Module Name
Quantum Computing

Type of Module	**Module Code**
Advanced Module	AN-QC

Identification Number	**Workload**	**Credit Points**	**Term**	**Offered Every**	**Start**	**Duration**
MSc-I-QC	180 Hours	6 CP	1. – 3. Semester	SuSe	Summer term only	1 Semester

1	**Course Types**	**Contact Time**	**Private Study**	**Planned Group Size**
	a) Lecture	45 h	90 h	No limits
	b) Exercise	15 h	30 h	

2 Module Objectives and Skills to be Acquired

This course will:

- Acquaint participant with a physics, math, or computer science background with the mathematical frameworks of finite-dimensional multi-partite quantum mechanics and of information processing.
- Introduce the paradigmatic phenomena that show the difference between classical and quantum information (Bell inequality violations, entanglement, no-cloning, teleportation…)
- Discuss practically relevant applications such as quantum key distribution and concrete quantum algorithms.

3 Module Content

Background

- Finite-dimensional quantum systems, tensor products, unitary gates, quantum circuits
- Bits, qubits, communication channels, circuit model of computation

Quantum Information

- Bell inequalities, entanglement, no-cloning, quantum teleportation
- Quantum channels and coding
- Quantum key distribution

Quantum Computation

- Grover‘s algorithm
- Shor‘s algorithm
- Brief introduction to quantum and classical complexity theory

4 Teaching Methods

Lecture, Exercise

5 Prerequisites (for the Module)

Formally: None

Regarding the contents: Linear algebra. Basic familiarity with quantum mechanics and computer science are advantageous, but a short introduction to both topics will be given at the beginning of the course.

6	**Type of Examination** One oral or written exam (3 hours) at the end of the semester. To qualify for the exam, students must actively participate in the problem class, solve the homework problems and register for the exam.
7	**Credits Awarded** Passing the final Examination
8	**Compatibility with other Curricula** Master of Science Informatik
9	**Proportion of Final Grade** 6/114
10	**Module Coordinator** Tommaso Calarco, David Gross, Rochus Klesse
11	**Further Information**