Faculty of Technology and Science
Physics

Syllabus

Course Approval
The syllabus was approved by the Faculty Board of Technology and Science on 28 March 2012 , and is valid from the Spring semester of 2012 at Karlstad University.

Course Code: FYGB07
Quantum Physics I, 7.5 ECTS Credits
(Kvantfysik I, 7.5 Swedish credit points)
Degree Level: Bachelor
Progressive Specialisation: G2F (First cycle, has at least 60 credits in first-cycle course/s as entry requirements)

Language of Instruction
Swedish or English

Prerequisites
Completed courses in Physics, 22.5 ECTS Credits, and courses in Mathematics, 22.5 ECTS Credits plus attended courses: Linear Algebra and Vector Analysis 7.5 ECTS cr and Basic Mathematical Mathematical Physics 7.5 ECTS cr, or Tensor, Complex Analysis and Transformer 7.5 ECTS cr, or equivalent.

Major Field of Study
FYA (Physics), TKA (Engineering Physics)

Learning Outcomes

The aim of the course is that students deepen their understanding of quantum mechanical phenomena and models as well as develop their ability to ananlyse quantum mechanical systems of single particles and the hydrogen atom mathematically.

Upon completion of the course, students are expected to be able to:
- give an account of some of the most important historical experiments that showed the inadequacy of classical physics for describing physical phenomena, such as the spectral distribution of blackbody radiation, the photoelectric effect, the Compton effect, and the line spectra of atoms,
- give an account of the concepts, postulates, and formalism of quantum mechanics, and apply these when solving problems,
- give an account of both the similarities and the differences between classical mechanics and quantum mechanics,
- solve the Schrödinger equation for one-dimensional model potentials and describe some of its applications,
- give an account of the different types of angular momentum in quantum mechanics and treat their most important representations mathematically,
- give an account of the solution of the Schrödinger equation in two and three dimensions through the separation method, and apply it to the harmonic oscillator and the hydrogen atom,

Content and Form of Instruction

Instruction is in the form of lectures and exercise sessions.

The course covers the following topics:

- The emergence and structure of quantum theory: the interpretation and properties of the wave function, the superposition principle, wave packets, Heisenberg's uncertainty relation, the time-dependent Schrödinger equation, free particles, probability current and probability conservation, expectation values, the correspondence principle, operators, commutators, Hermitean operators, the time-independent Schrödinger equation and stationary states.
- Applications in one dimension: rectangular potentials, the harmonic oscillator and the tunneling phenomenon.
- The postulates and formalism of quantum mechanics: Dirac's bra-ket notation, Hermite conjugation, eigenfunctions as orthonormal bases, wave function collapse, compatible observables, the time evolution of expectation values, the general uncertainty principle.
- Angular momentum: eigenfunctions for angular momentum operators, the Legendre polynomials and spherical harmonics, the rotation energy of molecules, general angular momentum and spin, spin in matrix bases, and addition of angular momenta, step operators.
- Solution of the Schrödinger equation in three dimensions: separation ansätze, three-dimensional rectangular and harmonic potentials, central potential, and the hydrogen atom.

Reading List

See separate document.

Examination

Assessment is based on a written exam and hand-in assignments.

Grades

One of the grades U (Fail), G (Pass) or VG (Distinction) is awarded in the examination of the course. Engineering students are awarded one of the grades U (Fail), 3 (Pass), 4 (Pass not without Distinction) or 5 (Pass with Distinction).

Quality Assurance

Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course assessment is based on student views and experiences as reported in written course evaluations and/or group discussions. Students will be informed of the result of the evaluation and of the measures to be taken.

Course Certificate

A course certificate will be provided upon request.

Additional Information

Students who enrolled before 1 July 2007 will complete their studies in accordance with the requirements of the earlier admission. Upon completion students may request degree and course certificates to be issued under the current ordinance if they meet its requirements.

The local regulations for studies at the Bachelor’s and Master’s levels at Karlstad University stipulate the obligations and rights of students and staff.