Faculty of Science

FYST85, Physics: Quantum Computation, 7.5 credits

Fysik: Kvantdatorer, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2023-12-06. The syllabus comes into effect 2023-12-06 and is valid from the autumn semester 2024.

General information

The course is an elective course for second-cycle studies for a Degree of Bachelor of Science (180 credits) or Master of Science (120 credits) with a specialisation in physics or mathematics.

Language of instruction: English

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

Learning outcomes

The course aims at giving the participants a basic understanding of central concepts in quantum information science and quantum computing. In the course, quantum mechanics is used to describe information and computation. Special quantum algorithms are studied and experimental platforms for implementing quantum computation is discussed,

Knowledge and understanding

On completion of the course, the student shall be able to:

- explain the principles of single and coupled quantum bits
- apply basic knowledge about quantum gates and elementary quantum circuits
- account for the basic concepts of central quantum algorithms

- demonstrate knowledge about physical systems for the implementation of quantum bits
- account for basic knowledge of errors and error correction.

Competence and skills

On completion of the course, the student shall be able to:

- analyze the properties of simple quantum algorithms
- carry out calculations related to simple quantum information processes
- analyze experimental manipulation of single quantum bits
- alone or in pairs carry out a project work regarding a specific problem task within the field.

Judgement and approach

On completion of the course, the student shall be able to:

- demonstrate insight into how the development of quantum information might affect the information technology area in the future

Course content

The course consists of:

- Introduction to quantum mechanics and computer science.
- Superposition states and entangled states.
- Single and coupled quantum bits.
- Quantum circuits and universal quantum gates.
- The quantum Fourier transform, Shors algorithm of prime number factorization, and the Grover search algorithm.
- Physical implementations of quantum bits and quantum circuits.
- Noise, bit- and phase-errors, and error correction.

Course design

Teaching consists of lectures, projects and laboratory work. Participation in course elements related to projects and laboratory work is mandatory.

Assessment

Examination is in the form of written and oral project reports, assignments and a laboratory session.

For students who have not passed the regular presentation, an opportunity for supplementation is offered by agreement.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
A passing grade on the entire course requires passed laboratory work, paesed project work and passed assignments. The grading scale for laboratory work and assignments is Fail, Pass, while the project work is graded according to the grading scale Fail, Pass, Pass with distinction. The course grade is based on an overall assessment of the written and oral project presentation.

Entry requirements

Admission to the course requires 75 credits in physics and 45 credits in mathematics including knowledge equivalent to FYSB22 Physics: Basic Quantum Mechanics, 7.5 credits and FYSB24 Physics: Atomic and Molecular Physics, 7.5 credits - or a bachelor's degree in physics or equivalent, including knowledge equivalent to FYSB22 Physics: Basic Quantum Mechanics, 7.5 credits. English 6/B and general entry requirements.

Further information

The course replaces FYST30, Physics: Quantum Information, 7.5 credits and cannot be credited in a degree together with this course.

The course is co-taught in its entirety with FAFN41, Quantum Computers, 7.5 credits, which is a course at the Faculty of Engineering, LTH.

The course is given at the Department of Physics, Lund University.