UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2021/2022
BACHELOR'S DEGREE (BSC)	PHYSICS
SUBJECT	DETERMINISTIC CHAOS
TYPE OF EDUCATIONAL ACTIVITY	D
AMBIT	10542-A scelta dello studente
CODE	21970
SCIENTIFIC SECTOR(S)	FIS/07
HEAD PROFESSOR(S)	MANTEGNA ROSARIO Professore Ordinario Univ. di PALERMO NUNZIO
OTHER PROFESSOR(S)	
CREDITS	3
INDIVIDUAL STUDY (Hrs)	51
COURSE ACTIVITY (Hrs)	24
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MANTEGNA ROSARIO NUNZIO** Tuesday 15:00 17:00 Studio del docente presso l'Edificio 18 di Viale delle Scienze previa comunicazione email all'indirizzo rosario.mantegna@unipa.it Professor's office located at Building 18 in Viale delle Scienze upon previous email agreement to rosario.mantegna@unipa.it

DOCENTE: Prof. ROSARIO NUNZIO MANTEGNA

PREREQUISITES	None
LEARNING OUTCOMES	Knowledge and understanding Consolidation of knowledge of Newtonian mechanics and electromagnetism. Acquisition of knowledge in the field of nonlinear dissipative systems. Limits of predictability in classical deterministic systems. Examples of chaotic systems and indicators of the chaotic state. Ability to apply knowledge and understanding Ability to apply the knowledge acquired in different contexts and to perceive the interdisciplinary value of the theories and methodologies learned. Ability to use the acquired knowledge to understand some current topics of research in chaotic dynamical systems. Autonomy of judgment Ability to evaluate the limits of approximations for the physical theories considered in describing model physical systems and / or many-body systems. Communication skills Ability to expose the key concepts of deterministic chaos. Learning skills Ability to independently investigate current research topics that use deterministic chaos concepts and methodologies.
ASSESSMENT METHODS	Examination consists of an oral interview. The interview is focused on enunciation and discussion of the topics covered during the course. This interview allows to evaluate, in addition to the candidate's knowledge and ability to apply them, also the possession of scientific language properties and of clear and direct presentation skills. The assessment, suitably graded, will be formulated on the basis of the following conditions: a) Basic knowledge of the models and applications of deterministic chaos and limited ability to apply them autonomously, sufficient ability to analyze the phenomena presented and to explain the procedures followed (grade 18-21); b) Good knowledge of the models and applications of deterministic chaos and ability to apply them autonomously to situations similar to those studied, good ability to analyze the phenomena presented and to explain the procedures followed (grade 22-25); c) In-depth knowledge of the models and applications of deterministic chaos and ability to apply them to any proposed physical phenomenon, albeit with some hesitation, good ability to analyze the phenomena presented and to explain the procedures followed (grade 26-28); d) In-depth and widespread knowledge of the models and applications of deterministic chaos and ability to apply them promptly and correctly to each proposed physical phenomenon, excellent ability to analyze the phenomena presented and excellent communication skills (grade 29-30L).
EDUCATIONAL OBJECTIVES	- Introduction of the student to the description of dissipative dynamical systems. - Allow to understand the meaning of the concepts of deterministic chaos, Lyapunov exponent, strange attractor, fractal structure of an attractor, sensitivity of the temporal evolution of a dynamical system to initial conditions. - Presentation and applications of concepts of the physics of chaotic systems of a physical and interdisciplinary nature.
TEACHING METHODS	The teaching activity consists of frontal lectures. The aim of the lectures is to provide the theoretical basis of the teaching contents. The presentation of the contents is interspersed with examples carried out in the classroom that might have both an analytical and numerical character.
SUGGESTED BIBLIOGRAPHY	Edward Ott, Chaos in Dynamical Systems, 2nd Edition, Cambridge University Press 2002, ISBN: 9780521010849

SYLLABUS

Hrs	Frontal teaching
2	Introduction. Determinism, random phenomena and limits to predictability in deterministic systems.
2	Classic examples of chaotic systems: The logistic map. The Henon Map.
2	The Lorentz model. Electronic realization of the Lorentz attractor. The Chua oscillator.
2	Lyapunov exponents. Fractal dimension of a strange attractor. Basins of attraction with fractal boundaries.
2	From order to chaos: Landau and Hopf. Ruelle and Takens. Feigenbaum (successive bifurcations).
2	From order to chaos: Pomeau and Manneville (intermittent).
2	Reconstruction of attractors.
2	Algorithms and computational complexity. Information and entropy.
2	Experimental analysis of chaotic systems.
2	Chaos in Hamiltonian systems. Deterministic chaos in the solar system.
2	Notes on Chaos in quantum systems
2	Numerical simulation of chaotic systems