COURSE DESCRIPTION CARD - SYLLABUS

Course name
Quantum communication [S2ETI2>KK]

Course

Field of study
Education in Technology and Informatics

Year/Semester
1/2

Area of study (specialization)
–

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

2,00

Coordinators

dr Gustaw Szawioła
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Lecturers

Prerequisites

Technical, IT, and mathematical skills in line with the learning outcomes of engineering studies in the field of technical and IT education (first-cycle and second-cycle studies, semester 1), in particular in the areas of quantum computing, advanced mathematics, fiber optic techniques, electrical engineering, and electronics. Openness to expanding one's competences in the field of new technologies. Ability to work in a team.

Course objective

The module presents the physical conditions, limitations, selected solutions, and prospects for the development of quantum communication based on quantum encryption key distribution protocols.

Course-related learning outcomes

Knowledge:
1. Using the concepts and methods of quantum information theory, the student defines the structure, conditions, and limitations of quantum encryption key distribution protocols and systems.
2. The student explains a selected physical implementation of the indicated quantum encryption key distribution protocol, taking into account the impact of the parameters of selected modules on the level of quantum communication security achieved.

Skills:
1. The student analyzes the phases (layers) of a selected quantum encryption key distribution protocol and simulates it using a model of the key layer in the form of quantum circuits
2. The student plans the physical configuration of a demonstration quantum encryption key distribution system and draws up specifications for the physical modules of the selected implementation of this system.

Social competences:
1. The student is aware of the importance and security of IT systems and the dynamics of change in this area driven by advances in quantum technology
2. The student conscientiously, timely, and ethically fulfills their individual and team responsibilities
3. The student is aware of the importance of the role of IT systems in the functioning of modern society and the economy

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture:
- form and components of assessment (percentage): summary test (80%), constructive activity during lectures (20%);
Assessment criteria/assessment: in accordance with the study regulations2. Exercises:
- form and components of assessment (percentage): substantive implementation of the project (50%), individual participation and defense of the project (30%), timeliness 20%;
Assessment criteria/assessment: in accordance with the study regulations

Programme content

1. Elements of classical and quantum information theory.
2. Selected protocols for quantum key distribution.
4. Selected quantum key distribution systems and an outline of their physical implementation.

Course topics

Lecture:
1. Physical foundations and conditions of quantum communication
2. Elements of classical and quantum information theory.
3. Selected protocols for quantum encryption key distribution in implementations on single photons without quantum entanglement
4. Selected protocols for quantum encryption key distribution in implementations on pairs of photons in quantum entangled states.
5. Selected physical implementations of quantum key distribution systems - elements of physical hardware used in QKD systems.
Project:
1. Simulation of the key layer of a selected quantum key distribution protocol using a quantum computer simulator.
2. Design of an educational system for a selected quantum key distribution protocol based on commercially available functional modules.

Teaching methods

1. Lecture: multimedia presentation illustrated with examples given on the board.
2. Project: team project work supported by regular consultations, discussion of solutions, and review of results achieved.

Bibliography

Basic:
1. Ramona Wolf, Quantum Key Distribution, An Introduction With Exercises. Springer Cham 2021
2. Ivan B. Djordjevic, Physical-Layer Security and Quantum Key Distribution, Springer 2019 (w wersji elektronicznej), pozycja dostępna w formie e-booka poprzez E-Zasoby Biblioteki Politechniki Poznańskiej

3. Zasoby: https://quantum.cloud.ibm.com/learning/en oraz https://quantum.cloud.ibm.com/docs/en
4. publikacje oryginalne i przeglądowe z czasopism naukowych

Additional:
1. Gianfranco Cariolaro, Quantum Communications, Springer 2015 (w wersji elektronicznej), pozycja dostępna w formie e-booka poprzez E-Zasoby Biblioteki Politechniki Poznańskiej
2. R. S. Sutor, Dancing with Qubits, Second Edition, Packt Publishing, Birmingham-Mumbai, 2024
3. R. S. Sutor, Dancing with Python. Learn to code with Python and Quantum Computing. Packt Publishing, Birmingham-Mumbai, 2021
4. M. Le Bellac, Wstęp do informatyki kwantowej. PWN 2015, pozycja dostępna w formie e-booka poprzez E-Zasoby Biblioteki Politechniki Poznańskiej

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00