GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2021-2022

Quantum Mechanics 1 (C002240)

Due to Covid 19, the education and assessment methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h** **Contact hrs** 52.5h

Course offerings and teaching methods in academic year 2021-2022

A (semester 1)	Dutch	Gent	seminar: coached exercises	22.5h
			lecture	30.0h

Lecturers in academic year 2021-2022

Ryckebusch, Jan	WE05	lecturer-in-charge

Offered in the following programmes in 2021-2022	**crdts**	**offering**
Bachelor of Science in Mathematics	6	A
Bachelor of Science in Physics and Astronomy	6	A

Teaching languages

Dutch

Keywords

Quantum mechanics, modern physics, particle-wave duality, Schrödinger equation

Position of the course

This course unit belongs to the learning pathway "General physics" in the Bachelor program Physics and Astronomy.
The course aims at providing graduates with basic knowledge in quantum mechanics. The course illustrates that a number of crucial experiments that were carried out in the early 1900s prompted thorough revisions of existing physical theories in order to provide a proper description of the physics of subatomic phenomena. We start from the concept of the wave function. The time-dependent Schrödinger equation is thoroughly studied. After dealing with the general formalism, attention is paid to the study of one-dimensional quantum systems. One of the major goals of the course is to establish the importance of quantum mechanics for the description of many systems, including nuclei and elementary particles.

Contents

- Introduction to quantum mechanics (black-body radiaton, energy spectrum of atoms and molecules, Compton effects, photoelectric effect, Stern-Gerlach experiment)
- Properties of matter (Bohr's atomic model, de Broglie wave nature of matter)
- The concept of wave function (particle-wave duality, free particle, momentum wave function and Fourier transformations, uncertainty in quantum mechanics)
- The Schrödinger equation (time-dependent Schrödinger equation, continuity equation, current conservation, expectation value, Ehrenfest theorem, time-independent Schrödinger equation, energy quantisation, eigenvalue problems: energy spectrum and wave functions)
- One-dimensional systems (free particle, potential step, various potential well problems, quantum tunneling, harmonic oscillator)
- The formalism of quantum mechanics (introduction, Dirac bra-ket vectors, measuring in quantum mechanics. Heisenberg principle, representations in quantum mechanics, occupation number representation for the harmonic oscillator)
- Introduction to the quantum physics of atoms and atomic nuclei. Quantum mechanics and Subatomic physics.

Initial competences

Prerequisites: basics of physics (mechanics, waves and optics, electricity and magnetism) and the basics of mathematics (linear algebra and calculus).

Final competences

1 The course provides an introduction to quantum mechanics which is indispensable for studying various subjects that appear in modern physics curricula, like condensed-matter physics, subatomic physics, atomic and molecular physics, astrophysics, elementary particle physics.
2 In addition the course provides the background knowledge which is essential to study the important branches of theoretical physics like relativity, relativistic quantum mechanics, statistical physics, and field theory.
3 The student has a sound knowledge of the mathematical aspects of quantum mechanics, including probability distributions, probability currents, second-order partial differential equations, Hilbert spaces.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, Seminar: coached exercises

Extra information on the teaching methods

Lectures present the theoretical concepts. Tutorials aim at providing a deeper insight into the concepts of the course. The tutorials train the students in problem solving.

Learning materials and price

The presentations and the solutions to the problem sessions are made available through the electronic learning environment.
Mandatory text book is "Quantum Mechanics", B.H.Bransden and C.J. Joachain, (Second Edition, Prentice Hall, 2002), (about 60,00 €).

References

i) "Introductory Quantum Mechanics", R. Liboff (Fourth Edition, Addison Wesley, 2003)

ii) "Quantum Mechanics: an accessible introuction", Robert Scherrer (Pearson, San Francisco, 2005)

Course content-related study coaching

The possibility is provided for students to contact the lecturer(s) after the lecture hours. Appointments for small groups of students can be arranged in order to supply
Additional course information.

Assessment moments

end-of-term assessment

Examination methods in case of periodic assessment during the first examination period

Oral examination, Open book examination, Written examination with open questions

Examination methods in case of periodic assessment during the second examination period

Oral examination, Open book examination, Written examination with open questions

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

- the written exam consists of two parts: an open-book part and a closed-bood part. The open-book part has a number of problems (typically two) that the student has to solve.
- the oral exam adopts the following format: the student receives a question and

can work on it for thirty minutes. For another 15 minutes the student interacts with the lecturer.

Calculation of the examination mark

- 40% for the oral exam
- 40% for the open-book part of the written exam
- 20% for the closed-book part of the written exam