Faculty of Technology and Science

Syllabus

Post graduate level

Course Approval
The syllabus was approved by the Faculty Board for Technology and Science on 9 February 2011 (Reg No: FAK2 2011/32:1), and is valid from the spring semester of 2011 at Karlstad University.

Code:
2FYS001

Doctoral study object
Physics

Course name
Advanced quantum physics
Avancerad kvantfysik

Credit points
7.5 ECTS credits

Language of Instruction
Swedish or English

Degree level
Doctor

Target group and prerequisites
Admission to doctoral studies in physics or a Master's degree in physics.
Mathematics 45 ECTS cr., Physics 90 ECTS cr., including the course Quantum Physics I, or equivalent.

Aims
The aim of the course is that students further develop their knowledge and skills in quantum mechanics. This theory is fundamental to the description of matter and to the basic natural laws, and skills in this field are central to physics, chemistry and modern biology.

Upon completion of the course, students should be able to:

- give a detailed account of basic concepts and methods in non-relativistic quantum mechanics
- give an account of important manipulations of operators in Hilbert spaces
- give a detailed account of the mathematical formalism for angular momentum and spin, and apply it to quantum mechanical systems
- give a detailed account of the quantum mechanical description of identical particles and apply it to quantum mechanical systems
- demonstrate command of the methods for time-independent and time-dependent perturbation calculation and for calculation of scattering amplitudes
- give an account of the basic problems in interpreting quantum mechanics
- solve a given selection of the problems related to course literature and content.

Course Content
Instruction is in the form of lectures and seminars at which student's present parts of the course literature. The presentations are submitted in writing.

The course deals with non-relativistic quantum mechanics, the theoretical foundation as well as various applications. The following components are included:

- The basic concepts and ideas of quantum mechanics: Hilbert spaces, bra-ket-notation, observables and operators, matrix representation, change of basis, measurement, uncertainty relation, position and angular momentum representation, density matrix
- Quantum dynamics: time development, Schrödinger and Heisenbergpictures, Schrödinger equation, propagators, path integral formalism, gauge transformations
- Theory of angular momentum： Spin, two-particle systems and addition of of angular momentum, finite and infinitesimal rotations, SO(3) and SU(2), Schwinger's oscillator model etc.
- Symmetry in quantum mechanics, correlation with preservations laws, parity, time inversion
- Time-independent and time-dependent perturbation theory
- Identical particles, permutation symmetry, Bose-Einstein and Fermi-Dirac statistics
- Scattering theory.

Reading List
See separate document.

Examination
Assessment is continuous in the form of written and oral seminar presentations and hand-in assignments. There is also a final oral exam.

Course Certificate
A course certificate will be provided upon request.

Quality Assurance
The purpose of the course management is to promote a continuous dialogue on teaching processes and on the fulfillment of learning outcomes. A written evaluation is performed at the end of the course, combined with a discussion between students and teachers of their experiences with all pertinent aspects of the course.
Course evaluations are compiled by the responsible department in accordance with the quality assurance procedures laid down by the Faculty and are made available to the Faculty Board, no later than one semester after completion of the course.

Grades
One of the grades Fail (U) or Pass (G) is awarded in the examination of the course.

Additional information

Reading List

Advanced Quantum Physics, 2FYS001, 7,5 ECTS credits (Post graduate level)
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Sakurai, J J, *Modern Quantum Mechanics*. Last edition, Addison Wesley