



# UNIVERSITÀ DI PISA

---

## COMPLEX SYSTEMS / SISTEMI COMPLESSI

**RICCARDO MANNELLA**

Anno accademico 2023/24  
CdS FISICA  
Codice 230BB  
CFU 9

Moduli	Settore/i	Tipo	Ore	Docente/i
SISTEMI COMPLESSI	FIS/03	LEZIONI	54	RICCARDO MANNELLA

### Obiettivi di apprendimento

#### *Conoscenze*

Students are expected to acquire: some knowledge of stochastic calculus and probability, chaos dynamics and of the relevant tools and models; some knowledge of the appropriate tools to approach complex systems;

#### *Modalità di verifica delle conoscenze*

Students are expected to apply the learnt methods to a concrete case of interest. The emphasis will be on how they apply the learnt methodologies rather than on the results achieved in the application.

Methods:

- Final essay

#### *Capacità*

The student will be able to study and model some simple "complex system"

#### *Modalità di verifica delle capacità*

The student will be invited to apply to concrete cases some of the methodologies taught, throughout the lectures

#### *Prerequisiti (conoscenze iniziali)*

The student needs to have the standard knowledge in maths and physics of a physics bachelor: calculus in many variables, knowledge of Fourier transform, classical physics (in particular, Hamiltonian mechanics), some background in classical thermodynamics.

#### *Indicazioni metodologiche*

Delivery: face to face

Learning activities:

- attending lectures
- individual study

Attendance: Advised

Teaching methods:

- Lectures

#### *Programma (contenuti dell'insegnamento)*

The course has a modular structure: 6 ECTS are devoted to general tools to study complex systems, like stochastic methods, chaotic dynamics etc.. The students then take an additional 3 ECTS modulus which applies the general tools to some complex systems. The modulus offered will depend on the specific academic year: this year it will mostly cover subjects on Econophysics

The general tools part of the course will cover topics like:

Brownian motion, Chapman Kolmogorov equation, Stable (Levy) distributions, Stochastic integration, Fokker Planck equation, Mean First Passage Time related problems, Path integral approach to stochastic processes; Chaotic dynamics both for conservative and dissipative flows, related tools (like Poincare maps and Lyapunov exponents), Fractals.



## UNIVERSITÀ DI PISA

---

### Bibliografia e materiale didattico

Gardiner, Handbook of stochastic methods

Reichl, The transition to chaos

Tabor, Chaos and integrability in nonlinear dynamics

### Modalità d'esame

The exam will be in oral form. The student is expected to work on a small project during which he/she will apply the tools and methodologies taught in the lectures, and to prepare a small talk/script, which will be the basis from which the oral exam will be carried out

*Ultimo aggiornamento 20/12/2023 23:46*