

PHYS-641

Quantum Computing

Savona Vincenzo

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Minor in Quantum Science and Engineering	H	Opt.
Physicien	MA1, MA3	Opt.
Physics		Opt.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	4 weekly
Lecture	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

Assessment methods

Oral

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

- [Quantum Computation and Quantum Information /Nielsen](#)

Moodle Link

- <https://go.epfl.ch/PHYS-641>