UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2020/2021
MASTER'S DEGREE (MSC)	PHYSICS
SUBJECT	STATISTICAL PHYSICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50340-Microfisico e della struttura della materia
CODE	16180
SCIENTIFIC SECTOR(S)	FIS/03
HEAD PROFESSOR(S)	MANTEGNA ROSARIO NUNZIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	98
COURSE ACTIVITY (Hrs)	52
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
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 the background in thermodynamics and understanding of basic concepts of statistical physics. Acquisition of knowledge in the field of critical phenomena. Introduction to problems of non-equilibrium statistical mechanics. Presentation of examples of applications of statistical physics methodology to multifractal phenomena, complex networks and agent based models. 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 knowledge acquired to understand some current topics of frontier research in statistical physics. 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 statistical physics. Learning skills: Ability to independently deepen current research topics that use statistical physics concepts and methodologies.
ASSESSMENT METHODS	The final examination consists of a written test followed by an oral test. The written test concerns the resolution of some problems and / or questions concerning the main topics of statistical physics. The oral exam consists of an interview concerning the enunciation and discussion of the topics developed during the course and the setting of the resolution of problems proposed to the candidate. In addition to the candidate's knowledge and ability to apply them, this test also assesses the possession of scientific language properties and clear and direct exposure skills. The assessment, suitably graded, will be formulated on the basis of the following conditions: a) Only basic knowledge of the studied models and applications of statistical physics and limited ability to apply them independently, sufficient ability to analyze the phenomena presented and to present the procedures followed (mark 18-21); b) Good knowledge of the studied models and applications of statistical physics and ability to apply them independently to situations similar to those studied, fair ability to analyze the phenomena presented and to show the procedures followed (marks 22-25); c) In-depth knowledge of the studied models and applications of statistical physics and ability to apply them to each physical phenomenon proposed, albeit with some hesitation, good ability to analyze the phenomena presented and to show the procedures followed (vote 26-28); d) In-depth and widespread knowledge of the studied models and applications of statistical physics and ability to apply them promptly and correctly to each physical phenomenon proposed, excellent ability to analyze the phenomena presented and excellent communication skills (grade 29-30L).
EDUCATIONAL OBJECTIVES	(i) Introducing the student to the statistical physics of many-body systems by highlighting the nature and characteristics of critical phenomena. (ii) Understanding the meaning of the concepts of phase of a system, emergency, critical state, scaling laws and universality. (iii) Introduction to the main concepts of physics of non-equilibrium systems. (iv) Presentation of applications of methodologies and concepts of statistical physics in many-body systems of physical and interdisciplinary nature.
TEACHING METHODS	Lectures and tutorials.
SUGGESTED BIBLIOGRAPHY	K. Huang. Meccanica statistica. Zanichelli. R.K. Pathria & P.D. Beale. Statistical mechanics (Third edition). Academic press. R. Piazza. Statistical Physics. Springer G. Livan, M. Novaes, P. Vivo. Introduction to Random matrices. Theory and practice. Springer.

SYLLABUS

Hrs	Frontal teaching
6	Postulates of statistical mechanics. Liouville theorem. Ergodic hypothesis. Microcanonical ensemble. Canonical and grancanonic ensemble.
2	Quantum formulation of statistical mechanics. Density matrix.
4	Percolation theory. Critical phenomena. The mean field approach. Landau's theory. Hamiltonian of Ginzburg-Landau.
6	Ising model. Mean field theory of the Ising model. Ising model in one dimension. Ising model in two dimensions.
4	Basic concepts of probability and stochastic processes. Brownian motion - Spectral analysis of fluctuations - Wiener-Khintchine theorem
2	Transport phenomena - Fluctuation-dissipation theorem - Onsager relations.

SYLLABUS

Hrs	Frontal teaching
2	Fractals. Geometric fractals. Stochastic fractals. Multifractal formalism.
4	Elements of Random matrix theory. Applications of Random matrix theory.
4	Percolation in complex networks: Erdos-Renyi model. Exponential random graphs.
2	Critical phenomena in agent based models. Schelling model.
2	Kirman model
2	Minority game

Hrs	Practice
12	Partition function. Percolation. Critical exponents. Ising model. Random matrix theory. Exponential random graph. Agent based models.