

# UE Quantum Physics I



Level  
Baccalaureate  
+4



ECTS  
3 credits



Component  
UFR PhITEM  
(physique,  
ingénierie, terre,  
environnement,  
mécanique)



Semester  
Automne

- > **Teaching language(s):** English
- > **Open to exchange students:** Yes
- > **Code d'export Apogée:** PAX7NQAB

## Presentation

### Description

*Goal:* This course is a deepening of the quantum mechanics concepts introduced in the undergraduate courses. The fundamental principle of quantum mechanics are illustrated by applications to nanoscale condensed-matter systems taken from recent research works and by discussing prospects for quantum information technologies. The concepts presented in this course are prerequisites for many second-year courses related to nanophysics and quantum engineering. A good knowledge in quantum mechanics is indeed more and more essential for technological research and development of nanoscale quantum devices.

#### Content

- **Chapter 1:** Introduction and recalls on the quantum mechanics postulates and formalism (Dirac notation, Hilbert space). Two-level system, Zeeman effect, spin Hamiltonian. Tensorial product notation for states and operators. Many-body quantum states (bosons and fermions).  
Exercices: Basics of quantum mechanics formalism.
- **Chapter 2:** Recalls on confinement problem. Electron bound states in a potential.  
Exercices: Example of 1D confinement problems, quantum harmonic oscillator.
- **Chapter 3:** Introduction to atomic physics. Spherical symmetry, angular and spin kinetic momenta. Mean field approximation, central potential, many electrons atoms, Hund rules, spin-orbit coupling, optical transitions.  
Exercices: Grotrian diagrams, spin-orbit coupling, fine and hyperfine structure.
- **Chapter 4:** Approximation methods for eigenstate calculations, perturbation theory, variational method.

Exercices: Application to electronic systems.

- **Chapter 5:** Time evolution. General equation for the time evolution, two-level systems, perturbation theory, Fermi golden rules.

Exercices: Application to Rabi oscillations.

*Prerequisites:* Basics of quantum mechanics.

*Bibliography:* Quantum mechanics, C. Cohen-Tannoudji, Vol. 1, ISBN-13: 978-0471164333, Vol. 2, ISBN-13: 978-0471569527.

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## Course parts

UE Quantum Physics I - CMTD

Lectures (CM) & Teaching Unit (UE)

24h

**Period :** Semester 7

## Useful info

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## Campus

› Grenoble - Saint-Martin d'Hères