Quantum Computers

Programme course

6 credits

Kvantdatorer

TFYA19

Valid from:

Determined by

Date determined

Main field of study
Applied Physics, Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanoscience, Master's programme
- Materials Science and Nanotechnology, Master's programme
- Applied Physics and Electrical Engineering - International, M Sc in Engineering

Specific information
The course is not available 2017.

Prerequisites
Quantum mechanics, Thermodynamics and statistical mechanics, Quantum dynamics

Intended learning outcomes
The course represents a comprehensive survey on the concept of quantum computing with an exposition of qubits, quantum logic gates, quantum algorithms and implementation. Starting with the main definitions of the theory of computation, the course mostly deals with the application of the laws of quantum mechanics to quantum computing and quantum algorithms. Some related topics concerned mainly to the problem of quantum communication are also be considered. To achieve this aim students should be able to
- know the definition of qubit, quantum logic gates, quantum circuits and quantum algorithms
- understand how quantum parallelism is used in the simplest quantum algorithms such as Deutsch, period finding and quantum Fourier transform
- simulate the Feynman processor numerically
- know the basic requirements for implementation of quantum computers and classify the schemes for implementation of quantum computers
- review the selected original scientific papers about quantum computers and quantum information.

Course content

Computer organization and theory of computation: binary system, Boolean algebra, logic gates, quantum logic gates, algorithms, Turing machines and effective computability.
Quantum mechanics and computers: from bits to qubits, superposition, measurement, classical and quantum coin-tosses, uncertainty principle.
Quantum algorithms: quantum parallelism, discrete Fourier transfom, phase estimation, Shor's factoring and Grover's searching algorithms.
Physical realization of quantum computation: ion trap, cavity QED, nuclear magnetic resonance (NMR) and solid-state-based quantum computers.
Quantum cryptography, quantum teleportation and quantum error correction.

Teaching and working methods

The course contains lectures, solution of home problems, numerical projects, study visit in cryptolab.

Examination

MUN1	Oral examination, solutions of home problems	6 credits	U, 3, 4, 5

Grades

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Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Johansson

Examiner

Iryna Yakymenko

Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html?selection=all&sort=kk

Education components

Preliminary scheduled hours: 40 h
Recommended self-study hours: 120 h

Course literature

I.I. Yakymenko. Lecture Notes on Quantum Computers.
M.A. Nielsen, I.L. Chuang. Quantum computation and quantum information,Cambridge University Press, 2011, 10th ed. (selected chapters), och valda vetenskapliga artiklar.