



Bachelor in Physics

(Academic Year 2021-22)

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	54	29	25

Learning Objectives (according to the Degree's Verification Document)
<ul style="list-style-type: none"> 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
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Theory/Exercises – Schedule and Teaching Staff								
Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	Mo, Tu Fr	9:00-10:30 9:00-10:00	Carmelo Pérez Martín	Full term	54	T/E	FT

T: Theory, E: Exercises

Office hours				
Group	Professor	Schedule	E-mail	Location
B	Carmelo Pérez Martín	Tue & Thu: 11:00-14:00	carmelop@fis.ucm.es	Office 10. 3 rd floor. West wing

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 Physics: 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		
On-campus teaching 100% (Scenario 0)		
<p>A) Blackboard lectures and exercise solving classroom sessions with the following aims</p> <ul style="list-style-type: none"> - 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. <p>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.</p> <p>That the student participates in discussions in the classroom and attends tutorials will be very much encouraged.</p>		
Semi-online teaching (Scenario 1)		
<p>Group B: Modality B.</p> <ul style="list-style-type: none"> * Partially classroom-based lectures on problem resolution, practical cases, etc. repeating these activities for every subgroup. The audio and the blackboard projection will be broad-casted live via internet. The lectures will be recorded and made available in the Virtual Campus for later asynchronous consultation. * Previously, the corresponding theoretical lectures will be made available for the students in the Virtual Campus This necessary theoretical material to understand the classroom-based lectures will be provided beforehand (flipped classroom). It will mainly consist of videos with the explanations of the professor. * The students will be provided with practical worksheets before solving them at class. * There will be in-person tutorials if appropriate and always keeping the due health and safety measures. Alternatively, they will be via electronic mail, videos or synchronous streaming tools (Microsoft Teams, Google Meet, etc.). Online tutorials will be conducted within the schedule established for them by the each professor. 		
Online teaching (Scenario 2)		
<p>Guidelines for the non-classroom-based scenario:</p> <ul style="list-style-type: none"> * Previously recorded video-lectures will be uploaded to the Virtual Campus. * Tests with detailed notes and practical problem solutions, uploaded to the Virtual Campus. Videos with the explanations of the notes and the resolution of the practical problems will be uploaded to the Virtual Campus. * Synchronous tutorials and classes will be organized via Microsoft Teams, Google Meet, Zoom, etc. They will be recorded and made available in the Virtual Campus for later asynchronous consultation. 		
Evaluation Criteria		
Exams	Weight:	70%
<p>-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.</p>		
Other Activities	Weight:	30%
<p>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.</p>		
Final Mark		
<p>The final mark will be worked out by using the following formulán Final mark = maximum {F, WM} where $WM = 0.7 F + 0.3 C$, and F and C are defined above.</p>		