UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2019/2020
MASTER'S DEGREE (MSC)	PHYSICS
SUBJECT	ADVANCED QUANTUM MECHANICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50339-Teorico e dei fondamenti della fisica
CODE	15316
SCIENTIFIC SECTOR(S)	FIS/02
HEAD PROFESSOR(S)	RIZZUTO LUCIA Professore Associato Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	98
COURSE ACTIVITY (Hrs)	52
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**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	Basic notions of analytical mechanics and quantum mechanics.
LEARNING OUTCOMES	Knowledge and understanding: Knowledge of the fundamental concepts and main results of quantum mechanics. Applying knowledge and understanding: Capability of using and applying the methods of quantum mechanics to different fields of physics. Making judgements: Capability of a rigorous and critical analysis of the fundamental aspects of a specific problem of quantum mechanics. Communication skills: The student should be able to focus on and explain the essential elements of a specific problem related to quantum mechanics. Learning skills: The students should be able to study autonomously and gain a deep understanding of arguments of quantum physics.
ASSESSMENT METHODS	The final exam is an oral examination consisting in a presentation of a specific argument, not developed during the course, that the student should prepare autonomously and a discussion/questioning on 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).
EDUCATIONAL OBJECTIVES	Aim of the course is to give to students a deeper knowledge of some basic concepts of modern quantum mechanics.
TEACHING METHODS	The course is held in the first semester of the first year of the Master Course in Physics. It consists of lectures and exercises. The lectures aim to give a knowledge of quantum mechanics and basic notions of relativistic quantum mechanics and quantum electrodynamics; some applications to physical systems are also discussed.
SUGGESTED BIBLIOGRAPHY	J.J. Sakurai, Meccanica Quantistica Moderna - Zanichelli R. Loudon, The Quantum Theory of Light – Oxford Science Publications L.I. Schiff, Quantum Mechanics, McGraw-Hill Book Company Other suggested textbooks: W. Greiner, Quantum Mechanics, an introduction - Springer W. Greiner, Quantum Mechanics; special chapters - Springer

SYLLABUS

Hrs	Frontal teaching
2	Identical particles in quantum mechanics
4	Time evolution in quantum mechanics; interaction picture; Dyson expansion.
2	Time dependent Hamiltonians; Adiabatic approximation.
2	Relativistic wave equations; Klein-Gordon equation for free particle.
3	Dirac equation for free particle; negative energy solutions.
3	Dirac equation for a central field. Spin-orbit interaction.
2	Hyperfine structure of hydrogen atom
4	Quantization of the electromagnetic field in free space; Fock states of the electromagnetic field; zero-point energy of the electromagnetic field. Casimir effect.
4	Quantization of the electromagnetic field in the presence of sources; Interaction Hamiltonian in the minimal coupling scheme. Hamiltonian in the multipolar coupling scheme.
2	Spontaneous emission of an excited atom; Einstein coefficients; ; spontaneous emission of an excited atom in a cavity and Purcell effect
3	Lamb shift; Bethe's mass renormalization
2	Dicke model. Superradiance and subradiance in atomic systems
4	Introduction to scattering theory; Scattering matrix; Born approximation.
3	Approximation methods: Variation method; WKB approximation. Applications.

Hrs	Practice
1	Derivation of the Einstein coefficients

Hrs	Practice
2	Equivalence between the schemes p•A e d•E of the interaction Hamiltonian
2	Non relativistic limit of Dirac equation; Fine structure of hydrogen atom
4	Exercises on scattering theory; calculation of the cross section for specific potentials
2	Exercises on variation method
1	Exercises on WKB approximation