Basic/Essential Course Information	
Course title	Computational Physics
Degree Course title	Physics
ECTS	6
Compulsory attendance	Yes
Course teaching language	ENGLISH

Teacher	Sebastiano Stramaglia	Sebastiano.stramaglia@uniba.it

ECTS Details	Disciplinary area/broad field:	SSD	ECTS
	Characterizing	FIS/01	6

Time management and teaching activity type	Period	Year	lesson type
	2nd semester	1st	Computational Laboratory (62h)

Time management	Total hours	in-class/in-lab study hours	out-of-class study hours
	150	62	88

Course calendar	Starting date	Ending date
	First week of March	Last week of May

Syllabus	
Prerequisites	Background knowledge on classical mechanics and statistical physics
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding** of the main data analysis techniques and their application to solve concreate physics problems. **Applying knowledge and understanding.** Capability to apply the main methods to extract information from complex physics datasets. The students will be able to gather, summarise and visualise the statistically relevant features of a dataset; furthermore, they will learn how to qualitatively and critically compare theoretical predictions with the experimental data. Capability to numerically solve differential equations arising in physics and complex systems science. **Making judgements.** Knowledge and skills acquired in this course will allow a greater level of autonomy in the evaluation of methodologies to simulate physical systems and to analyze data from Complex Systems.

	Transferable Communication skills. Enable transition from theoretical physical models towards the numerical implementation and analysis of the corresponding simulations. **Lifelong learning skills.** Follow the current progress and further prospects within the area of simulation and analysis of complex systems. Discuss models and methods introduced in the course and assess the reliability of the description by numerical simulations.
Course contents summary	Numerical solutions of differential equations. Complex Networks analysis. Monte Carlo methods and their applications to Statistical Mechanics models.
detailed syllabus	An introduction to MATLAB Numerical solution of differential equations. Euler's method. Euler-Cauchy method. Verlet method. Applications: Lotka-Volterra model of prey-predator systems, SIR model for the spreading of infections, real pendulum, Foucalt's Pendulum, motion of a planet in the gravitational field of the Sun. Introduction to Complex Networks. Implementation of complex networks models: Erdos networks, Watts-Strogatz model, Barabasi-Albert model. Finding communities in complex networks, Spectral methods and optimization of modularity. Spreading models of informations, ideas and viruses on complex networks. Random walks in two and more dimensions. Self avoiding walks. Diffusion limited aggregation. Random sampling and Monte Carlo method. Monte Carlo Integration: rejection method, importance sampling, filtering techniques. Monte Carlo methods for the simulation of physics phenomena. Markov chain method. Metropolis algorithm. Statistical mechanics ensembles. The case of the two dimensional Ising model of ferromagnets: phase transition and critical exponents. Techniques to assess and extract the statistical features of a physics datasets and comparison with model predictions. Visualisation and graphical representation of datasets and their properties.
books	Rubin Landau, Manuel Paez, Cristian Bordeianu, Computational Physics. --: Wiley-VCH
notes	Selected chapters
Teaching methods	Lectures in the multimedia room. Development of matlab routines beamed on the room screen.
Assessment % of final mark	Oral exam consisting in a discussion about the reports on the programming activities developed during the course. (100%)
Evaluation criteria	Capability to translate the physical problem in a computer program aiming at highlighting the physical behaviour of the system; capability to analyse data from complex systems. Adequate comprehension and global

	knowledge of concepts and arguments at the basis of the computational methods described throughout the course.