PHYS-460 **Nonlinear dynamics, chaos and complex systems**

Ricci Paolo

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

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

- S.H. Strogatz, Nonlinear dynamics and chaos, with application to Physics, Biology, Chmistry, and Engineering, Second Edition, Westwiew Press.
- P.G. Drazin, Nonlinear systems, Cambridge University Press.
- M.W. Hirsch, S. Smale, and R.L. Devaney, Differential equations, dynamical systems, and an introduction to chaos, Elsevier.
- M. Dichter, Student solutions manual for Nonlinear dynamics and chaos, Westview Press.

Ressources en bibliothèque

- Strogatz / Nonlinear dynamics and chaos
- Dichter / Nonlinear dynamics and chaos - Student solution
- Drazin / Nonlinear systems
- M.W. Hirsch, S. Smale, and R.L. Devaney, Differential equations, dynamical systems, and an introduction to chaos, Elsevier.

Moodle Link

- https://moodle.epfl.ch/course/view.php?id=15697