SUBJECT TEACHING GUIDE

G68 - Quantum mechanics

Double Degree in Physics and Mathematics
Degree in Physics
Degree in Physics

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics Degree in Physics			Type and Year	Optional. Year 5 Optional. Year 4
Faculty	Faculty of Sciences				
Discipline	Subject Area: Quantum Mechanics Mention in Fundamental Physics				
Course unit title and code	G68 - Quantum mechanics				
Number of ECTS credits allocated	6	Term		Semester based (1)	
Web					
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. FISICA MODERNA
Name of lecturer	DIEGO SANTIAGO PAZO BUENO
E-mail	diego.pazo@unican.es
Office	Facultad de Ciencias. Planta: + 1. DESPACHO (1012)
Other lecturers	PABLO MARTINEZ RUIZ DEL ARBOL

3.1 LEARNING OUTCOMES
- Handle with ease the formalism of Quantum Mechanics.
- Handle appropriate approximation techniques to apply Quantum Mechanics to different physical systems .
- Understand the role played by angular momenta in the analysis of physical systems.
- Understand the origin of spin and its importance in systems of identical particles.
- Be able of proposing suitable measurements in diffusion problems.
- Address new problems in the quantum domain, identifying similar analyses in the bibliography, and setting out the approximation methods to be applied.

4. OBJECTIVES
Grasp the basic notions of the mathematical structure of Quantum Mechanics
Get a deeper insight into the time evolution of a quantum system.
Gain knowledge concerning some of the techniques that are used in Quantum Mechanics to study simple systems (specially approximate methods)
Understand the concept and properties of the angular momentum.
Understand the mathematical description of the states of a particle with spin.
Learn how to solve the two body problem with a central potential.
Understand the indistinghishability of identical particles and its consequences.
Getting started in the use of approximate methods in Quantum Mechanics.

6. SUBJECT PROGRAM	
CONTENTS	
1	PRINCIPLES OF QUANTUM MECHANICS
1.1	REVIEW OF WAVE MECHANICS: The wave function and its interpretation. The wave packet. The free particle. Unidimensional systems.
1.2	DIRAC FORMALISM: Vector space, scalar product, operators, bases, ...
1.3	POSTULATES OF QUANTUM MECHANICS
1.4	OBSERVABLES. Commuting observables. Complete set of commuting observables. Uncertainty relation.
1.5	TIME EVOLUTION. SCHRÖDINGER EQUATION: Stationary states. Ehrenfest Theorem. Energy-time uncertainty
1.6	THE HARMONC OSCILLATOR: Creation, annihilation and number operators. Algebraic method for the calculation of the stationary states.
2	MISCELLANEA
2.1	APPROXIMATION METHODS: Time independent perturbation theory (non-degenerate levels).
2.2	THE ANGULAR MOMENTUM IN QUANTUM MECHANICS: Eigenvalues and eigenvectors. Orbital angular momentum. Spherical harmonics.
2.3	CENTRAL POTENTIALS: The quantum two body problem. Separation of variables. Radial equation.
2.4	THE SPIN: The state space. Particle with spin in the presence of an electromagnetic field.
2.5	COMPOSITION OF ANGULAR MOMENTA: Tensor product. Clebsch-Gordan coefficients
2.6	IDENTICAL PARTICLES: Indistinguishability and Quantum Mechanics. Symmetrization postulate. spin-statistics theorem. Pauli exclusion principle.

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Written exam with problems and questions of the first part of the course.	Written exam	No	Yes	50,00
Written exam with problems and questions of the first part of the course (excl. Identical particles).	Written exam	No	Yes	40,00
Final exam, consisting of three parts corresponding: 1) Part I, 2) Identical particles, and 3) Part II (excluding Identical particles).	Written exam	Yes	No	10,00
TOTAL				100,00

Observations

In the exams the students are allowed to make use of an equations sheet provided by the teachers.

The qualification of the subject is the average of marks in parts 1 and 2. The mark of each part is taken as the highest among the two exams made (mid-term and final). To pass it is compulsory to obtain marks equal or above 3 in each part.

Two partial exams represent the (50%+40%=)90% of the final qualification. The final examination includes one exam of identical particles for the remaining 10%. Apart of this, two exams allow the student to improve the qualifications of both mid-term exams.

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The extra call session consists of one single exam of the whole course.

Observations for part-time students

Part-time students should make the final examination (consisting of three separate exercises).

For the extraordinary call, the exam will include the whole course.

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

Apuntes proporcionados por los profesores.

C. Cohen-Tanoudji, B. Diu, F. Laloë, Quantum Mechanics (vol. 1 y 2) Ed. Wiley

N. Zettili, Quantum Mechanics. Concepts and Applications. Ed. Wiley