UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè		
ACADEMIC YEAR	2019/2020		
BACHELOR'S DEGREE (BSC)	PHYSICS		
INTEGRATED COURSE	QUANTUM MECHANICS		
CODE	14028		
MODULES	Yes		
NUMBER OF MODULES	2		
SCIENTIFIC SECTOR(S)	FIS/03		
HEAD PROFESSOR(S)	PASSANTE ROBERTO	Professore Associato	Univ. di PALERMO
OTHER PROFESSOR(S)	PASSANTE ROBERTO NAPOLI ANNA	Professore Associato Professore Associato	Univ. di PALERMO Univ. di PALERMO
CREDITS	12		
PROPAEDEUTICAL SUBJECTS			
MUTUALIZATION			
YEAR	3		
TERM (SEMESTER)	Annual		
ATTENDANCE	Not mandatory		
EVALUATION	Out of 30		
TEACHER OFFICE HOURS	**NAPOLI ANNA** Monday 15:00 16:30 Dipartimento di Fisica e Chimica, stanza 122, Via Archirafi 36 Friday 14:30 16:00 Dipartimento di Fisica e Chimica, stanza 122, Via Archirafi 36 **PASSANTE ROBERTO** Tuesday 15:00 17:00 Studio docente (stanza N. 208) - Dip. Fisica e Chimica, Via Archirafi 36 Thursday 15:00 17:00 Studio docente (stanza N. 208) - Dip. Fisica e Chimica, Via Archirafi 36		

DOCENTE: Prof. ROBERTO PASSANTE

PREREQUISITES	The prerequisites of the course are: differential and integral calculus, linear algebra, general physics, analytical mechanics, as studied in Corso di Laurea in Scienze Fisiche
LEARNING OUTCOMES	knowledge (i) of the fundamental concepts of the Quantum Mechanics (QM), of the used mathematical methods (eg: vectorial nature of the state space, Dirac's notation); (ii) of the basic quantum systems (eg: harmonic oscillator, hydrogen atom); (iii) of some of the approximation methods used in the solution of the Schroedinger equation. -Ability in the application of the knowledge and comprehension Ability in the application of the QM to simple systems; ability in the autonomous understanding of intermediate level texts. -Autonomy of discerment capacity in the comprison between the quantum and the classical results and development of the intuition on quantum effects. -Communication ability the Student must be made able to extract, focus and tell the fundamental concepts of QM and the principal points of its applications. -Learning capacity: the Student will become able to autonomously deepen some specialistics topics of the QM and to learn and master the use of the mathematical tools of QM.
ASSESSMENT METHODS	The final assessment is made of a written and an oral section but at the end of the first modulus a mid term check is planned. The written part concerns the solution of non elementary problems of the topics taught in the whole course. The oral session corcerns the discussion of the main principles of QM presented n the course, and in the solution os simple problems. The final assessment will be determined on the basis of the achivement of the following goals: a)Basic knowledge of the fundamental concepts object of the course, sufficient level of understanding and of autonomy in the discussion of the themes of the examination (mark 18-22) b)Good knowledge of the topics of the course, good level of conceptualization and autonomy in the discussion of the topics (mark 23-26) c)Deep knowledge of the fundamental concept taught in the course; very good conceptualization and autonomy in the discussion of the topics; optimal discussion of the subjects of the examitation (mark 27-29) Complete and optimal knowledge of the subjects of the course, quick ability in their correct application to several physical situation and very good communication skill (mark 30 30L).
TEACHING METHODS	The annual course is taught during the third year of the CdL in Scienze Fisiche. It consists of the units. The course consists of lessons on the fundmental concepts of QM (free particle, potential well, harmonic oscillator, angular momenta, hydrogen atom, perturbation theory) and of numerical applications of the concepts developed during the lessons.

MODULE
HYDROGEN ATOM AND PERTURBATION CALCULUS

Prof. ROBERTO PASSANTE

SUGGESTED BIBLIOGRAPHY

Testo di base
D. J. Griffiths: Introduzione alla Meccanica Quantistica, ed. Ambrosiana
Testi di approfondimento
C. Cohen-Tannoudji, B. Diu, F. Laloe: Quantum Mechanics, Vol I and II, Wiley
L. Landau, E. Lifsits: Meccanica Quantistica, Editori riuniti

AMBIT	50162-Microfisico e della struttura della materia
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56

EDUCATIONAL OBJECTIVES OF THE MODULE

Comprehension of the basic theory to fundamental problems of the Quantum <mechanics: angular momenta,; hydrogen and helium atom; perturbation theory.
Particular attention is devoted to the complete and correct solution of the problems.

SYLLABUS

Hrs	Frontal teaching
6	Quantum Theory of the angular moment: operators, eigenstates and eigenvalues. Relation between angular momentum and rotation.
2	Spin angular momentum, Pauli matrices
3	Motion in a central potential. Separation of the variables in the Schroedinger equation
5	Hydrogen atom: energy levels, spectrum; quantum numbers.
5	Time independent perturbation theory; non degenerate case and degenerate
3	Time dependent perturbation theory and transition probability
3	Different types of perturbations: sudden, periodic. Resonance and rotating wave approximation. Fermi Golden rule
2	Composition of angular momenta
3	helium atom and exchange interaction

Hrs	Practice
12	Problem solving in angular momentum and spin. Singlet and triplet states. Angular momentum composition.
12	Time dependent and independent perturbation theory. Stark and Zeeman effect. Anharmonic potential

MODULE
INTRODUCTION TO QUANTUM MECHANICS

Prof.ssa ANNA NAPOLI

SUGGESTED BIBLIOGRAPHY

Testi di base: J.J.Sakurai, Meccanica Quantistica, Zanichelli D.J. Griffiths, Introduzione alla Meccanica Quantistica, Casa Editrice Ambrosiana
Libri di approfondimento:Stefano Forte, Luca Rottoli, Fisica Quantistica, Zanichelli; C. Cohen-Tannoudji. B. Diu, F. Laloe, Quantum Mechanics Vol I e II, Wiley;
R.P.Feynman, R.B. Leighton, M. Sands, The Feynman Lectures on Physics Vol 3, Addison Wesley

AMBIT	50162-Microfisico e della struttura della materia
INDIVIDUAL STUDY (Hrs)	94
COURSE ACTIVITY (Hrs)	56

EDUCATIONAL OBJECTIVES OF THE MODULE

This course aims at introducing the fundamental principles of Quantum Mechanics necessary to access future studies. The course objective is to achieve the understanding of the mathematical models and methods apt to represent the behaviour of the world at the microscopic scale

SYLLABUS

Hrs	Frontal teaching
4	Quantum Interference with particles, photon polarization, probability amplitudes, state vectors
4	Hermitean operators, dual spaces, measurement postulate, expectation value, unitary operators
4	Time evolution and Schrödinger equation, Hamiltonian, energy eigenstates
4	Electron spin, Pauli operators
4	Continuum spectrum, position and momentum operators, canonical commutation relations, eigenstates of the momentum operator, uncertainty principle
6	Infinite square wells, stationary states in the position and momentum representation, delta potential, tunnel effect, finite square well
6	Quantum Harmonic oscillator, creation and annihilation operators, number states, coherent states, two dimensional harmonic oscillator

Hrs	Practice
2	Quantum interferometers
6	Fourier transform, Dirac delta function, gaussian wavepacket
12	Probability fluxes, Heisenberg representations, coupled wells, lattices, energy bands, coupled modes, coherent states
4	Resolution of exam problems