SUBJECT TEACHING GUIDE

G68 - Quantum Mechanics

Double Degree in Physics and Mathematics
Degree in Physics

Academic year 2020-2021

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics 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
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Office	IFCA - Edificio Juan Jordá. Planta: + 0. DESPACHO (006)
Other lecturers	PABLO MARTINEZ RUIZ DEL ARBOL

3.1 LEARNING OUTCOMES
- Handle with ease the basic formalism (particularly in Dirac notation): operators, basis, representations
- Obtain the time evolution for simple systems
- Calculate expectation values and matrix elements of physical quantities
- Obtain the probabilities of the possible outcomes of a measurement
- Understand the concept of angular momentum, and gain ability to perform calculations by using its algebraic properties
- Understand the structure of the states of particles with spin.
- Know how to express angular functions with the aid of the spherical harmonics.
- Solve problems with central potentials by means of the radial equation.
- Obtain correct states for systems of identical particles, by using permutation operators.
- Apply appropiate approximation methods.

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. COURSE ORGANIZATION

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	THE SPIN: The state space. Particle with spin in the presence of an electromagnetic field.
2.4	COMPOSITION OF ANGULAR MOMENTA: Tensor product. Clebsch-Gordan coefficients
2.5	IDENTICAL PARTICLES: Indistinguishability and Quantum Mechanics. Symmetrization postulate. spin-statistics theorem. Pauli exclusion principle.
2.6	CENTRAL POTENTIALS: The quantum two body problem. Separation of variables. Radial equation.

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 second part of the course.	Written exam	No	Yes	50,00
Final exam consists of two parts corresponding to the two parts of this course.	Written exam	Yes	No	0,00
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.

In addition, students may add up to 1 extra point to their final qualification, by solving problems proposed by the teacher along the course as well as by their active participation in the lectures.

In case that the exams cannot be made in person, the evaluation will be on-line. Depending on the number of pupils, the teachers may evaluate through oral examinations.

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The extra exam session consists of one single written exam. A mark equal or above 5 is required to pass.

Observations for part-time students

Part-time students must carry out a work and deliver solved problems throughout the semester according to the instructions of the teacher. This will constitute 30% of the final mark, the remaining 70% being the result of a global exam to be held at the end of the semester. The same conditions apply to the exam of the extraordinary call, in case the former was failed. In this situation, both work and exercises can be redone by the student. Also, according to the professor, the student can submit other exercises different from those delivered along the semester .

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