



# UNIVERSITÀ DI PISA

## SISTEMI COMPLESSI

**RICCARDO MANNELLA**

Academic year 2019/20  
Course FISICA  
Code 230BB  
Credits 9

Modules	Area	Type	Hours	Teacher(s)
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 to 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 the 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 need 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.



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### [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

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