

PHYS-313

**Quantum physics I**

Savona Vincenzo

Cursus	Sem.	Type
Electrical and Electronical Engineering	BA5	Opt.
Minor in Quantum Science and Engineering	H	Opt.
Physics	BA5	Obl.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	Written
Workload	150h
Weeks	14
<b>Hours</b>	<b>5 weekly</b>
Lecture	3 weekly
Exercises	2 weekly
<b>Number of positions</b>	

**Summary**

The objective of this course is to familiarize the student with the concepts, methods and consequences of quantum physics.

**Content**

1. A bit of history: the crisis of classical physics
2. The Stern and Garlach experiment: quantum states and spin  $1/2$
3. The axioms of quantum physics: state vectors, operators, measurement, representations
4. Continuous degrees of freedom: translation operator and canonical quantization
5. Time evolution: Schrödinger's equation and Heisenberg's point of view
6. Some simple problems in one dimension
7. Central potentials, angular momentum and hydrogen atom
8. Composite systems: entanglement and Bell's inequalities
9. Addition of angular momentum

**Keywords**

Quantum mechanics, Schrödinger equation, Heisenberg uncertainty principle, wave function, harmonic oscillator, hydrogen atom, spin, entanglement

**Learning Prerequisites****Required courses**

Basic physics and mathematics undergraduate courses

**Important concepts to start the course**

Strong working knowledge of calculus and linear algebra (covered in basic math courses).

**Learning Outcomes**

By the end of the course, the student must be able to:

- Explain the difference between classical and quantum physics

- Compare Schrödinger's and Heisenberg's viewpoints on quantum physics
- Derive Heisenberg's uncertainty principle
- Solve the quantum harmonic oscillator with the ladder operator method
- Interpret the measurement process in quantum physics
- Solve Schrödinger's equation for problems in 1,2 and 3 dimensions
- Characterize the amount of entanglement in a two-spin system
- Contextualise the postulates of quantum physics

### Teaching methods

Ex cathedra. Exercises prepared in class.

### Expected student activities

Students are expected to regularly attend the theory lectures and the exercise lectures. They are also expected to complete the exercises that are given on a weekly basis, as well as regularly study the learning material offered by the professor (lecture notes, exercises solutions etc).

### Assessment methods

Written exam

### Resources

#### Bibliography

The key reference is :

1. "Modern Quantum Mechanics" (2nd edition), J.J. Sakurai, J. Napolitano (Cambridge University Press, 2017)

Other books can be occasionally consulted, most notably

2. "Mécanique Quantique I-II", Cohen-Tannoudji, Diu, Lahoë (Hermann) [Also available in English]

### Ressources en bibliothèque

- [Quantum Mechanics](#)
- [Mécanique Quantique](#)
- [Modern Quantum Mechanics](#)

### Notes/Handbook

Lecture notes will be given at the beginning of the course

### Moodle Link

- <https://go.epfl.ch/PHYS-313>