Course syllabus

Kvantinformation
Quantum Information

FAFN40, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Main field: Nanoscience.
Elective for: F4, F4-f, MFOT1, MNAV1, N4
Language of instruction: The course will be given in English

Aim

The course aims at giving the participants a basic understanding of central concepts in quantum information science and quantum computing. Combining quantum mechanics and information science open new avenues and perspectives for processing and communicating data and the students are given the opportunity to reflect on the consequences this may give.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

have acquired

- a good understanding of single and coupled quantum bits
- basic knowledge about quantum gates and elementary quantum circuits
- understanding of the basic concepts in the more wellknown quantum algorithms
- knowledge about physical systems for implementation of quantum bits
- basic knowledge about errors and error correction
- understanding of the connection between the concept of entropi and quantum information

- knowledge of the basic principles for quantum teleportation and quantum cryptography.

Competences and skills
For a passing grade the student must

have acquired the ability to

- analyze the properties of simple quantum algorithms
- carry out calculations related to simple quantum information processes
- analyse manipulation of single quantum bits based on experiment carried out by themsleves
- alone or in pairs carry out a project analysing a specific quantum information problem or task
- alone or in pairs report a project in both written and oral form.

Judgement and approach
For a passing grade the student must

should have obtained some insight on how the developement of quantum information might affect the information technology area in the future.

Contents

Introduction to quantum mechanics and computer science. Single and coupled quantum bits. Quantum circuits and universal quantum gates. The quantum Fourier transform, Shors algorithm of prime number factorization, the Grover search algorithm. The concept of entropy in quantum information. Quantum communication and quantum cryptography. Quantum entanglement and quantum cryptography.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The course is based on lectures, a laboratory exercise, hand-in exercises and a project. To pass the course hand-in exercises, lab report and the written and oral project presentation needs to be approved. Grades, 3, 4 or 5, are primarily decided based on the written project report, but also the oral project presentation can influence the grade if the written report is at the border between two different grades.

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.

Admission

Assumed prior knowledge: Linear algebra, rudimentary quantum mechanics.
The number of participants is limited to: No

Reading list

- Michael A. Nielsen & Isaac L. Chuang: Quantum Computation and Quantum Information. Cambridge University Press, 2000.

Contact and other information

Course coordinator: Andreas Walther, andreas.walther@fysik.lth.se
Course homepage: https://www.atomic.physics.lu.se/education/elective-courses/fyst30-fafn40-quantum-information/