EuroTeQ Engineering University

Course

Part of the EuroTeQ course catalogue spring/summer 2023

Quantum Programming

Subject area: Computer Science/ICT

University:	CTU
Level:	BA3, BA4, MA all years
Teaching mode:	completely online, part synchronous, part asynchronous
Instructor(s):	Aurél Gábor Gábris (guarantor), Iskender Yalcinkaya

Short description

The goal of the course is to provide the basic skills for programming quantum computers, and to use these skills to develop understanding of fundamental quantum communication protocols and quantum algorithms.

Full description

The course is suitable both for bachelor and master's students from all years and familiarity with quantum mechanics is not necessary. The classes are held entirely online to get the most out of the learning material and make it internationally accessible. The quantum SDK Qiskit will be used during the course. Use of own laptops with the quantum SDK installed before the course start is required.
Outline of the course:

1. Probabilistic and quantum bits, quantum computing SDK
2. Bloch sphere representation of a qubit, general single qubit gates
3. Measurement, cloning, state identification of an ensemble
4. Two qubits, quantum correlations, quantum circuits
5. Quantum communication protocols: quantum teleportation, super dense coding
6. Quantum key distribution protocol: BB84
7. Multi-qubit gates, universal quantum computer
8. Deutsch–Jozsa algorithm, the Oracle
9. Grover's search algorithm
10. Quantum Fourier Transform
11. Quantum phase estimation
12. Shor's factorization, quantum Fourier transformation

Outline of the self-study material and homework:
The self-study materials are derivations of Jupyter notebooks used in QSilver and QBronze events of the non-profit QWorld Association. Students are expected to write code using the Jupyter notebook interface to python and submit them every week as their homework.
Links to course materials available from https://people.fjfi.cvut.cz/gabriaur/02QPROG

Learning outcomes

- Understanding of fundamental principles of quantum computers
- Ability to develop own code for quantum computers using a quantum SDK library

Recommended in particular for students of the following study programmes

Computer science, Physics, Quantum Technologies, Mathematics

General information

Contact hours per week:	2
Total workload:	75 (in student hours for the whole course)
ECTS credits:	3
Language:	English
Course start date:	20 February 2023
Course end date:	28 May 2023
Add. info about start date:	Start date course refers to the date of start of the semester at CTU.
Weekly teaching day/time:	
Time zone:	CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)
Further information:	Lectures are recorded, and are not mandatory to attend real time. Interactive tutorials are recorded and are mandatory to attend.
Prerequisites:	Basic linear algebra Complex numbers
Activities and methods:	Lectures, Self-study, Tutorial sessions
Presence on campus:	

Final examination

Form:	assignment
Date:	
Location/format:	
Re-sit possibility:	yes
Transcript available:	end of semester

Add. info/requirements:

Registration

To register for this course, follow the registration requirements of your **home university** as specified here: www.euroteq.eu/courses-registration.

Administration

Number of places:	not specified
Minimum participants:	not specified
Internal course code:	02QPROG
Contact:	gabris.aurel@fjfi.cvut.cz

This course is part of the EuroTeQ Engineering University joint course catalogue 2023. This is a collaborative activity of the partner universities DTU, L'X, TU/e, TalTech, CTU, TUM as well as Technion. Students from these universities can participate in the offered courses. It is the responsibility of the student to check if you fulfil the requirements to participate in a specific course. Students are also advised to check with their home institution how to get recognition of the ECTS credits gained in courses of the EuroTeQ course catalogue. For further information about EuroTeQ Engineering University, visit www.euroteq.eu or get in touch with the above-mentioned point of contact.