

CS-630

**Fault-tolerant quantum computing**

Soeken Mathias

Cursus	Sem.	Type
Computer and Communication Sciences		Opt.

Language of teaching	English
Credits	3
Session	
Exam	Project report
Workload	90h
<b>Hours</b>	<b>28</b>
Courses	28
<b>Number of positions</b>	

**Frequency**

Every year

**Remark**

spring 2025

**Summary**

The course explains how to execute scalable algorithms on fault-tolerant quantum computers. It describes error correction used to build reliable logical operations from noisy physical operations, and how quantum programs are mapped into logical operations sets taking into account layout constraints.

**Content**

1. Quantum computing stack, qubits, and quantum states
2. Quantum circuit model
3. Quantum error correction
4. Magic state distillation
5. Layout algorithms
6. Multi-controlled gates
7. Table lookup and state preparation
8. Quantum arithmetic
9. Unitary synthesis
10. Automatic oracle compilation
11. Quantum memory management

**Note**

The course will be self-contained. Familiarity with quantum computation is not necessary although helpful. By the end of the course, the student has a broad overview of the fault-tolerant quantum computing stack and can explain various transformations from one abstraction level to the other

**Keywords**

quantum gates, quantum circuit model, quantum algorithms, physical constraints, compilation

**Resources****Moodle Link**

- <https://go.epfl.ch/CS-630>