



Bachelor in Physics (Academic Year 2022-23)

Quantum Physics II			Code	800513	Year	3rd	Sem.	1st
Module	General Core	Topic	Quantum physics and statistics		Character	Obligatory		

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

Learning Objectives (according to the Degree's Verification Document)
<ul style="list-style-type: none"> Spin, general angular momenta and their coupling in quantum mechanics. Identical particles and the Pauli exclusion principle. Elementary time-dependent perturbation theory and its basic applications.
Brief description of contents
Spin and angular momentum. Pauli's exclusion principle. Approximate methods for Schrödinger's equation.
Requisites
Basic knowledge of the mathematical formulation of quantum mechanics. This includes the Schrödinger equation and the wave function, simple one-dimensional problems, and the commutation relations and the eigenvalue problem for orbital angular momentum.

Coordinator	Juan Manuel Rodríguez Parrondo		Department	EMFTEL
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Schedule and Teaching Staff								
Group	Lecture Room	Day	Time	Professor	Dates	Hours	T/p	Dept.
B	4 ^a	Mo We Th	10:00-11:00 10:30-12:00 11:00-12:30	Fernando Ruiz Ruiz	Full term	55	Both	FT

T: Theory, P: Problems

Office hours				
Group	Instructor	Office	Schedule	e-mail
B	Fernando Ruiz Ruiz	03.0315.0	Mo: 15:00 - 17:00 We: 12:00 - 14:00 Fr: 12:00 - 14:00	ferruiz@ucm.es

Syllabus

Mathematical formulation of quantum mechanics. Physical states of a quantum system. Observables and operators. Results and probabilities of measurements. Physical state after a measurement. Time evolution. Composite systems. Density matrix.

Spin and two-level systems. The Pauli and Goudsmit-Uhlenbeck hypotheses. The Stern-Gerlach experiment. Coupling of an electron to a magnetic field.

Angular momentum. General definition. Addition of two $\frac{1}{2}$ angular momenta. Addition of two general angular momenta and Clebsch-Gordan coefficients.

Identical particles. Indistinguishable particles and symmetrization and antisymmetrization of the wave function. Systems of identical non-interacting particles.

Time-independent perturbation theory. The idea of perturbative expansions. Perturbation theory for nondegenerate states. Perturbation theory for degenerate states. Applications to the Hydrogen atom.

The variational method. General description of the method. Applications.

Time-dependent perturbation theory. Time-dependent Hamiltonians and perturbations. Fermi's golden rule and selection rules.

Bibliography

Basic:

- C. Cohen-Tannudji, B. Diu, F. Laloë, Quantum mechanics, vols I y II, John Wiley (New York 1977).
- S. Gasiorowicz, Quantum physics, 3rd edition, John Wiley (New York 2003)

Complementary

- D. J. Griffiths, Introduction to Quantum Mechanics. Prentice Hall (New York 1995).
- D. D. Fitts, Principles of quantum mechanics, as applied to chemistry and chemical physics, Cambridge University Press (Cambridge 1999).
- B. Schumacher, M. Westmoreland, Quantum processes systems, and information, Cambridge University Press (Cambridge 2010).
- L. Ballentine, Quantum Mechanics: A modern development, World Scientific Publishing (Singapore 1998).
- M. Alonso, E Finn, Quantum and statistical physics Fundamental University Physics, vol III), Addison Wesley (Reading 1968).

Online resources

UCM's Virtual Campus.

Teaching method	
<p>Theory lectures and problem sessions will be given and conducted by the Instructor. He will use conventional chalk/blackboard or computer-assisted projections. Sample sheets to be discussed and/or solved in the classroom will be provided to students prior to problem sessions. Students are encouraged to take an active part in both theory lectures and problems sessions. The Instructor will be available for tutorials at the times specified in the office hours table above. Teaching material will be accessible at Campus Virtual.</p>	

Evaluation criteria		
Exams	Weight:	75%
<p>There will be a final exam, consisting of brief questions and problems of similar degree of difficulty to those in the sample sheets. To pass the subject, a minimal grade in the final examination, fixed by the Instructor in due time, will be required.</p>		
Other Activities	Weight:	25%
<p>One or more of the following activities may be run:</p> <ul style="list-style-type: none"> • Resolution of problems by students. These may be set as homework or as exercises to be solved in the classroom. • Mid-term tests which may comprise written and oral questions. 		
Final Mark		
<p>Let FE and OA stand for the final examination and other activities marks,</p> <p style="padding-left: 20px;">FE = mark in final examination</p> <p style="padding-left: 20px;">OA = mark in other activities described above</p> <p>Provided FE is larger than a minimum, fixed by the Instructor in due time, the grade in the subject will be calculated using the formula.</p> <p style="padding-left: 20px;">$\max (FE , 0.25 \cdot OA + 0.75 \cdot FE) .$</p>		