UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Introduction to quantum computing

86R-XXXVI-IQC

Aims

Describe the main quantum algorithms, including the factorisation and search ones. Outline the physical systems to implement quantum computation.

Contents

In these lectures we present the essential mathematical tools to deal with quantum computation, its formalism and the main quantum algorithms.

- Why quantum computation?
- Binary notation and Dirac formalism for classical logic.
- Quantum bits (qubits).
- Quantum evolution and quantum circuits.
- The standard computational process.
- Deutsch, Deutsch-Josza and Berstein-Vazirani algorithms.
- Grover algorithm for quantum search.
- Quantum Fourier transform (QFT).
- Application of the QFT: the phase estimation protocol.
- Shor algorithm for factorisation.
- Physical realisation of quantum computers and quantum computation.

Detailed program

- Why quantum computation?
- Binary notation and Dirac formalism for classical logic.
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Prerequisites

Basic knowledge of quantum mechanics.

Teaching form

1 CFU, 8-10 hours, language: English.

The lectures will be held using Zoom, here the link and the information to join:

https://us02web.zoom.us/j/84252763970?pwd=L1htZnM1L1d1RTUvRmtELys5amNwZz09

Meeting ID: 842 5276 3970

Passcode: 080509

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Textbook and teaching resource

- "Lecture Notes on Quantum Computing" available on the teacher website (https://sites.unimi.it/olivares/quantum-computing/).
- M. A. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information" (Cambridge University Press).
- N. D. Mermin, "Quantum Computer Science" (Cambridge University Press).
- S. Stenholm and K.-A. Suominen, "Quantum Approach to Informatics" (Wiley-Interscience).
- S. Haroche and J.-M. Raimond, "Exploring the Quantum: Atoms, Cavities, and Photons" (Oxford Graduate Texts).

- J. A. Jones and D. Jaksch, "Quantum Information, Computation and Communication" (Cambridge University Press).
- J. Stolze and D. Suter, " Quantum Computing: A Short Course from Theory to Experiment" (Wiley-VCH).

Semester

May 2021

Assessment method

The exam consists of an oral exam lasting about one hour in which the student describes some aspects of quantum computing (quantum algorithms, physical implementations of quantum computers,...) and proves to have acquired familiarity with the topics covered in the course.

Office hours

By e-mail appointment.