# COURSE DESCRIPTION CARD - SYLLABUS

Course name
Quantum communication systems [S1Cybez1>SKK]

## Course

| Field of study | Year/Semester |
| --- | --- |
| Cybersecurity | 4/7 |
| **Area of study (specialization)** | **Profile of study** |
| – | general academic |
| **Level of study** | **Course offered in** |
| first-cycle | Polish |
| **Form of study** | **Requirements** |
| full-time | elective |

## Number of hours

| Lecture | Laboratory classes | Other |
| --- | --- | --- |
| 16 | 16 | 0 |
| **Tutorials** | **Projects/seminars** | |
| 0 | 0 | |

## Number of credit points

2,00

## Coordinators

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## Lecturers

## Prerequisites

knowledge of the basics of linear algebra, ability to synthesize digital circuits, knowledge of Boolean algebra, basic knowledge in the field of quantum circuits and computations, understanding phenomena of quantum physics

## Course objective

The aim of the course is to present contemporary knowledge in the field of quantum communication, as well as the possibilities and limitations of quantum computers. Students will acquire skills in implementing quantum communication algorithms.

## Course-related learning outcomes

Knowledge:
The student knows the methods of representing the state of qubits, basic quantum gates, understands the consequences of reading the state of a qubit, knows the essence of superposition and entanglement of qubits, the essence of superdense coding and quantum teleportation, knows selected quantum cryptography protocols, knows the consequences of the interaction of a qubit with the environment, understands the need for quantum error correction. [K1_W13]

Skills:
The student is able to design quantum circuits and interpret the logic gates' operations on qubits, and is able to implement both selected quantum cryptography protocols and quantum protection codes. [K1_U02]

Social competences:
The student understands the need to ensure the confidentiality of data transmission and appreciates the possibilities of quantum communication in this area. He also understands the risk of breaking the encryption protocols currently used due to the development of quantum computing. [K1_K05]

## Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written exam with open questions, additional points for active participation in lectures; laboratory grade based on the on-going assessment of completed tasks.
In each form of the course assessment, the grade depends on the number of points the student earns relative to the maximum number of required points. Earning at least 50% of the possible points is a prerequisite for passing. The relationship between the grade and the number of points is defined by the Study Regulations. Additionally, the course completion rules and the exact passing thresholds will be communicated to students at the beginning of the semester through the university’s electronic systems and during the first class meeting (in each form of classes).

## Programme content

quantum gates and circuits, quantum algorithms, quantum cryptography protocols, quantum error correction

## Course topics

Lecture: brief summary of linear algebra and quantum mechanics' principles, review of quantum gates, methods of qubit state representation, quantum primitives, quantum teleportation, superdense coding, quantum encryption key distribution protocols, elements of quantum information theory, quantum data compression, quantum error correction, limitations of quantum computers
Laboratory: introduction (software used in the lab, access to simulators and quantum computers), implementation of selected quantum key distribution and error correction algorithms, observation of quantum phenomena

## Teaching methods

Traditional slide-based lecture, enriched with discussion and demonstration. Laboratory: developing quantum circuits and running them on a simulator and - if possible - on a quantum computer

## Bibliography

Basic:
Ch. Bernhardt, "Obliczenia kwantowe dla każdego", PWN, 2020
Eric R. Johnston, Nicholas Harrigan, Mercedes Gimeno-Segovia, "Komputer kwantowy: programowanie, algorytmy, kod", Helion 2021
Quiskit user's manual (https://docs.quantum.ibm.com/)

Additional:
Noson S. Yanofsky, Mirco A. Mannucci, "Quantum Computing for Computer Scientists", Cambridge University Pres, 2013
On-line course on quantum algorithms provided by IBM (https://learning.quantum.ibm.com/)
Scientific papers suggested by the teacher

## Breakdown of average student's workload

| | Hours | ECTS |
|---|---|---|
| Total workload | 57 | 2,00 |
| Classes requiring direct contact with the teacher | 32 | 1,00 |
| Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation) | 25 | 1,00 |