GHENT UNIVERSITY

Course Specifications

Valid in the academic year 2023-2024

Quantum Computing: Architecture and Algorithms (E061390)

Course size *(nominal values; actual values may depend on programme)*

Credits 3.0 **Study time 90 h**

Course offerings and teaching methods in academic year 2023-2024

A (semester 1)	English	Gent	seminar	0.0h
			lecture	0.0h
			independent work	0.0h

Lecturers in academic year 2023-2024

Bertels, Koen	TW06	lecturer-in-charge

Offered in the following programmes in 2023-2024	**crdts**	**offering**
Master of Science in Computer Science Engineering	3	A

Teaching languages

English

Keywords

(Perfect) Qubits, quantum logic, quantum computing, Tensor mathematics, quantum circuits

Position of the course

The course gives an introduction and practical use of quantum computing based on normal computer architecture concepts but extended with the use of quantum bits, called qubits, and quantum gates.
The course will describe what the different layers are in a quantum computer architecture and will offer tools to the students based on the public domain platform called Qiskit to write some quantum circuits and execute them on a small set of qubits.
The quantum computing concept is orthogonal to the classical computer architecture where the data is transported to processors and the result of the classical gates is written back to the memory. In quantum computing, the logic is directly applied on the qubits, which is a way to store and represent the data on which one is working.
The execution of quantum algorithms will be on the QBee platform and will assume perfect qubits, rather than physical ones.

Contents

- Quantum computing – basic principles
- Quantum bits – qubits and Quantum gates
- Quantum principles such as superposition, full-entanglement, no-cloning
- Full stack of a quantum accelerator
- Qiskit platform
  - OpenQASM language explanation
  - Quantum circuit examples explained
- Exercises of the Full-Stack and executed on Qiskit, using the Qiskit simulator

Initial competences

Basic knowledge in computer architecture, basic programming skills

Final competences

1 To understand the basics of quantum computing and quantum logic
2 To understand the properties such as superposition, full entanglement of qubits
3 To understand quantum gates, Bloch sphere and quantum circuits
4 To understand basic properties of quantum logic such as non-cloning
5 To understand and implement small quantum circuits on a small number of qubits

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture, Independent work

Learning materials and price

Slides in English will be available

References

E. Desurvire, Classical and Quantum Information Theory, CUP, 2009, 691 p.

Course content-related study coaching

By lecturer and teaching assistants

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Written assessment

Examination methods in case of periodic assessment during the second examination period

Written assessment

Examination methods in case of permanent assessment

Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

- Written, open-book exam: Peer review report on scientific article
- Project work: Graded computer exercises throughout the semester

Calculation of the examination mark

Overall grade consists of 50% exam (peer review report written about a scientific article) and 50% on non-periodic evaluation (computer exercises). A student needs to pass on both parts to pass the course. If the student fails on one of the two parts and if the calculated total score is higher than 10/20, the total grade is reduced to the highest failing mark (9/20).