UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2019/2020
BACHELOR'S DEGREE (BSC)	PHYSICS
INTEGRATED COURSE	ANALYTICAL AND RELATIVISTIC MECHANICS
CODE	16169
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	FIS/02
HEAD PROFESSOR(S)	RIZZUTO LUCIA Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	RIZZUTO LUCIA Professore Associato Univ. di PALERMO MILITELLO BENEDETTO Professore Associato Univ. di PALERMO
CREDITS	12
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	Annual
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**MILITELLO BENEDETTO** Tuesday 14:30 16:00 Stanza 122, Dip. Fisica e Chimica, Via Archirafi 36. Thursday 14:30 16:00 Stanza 122, Dip. Fisica e Chimica, Via Archirafi 36. **RIZZUTO LUCIA** Monday 15:00 17:00 Dipartimento di Fisica e Chimica E. Segre - Via Archirafi 36 - Piano II - Stanza A36P2017 Friday 15:00 17:00 Dipartimento di Fisica e Chimica E. Segre - Via Archirafi 36 - Piano II - Stanza A36P2017

DOCENTE: Prof.ssa LUCIA RIZZUTO

PREREQUISITES	The prerequisites to attend the course are: good knowledge of classical mechanics; basic notions of differential and integral calculus, as well as vector calculus.
LEARNING OUTCOMES	Knowledge and understanding: Knowledge of the fundamental concepts and main results of analytical mechanics, relativity and of the mathematical techniques. Applying knowledge and understanding: Capability of using and applying the acquired knowledge and methods to non relativistic and relativistic mechanics of simple system. Making judgements: Capability of a rigorous and critical analysis of the fundamental aspects of a specific problem of analytical and relativistic mechanics. Communication skills: The student should be able to focus on and explain the essential elements of a specific problem related to non relativistic and relativistic mechanics. Learning skills: The students should be able to study autonomously and gain a deep understanding of arguments of analytical and relativistic mechanics.
ASSESSMENT METHODS	The final exam consists of a written test and a colloquium. The written test consists in solving problems concerning the arguments developed in the course of Analytical and Relativistic Mechanics. The colloquium consists in a discussion of the main arguments treated in the course. The assessment and the final mark will be given according the following criteria: a) Essential knowledge of the fundamental concepts of the course, sufficient understanding and capability of discussing/applying them (18-22); b) Good knowledge of the fundamental concepts of the course, good understanding and capability of discussing/applying them (23-26); c) Broad and deep knowledge of the fundamental concepts and subjects of the course, very good understanding and capability of discussing/applying them (27-29); d) Outstanding and throughout knowledge of the concepts and subjects of the course, excellent understanding and capability of discussing and applying them to different physical systems (30-30L).
TEACHING METHODS	The course is organised in two semesters. It consists of lectures and exercises. The lectures aim to give a knowledge of analytical mechanics (first semester) and basic notions of relativistic mechanics and electrodynamics (second semester); some applications to physical systems are also discussed. The exercises consist in applications of the methods and concepts of analytical and relativistic mechanics to some simple physical system. At the end of the first semester, there is a written test (not mandatory). The test can be used by the student as a first part of the final exam.

MODULE
RELATIVISTIC MECHANICS

Prof. BENEDETTO MILITELLO

SUGGESTED BIBLIOGRAPHY

P. G. Bergmann, Introduction to the Theory of Relativity, Dover Publications, New York, 1975.
Per approfondimenti:
L. Landau e E. M. Lifshitz, Teoria dei Campi, Editori Riuniti, 1976.
R. Resnick, Introduzione alla relativita' ristretta, Casa Editrice Ambrosiana

AMBIT	50165-Teorico e dei fondamenti della Fisica
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56

EDUCATIONAL OBJECTIVES OF THE MODULE

This part of the course aims to provide the physical concepts and mathematical tools of the special relativity. The knowledge and abilities acquired in the part of the course devoted to classical mechanics are exploited and suitably adapted to take into account the principle of invariance of the speed of light.

SYLLABUS

Hrs	Frontal teaching
4	Galilean principle of relativity. Invariance of the equations of motion. Physical basis of Einstein's principle of relativity. Non-invariance of wave equations. The light propagation problem and relevant phenomenology: Fizeau's experiment, aberration of light, Michelson-Morley experiment.
4	Necessity to re-examine the way to measure space and time. Determination of distances and synchronization of clocks. Notion of space-time.
4	Lorentz' transformations. Simultaneity in Einstein's relativity. Length contraction and time dilation.
4	Minkowski space-time. Scalars, four-vectors and tensors. Four-momentum.
4	Density of four-momentum. Four-current.
4	Relativistic least action principle for free particles . Action for particles interacting with a four-vector field. Equations of motion. Relativistic Hamiltonians.
4	Einstein's equation: transformation of mass and energy. Massless particles. Electromagnetic four-potential.
4	Electromagnetic field tensor. Maxwell's equations in covariant form. Transformation laws for the electromagnetic field.

Hrs	Practice
4	Relativistic and non-relativistic transformations of the particle motion-equations and of wave-equations.
4	Applications of Lorentz' transformations.
4	Vector and tensor calculus.
4	Charged particles interacting with the electromagnetic field.
4	Relativistic Hamiltonian and energy-mass transformations.
4	Relativistic transformations of fields and sources.

MODULE
ANALYTICAL MECHANICS

Prof.ssa LUCIA RIZZUTO

SUGGESTED BIBLIOGRAPHY	
L. Landau, E.M. Lifshits, Meccanica, Editori riuniti H. Goldestein, Meccanica Classica, Zanichelli	
AMBIT	50165-Teorico e dei fondamenti della Fisica
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56
EDUCATIONAL OBJECTIVES OF THE MODULE	
Aim of the Course of Analytical Mechanics is to give to students the physical and mathematical conceptual bases of analytical mechanics. The knowledge and concepts of classical mechanics will be consolidated and discussed in a more general framework, starting from the principle of least action and introducing the Lagrangian and Hamiltonian formulation of classical mechanics.	

SYLLABUS

Hrs	Frontal teaching
4	Equations of motion, relation with the conservation laws; potential energy, closed path integrals, curl in cylindrical and spherical coordinates.
2	Variational principle; derivation of equations of motion
6	Basic introduction of functional derivatives; generalized coordinates; Principle of least action; Lagrangian and Euler-Lagrange equations; Galileo's relativity principle; Lagrangian for a free particle; Particle in a potential. Lagrangian for a system of point-like particles.
4	Homogeneity of time, homogeneity and isotropy of space. Symmetry and conservation laws
2	Integration of the equations of motion. Motion in a central field
2	Kepler's problem
4	Small oscillations. Oscillations of systems with more than one degree of freedom.
4	Conjugate momenta, Hamiltonian, canonical equations, Poisson's brackets. Canonical transformations.
2	Lagrangian in non-inertial systems
2	Basic introduction to motion of rigid body.

Hrs	Practice
10	Exercises on Lagrangian mechanics: Lagrangian in orthogonal, cylindrical and spherical coordinates. Lagrangian for specific physical systems; constants of motion
5	Exercises on small oscillations
9	Exercises on Hamiltonian formalism: Hamiltonian for simple physical systems; equations of motion; Poisson's brackets.