MICRO-435

# Quantum and nanocomputing

Charbon Edoardo, Graziano Mariagrazia

| Cursus | Sem. | Type |
|---|---|---|
| Microtechnics | MA1, MA3 | Opt. |
| Minor in Quantum Science and Engineering | H | Opt. |
| Quantum Science and Engineering | MA1, MA3 | Opt. |

| | |
|---|---|
| Language of teaching | English |
| Credits | 6 |
| Session | Winter |
| Semester | Fall |
| Exam | Written |
| Workload | 180h |
| Weeks | 14 |
| **Hours** | **6 weekly** |
| Lecture | 4 weekly |
| Exercises | 2 weekly |
| **Number of positions** | |

## Summary

The course teaches non von-Neumann architectures. The first part of the course deals with quantum computing, sensing, and communications. The second focuses on field-coupled and conduction-based nanocomputing, in-memory and molecular computing, cellular automata, and spintronic computing.

## Content

The topics covered by the course are summarized as follows:

- Fundamentals of quantum computing
- Qubit realization & control
- Cryo-CMOS components
- Scalable quantum computers
- Quantum communication, sensing, and metrology
- Nanocomputing based on conduction
- Field coupled nanocomputing (FCN)
- Logic in memory based on magnetic FCN
- BioMolecular Computing
- (Bio)Memristors

## Keywords

Qubit, quantum stack, von Neumann architectures, biomolecular computing, memristors, logic-in-memory, conduction-based computing

## Learning Prerequisites

### Required courses

- Basic mathematics/physics

### Recommended courses

- Basic quantum mechanics
- Solid-state devices
- CMOS circuit design

## Learning Outcomes

By the end of the course, the student must be able to:

- Generalize basic concept of a quantum computer
- Develop simple algorithms
- Design cryo-CMOS circuits and systems
- Contextualise the control and readout of spin qubits
- Elaborate basics of in-memory computing, molecular computing, memristors, and conduction-based computing

## Assessment methods

On-going assesment through homework
Final examination

## Resources

### Bibliography

- N.D. Mermin, â##Quantum Computer Science: An Introduction,â## Cambridge University Press, 5th printing, 2016. ISBN 978-0-521-87658-2
- M.A. Nielsen, I.I. Chuang, â##Quantum Computation and Quantum Informationâ##, Cambridge Press, 3rd printing, 2017. ISBN 978-1-107-00217-3

### Ressources en bibliothèque

- Quantum Computer Science: An Introduction / Mermin
- Quantum Computation and Quantum Information / Nielsen

### Moodle Link

- https://go.epfl.ch/MICRO-435