Bachelor in Physics
(Academic Year 2022-23)

Quantum Physics I		**Code**	800503	**Year**	2nd	**Sem.**	2nd
Module	General Core	**Topic**	Classical Physics	**Character**	Obligatory		

	Total	Theory	Exercises
ECTS Credits	6	3.5	2.5
Semester hours	55	30	25

Learning Objectives (according to the Degree's Verification Document)

- To acquire the concept of wave function and the basics on the quantum phenomena description by the Schrödinger equation.
- To solve one and three-dimensional problems with spherical symmetry (hydrogen atom and harmonic oscillator)

Brief description of contents

Origin and experimental basis of Quantum Physics. Mathematical formalism: states and observables. Schrödinger's equation: one and three-dimensional potentials. Harmonic oscillator and hydrogen atom.

Prerequisites

Mathematical concepts learned in Algebra and Calculus, Mathematical Methods I and II.

Coordinator	Antonio Muñoz Sudupe		**Dept.**	FT
	Office	03.0319.0	**e-mail**	sudupe@fis.ucm.es

Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	4ª	Mo,Tu Fr	9:00-10:30 9:00-10:00	Carmelo Pérez Martín	Full term	55	T/E	FT

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Carmelo Pérez Martín	Tu, Th: 11:00-14:00	carmelop@fis.ucm.es	Office 03.316.0

Syllabus

1.- Experimental outcomes and the dawn of Quantum Physics. Black body radiation and Planck's hypothesis. The Photoelectric effect. Compton scattering. The de Broglie's principle and its experimental verification. The double slit experiment.

2.- The Schroedinger equation. The probabilistic interpretation of the wave function and the continuity equation. Mean values and time evolution. Wave packets. The Heisenberg's uncertainty principles.

3.- One-dimensional problems. Stationary states and the time independent Schroedinger equation.

Bound states and Scattering states. Potential Wells and barriers. Reflection and transmission coefficients. The Tunnel effect.

4.- The mathematical formalism of Quantum Mechanics and The Quantum Mechanics postulates.

Hilbert spaces. Vectors and quantum states. Physical magnitudes and Self-adjoint operators. Measurements and probability. Commutation rules. Time evolution and conserved quantities. Compatible observables.

5.- The one-dimensional harmonic oscillator. Solving the Hamiltonian eigenvalue problem by using the Hermite polynomials. The algebraic resolution of the Hamiltonian eigenvalue problem: the creation and annihilation operators.

6.- Three-dimensional problems. Separation of variables in Cartesian coordinates: The infinite well and the harmonic oscillator. Central potentials and separation of variables in spherical coordinates.

The angular momentum and the spherical harmonics: commutation relations, ladder operators and

The spectrum. The radial equation. The hydrogen atom: energies and bound state wave functions.

The infinite spherical well and the isotropic harmonic oscillator.

Bibliography

Basic:

1. S. Gasiorowicz. Quantum Physics. New York 2003. John Wiley.
2. R. M. Eisberg, R. Resnick. Quantum Phys ics: of atoms, molecules, solids, nuclei and particles. New York 1985. John Wiley.
3. D. J. Griffiths. Introduction to Quantum Mechanics. New York 1995. Prentice Hall.

Complementary:

1. S. Flugge. Practical Quantum Mechanics. Springer. 1999.
2. G. L. Squires. Problems in Quantum Mechanics. Bangalore 1997. University of Bangalore Press.
3. I. I. Goldman, V. D. Krivchenkov. Problems in Quantum Mechanics. New York 1993. Dover.
4. L. Landau, E. Lifshitz. Quantum Mechanics. London 1958. .Pergamon Press.
5. Cohen-Tannoudji, B. Diu, F. Laloe. Quantum Mechanics. New York 1977. John Wiley.
6. A. Galindo, P. Pascual. Quantum Mechanics I and II. Berlin 1990. Springer-Verlag

Online Resources

UCM Virtual Campus

Methodology

A) Blackboard lectures and exercise solving classroom sessions with the following aims
- Explain the chief experimental results which gave rise to the advent of Quantum Physics and the new ideas and concepts that the latter involves.
- That the student grasps and masters the basic computational tools of Quantum Physics.
- That the student masters the quantum ideas and concepts by conducting solving- exercise sessions and by discussing examples in the classroom.

B) Exercise sheets will be handed down to students so that they can practice and put to work the ideas, concepts and techniques that will be introduced during course.

That the student participates in discussions in the classroom and attends tutorials will be very much encouraged.

Evaluation Criteria

Exams	Weight:	70%
-The exams will involve theoretical questions, short problems and longer problems with several parts. -All questions will be accurate and to the point and so the corresponding answers should be. -The final exam will be marked with a figure, say F, between 0 and 10, both inclusive.		
Other Activities	**Weight:**	**30%**
A mid-term exam will be run. The lecturer may propose—if he or she so wishes and time permits it—other activities such as essay presentations by the students, questions put to the students in the classroom, et cetera. This activity will be graded with a figure, say C, between 0 and 10, both inclusive.		

Final Mark

The final mark will be worked out by using the following formulan Final mark = maximum {F, WM}

where WM = 0.7 F + 0.3 C , and F and C are defined above.