PHYS-641

# Quantum Computing

Savona Vincenzo

| Cursus | Sem. | Type |
|---|---|---|
| Ing.-phys | MA1, MA3 | Opt. |
| Physicien | MA1, MA3 | Opt. |
| Physics | | Opt. |

| | |
|---|---|
| Language of teaching | English |
| Credits | 4 |
| Session | Winter |
| Semester | |
| Exam | Oral |
| Workload | 120h |
| Weeks | 14 |
| **Hours** | **4 weekly** |
| Courses | 2 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |

## Frequency

Every year

## Remark

Next time: Fall

## Summary

After introducing the foundations of classical and quantum information theory, and quantum measurement, the course will address the theory and practice of digital quantum computing, covering fundamental and advanced topics such as recent quantum algorithms and the theory of quantum error correction.

## Content

Introduction

- Crash course on quantum mechanics
- Quantum measurement and interaction with the environment
- Foundations of classical and quantum information theory

Quantum computing
- The quantum circuit model
- Universal quantum gates
- Quantum advantage and the Deutsch-Jozsa algorithm

Overview of quantum algorithms
- The quantum Fourier transform and Shor's factoring algorithm
- The quantum state amplification and Grover's database search algorithm
- The quantum phase estimation and linear system solving
- Digital quantum simulation and unitary time evolution
- The variational quantum eigensolver

Noise in quantum hardware and the digital noise model

Quantum error correction
- The Shor quantum error correction code
- Stabilizer codes
- Fault-tolerant quantum computing

Overview of recent advances in quantum hardware and software

## Learning Prerequisites

### Required courses

Quantum Physics I, Quantum Physics II

## Resources

### Bibliography

M. A. Nielsen & I. L. Chuang, Quantum Computation and Quantum Information (Cambridge, 2011)
John Preskill, Lecture Notes on Quantum Information and Computation

### Ressources en bibliothèque

- M. A. Nielsen & I. L. Chuang, Quantum Computation and Quantum Information (Cambridge, 2011) John Preskill, Lecture Notes on Quantum Information and Computation