

PHYS-460

**Nonlinear dynamics, chaos and complex systems**

Février Olivier

Cursus	Sem.	Type
Ing.-phys	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Oral
Workload	180h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Lecture	3 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**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, Chemistry, and Engineering, Second Edition, Westview 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

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

### Moodle Link

- <https://go.epfl.ch/PHYS-460>