Quantum Informatics Secondary Specialization

MSc Computer engineering

MSc Electrical engineering

Objective

Information technology and telecommunications based on quantum principles are now on the path of technological advances. Quantum computers and test networks are becoming available all over the world. In 2016, the European Union launched a program to gain a competitive edge. This program is growing significantly every year, both in terms of content and funding. Today, more and more multinational companies are hiring experts to prepare for the quantum leap, while more and more start-ups are being created around the world.

The primary objective of the quantum informatics secondary specialization is to train creative engineers who are internationally well-informed in the field, with a good understanding of the principles and practical applications of quantum technologies for domestic companies and enterprises. To this end, we will take an engineering approach to review the physical principles and rules of operation that underpin this field. The hardware solutions for quantum computers and the dominant quantum programming languages are presented. The main algorithms and application areas (data processing, optimization, etc.) will be reviewed. As with traditional computing, quantum computing can be networked to achieve qualitative advances, and students choosing this specialization will be introduced to optical fiber and satellite quantum communication systems, with a particular focus on quantum principles-based cryptography, in addition to the interconnection of quantum computers. In addition to the lectures, students will be introduced to design and analysis exercises. In the laboratory sessions of the specialization, students will gain experience in programming quantum computers with remote access and testing on the home quantum network.

Subjects of the specialization

Quantum computers and their applications

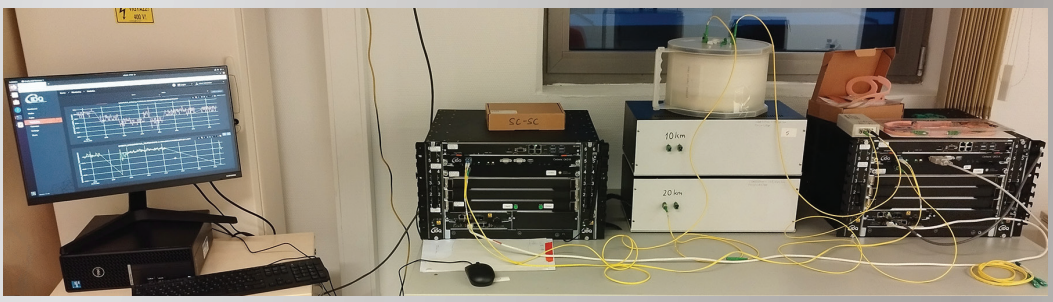
The main objectives of the subject are to provide knowledge of the operation and programming of quantum computers. In this context, students will become familiar with the different quantum computer architectures. On the other hand, the design methodology of quantum algorithms and the most important efficient algorithms will be introduced, as well as the state-of-the-art quantum computer programming languages and systems that allow them to run on quantum computers. Finally, students will be introduced to benchmarking techniques to qualify quantum computing systems.

Quantum networks

The aim of this course is to provide students with knowledge of quantum communications. The aim of the course is to explain the fundamentals of quantum communication networks and to explain the importance and diversity of applications of quantum communication. Following an introduction to the basic concepts of related quantum information theory, the course will provide a thorough overview of quantum communication networks, covering both quantum key distribution (QKD) networks and the so-called "beyond QKD" solutions that are the basis of the future quantum Internet.

Quantum informatics laboratory

The primary objective of the laboratory is to illustrate and deepen the knowledge acquired in the two courses of the quantum computing specialization through personal experience. The laboratory offers the opportunity to try out modern quantum programming paradigms and to test BME's own quantum network systems. Since EU will start the construction of the pan-European quantum network in 2023 and that BME is a key player in this process, we would like to provide an opportunity to get to know the network being built and to gain practical experience.



Project laboratory and diploma thesis

The topics for the project laboratory and diploma thesis are from all the topics of the Department of Networked Systems and Services but typically topics related to quantum computing and quantum communication, as appropriate to the specialization, are usually recommended.

Internships, industrial relations

The Department has traditionally good relations with a number of companies related to the subject of the specialization, which are happy to host students for internships, and diploma theses on company-related topics are often prepared.

Responsible for the secondary specialization

Dr. László Bacsárdi, associate professor

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The Mobile Communications and Quantum Technologies Laboratory

We are focusing on quantum computing, quantum communications (including fiber based quantum key distribution, free-space quantum key distribution, satellite based quantum key distribution, photon based quantum random number generators), 5G solutions (protocols of 5G, 5G and satellite communications), Internet-of-Things (IoT protocols and their applications in different domains including smart homes and agriculture), position based systems (position using wifi and other radio services) and the combination of optical and mobile communications (radio-over-fiber, visible light communication).

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