experimental observations.
2. Intermittency; universal properties, experimental observations. Type-III intermittency and robust chaos.

5. Strange attractors.

6. Student's choice of selected recent topics.

Practical: (labs/tutorials/seminars)
The students will develop some basic computational programs to construct bifurcation diagrams and to characterize chaotic behavior. Tutorials will help students with questions and will guide those interested in further research topics.

Course Texts – List of primary texts:
2. M. Cencini, F. Cecconi, A. Vulpiani, Chaos: from simple models to complex systems,
Introduction to Chaos Theory.
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World Scientific (2010).

Reference Texts – List of Secondary/Supplementary texts:

Curriculum Classification

Sciences, Engineering.

Learning Outcomes

At the conclusion of this course, the student should be able to:
1. Characterize chaotic behavior in nonlinear dynamical systems.
2. Understand the limits of prediction in nonlinear systems.
3. Know the universal properties of chaotic systems.
4. Apply basic methods to analyze the behavior of nonlinear systems.
5. Be aware on contemporary interdisciplinary research in complex systems.