UNIVERSITY OF GOTHENBURG

DEPARTMENT OF PHYSICS

FIM660 Quantum Informatics, 7.5 credits

Quantum Informatics, 7,5 högskolepoäng

Second Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2008-11-24 and was last revised on 2018-08-16 to be valid from 2018-08-16, autumn semester of 2018.

Field of education: Science 100%
Department: Department of Physics

Position in the educational system

The course Quantum informatics, 7.5 higher education credits, is a single subject course given within the Physics of materials and biological systems masters program, and is also given as a stand-alone advanced course in physics at the Department of Physics, University of Gothenburg.

The course can be part of the following programmes: 1) Physics and learning, Master's Programme (N2FOL), 2) Complex Adaptive Systems, Master's Programme (N2CAS), 3) Physics of Materials and Biological Systems, Master's Programme (N2PMB) and 4) Physics, Master's Programme (N2PHY)

Main field of studies	*Specialization*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Entry requirements

To be eligible for the course the student must have knowledge in physics equivalent of a Bachelor degree, including knowledge in quantum physics. A familiarity with the Dirac notation of quantum mechanics is helpful but not compulsory.

Applicants must prove knowledge of English: TOEFL test result of at least 600 points (computerized 250 points, on Internet 100 points) or IELTS test result of at least 6.0,

including at least 6.5 for the Writing. This requirement does not apply to students with a Bachelor degree from an English speaking university, or to students having passed English level B at Swedish/Nordic Upper Secondary School.

Learning outcomes

After the course the student is expected to be able to:

- explain the properties of the Jaynes-Cummings model
- use the Bloch equations to describe the dissipative dynamics of a two-level system
- explain the basic features of a quantum measurement process
- analyze the properties of simple quantum algorithms
- communicate the basic features of quantum computing and Shor's algorithm, teleportation and quantum cryptography to a friend

Course content

The aim of the course is to give an introduction to the rapidly growing field of Quantum Informatics, i.e. taking an informatics view on quantum mechanics. The course also aims at giving a basic introduction to the field of quantum optics, since the concepts needed in these fields to a large extent overlap.

The following questions will be discussed:

- What is quantum informatics? An introduction to the topic of quantum informatics and to the format of course.
- Building blocks of quantum mechanics and quantum optics:
  i) two-level systems and the Bloch sphere
  ii) atom-field interaction: Rabi-oscillations and the Jaynes-Cummings hamiltonian
  iii) decoherence
  iv) read-out
- Quantum algorithms: Deutsch-Josza, Quantum Fourier Transform, Shor, Grover
- Potential qubit candidates. DiVincenzos criteria for a realizable quantum computer.
- Quantum communication. Teleportation and cryptation
- Quantum error correction

Form of teaching

The course is given in form of lectures, exercises and laboratory work. The lectures are given in a self-contained form, introducing the necessary notation.

Language of instruction: English

Assessment

The examination will be based on an oral or written exam, weekly hand-ins and a lab rapport.

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
ECTS grades are also given on this course.

Course evaluation

The results of the evaluation will be communicated to the students and will function as a guide for the development of the course.

Additional information

The course is given jointly with Chalmers University of Technology. The Chalmers code for the course is FKA172.