



## UNIVERSITÀ DI PISA SISTEMI COMPLESSI

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**RICCARDO MANNELLA**

Anno accademico	2017/18
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 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 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.

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 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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