Nonlinear dynamics, chaos and complex systems

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Summary
The course provides students with the tools to approach the study of nonlinear systems and chaotic dynamics. Emphasis is given to concrete examples and numerical applications are carried out during the exercise sessions.

Content
The course consists of three parts.

Part 1: Nonlinear dynamics
- One-dimensional systems and elementary bifurcations
- Two-dimensional systems, phase-plane analysis, limit cycles, and Hopf bifurcations

Part 2: Chaos
- Lorenz system and chaotic dynamics
- Iterated maps, period-doubling, chaos, universality, and renormalization
- Fractals
- Strange attractors

Part 3: Introduction to complex systems
- The science of complexity
- Examples of complex systems, networks, turbulence, etc.

Keywords
Chaos, Nonlinear systems, Complex system, Fractals, Differential equations, Bifurcations.

Learning Prerequisites

Required courses
Introductory Physics and Math courses.

Learning Outcomes
By the end of the course, the student must be able to:

• Manipulate the fundamental elements of nonlinear systems and chaotic dynamics

Teaching methods
Ex cathedra and exercises in class.

Assessment methods
Oral Exam

Resources

Bibliography
- P.G. Drazin, Nonlinear systems, Cambridge University Press.

Ressources en bibliothèque
- Strogatz / Nonlinear dynamics and chaos
- Drazin / Nonlinear systems
- Dichter / Nonlinear dynamics and chaos - Student solution

Moodle Link