COURSE DESCRIPTION CARD - SYLLABUS

Course name
Quantum communications [S2Teleinf2-OSB>KK]

Course

Field of study
Teleinformatics

Year/Semester
2/3

Area of study (specialization)
Wireless network softwarization

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
14

Laboratory classes
24

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

The student has knowledge of the design and architecture of programmable digital systems and the possibilities of their practical applications The student has knowledge about modern mobile radio communication systems and modern technologies used in these systems The student has knowledge of digital technology.

Course objective

Understanding the fundamentals and key challenges related to quantum technologies in the context of telecommunications and computing, in particular learning about the key ideas of quantum computing and quantum communication

Course-related learning outcomes

Knowledge:
1. Has broadened and deepened knowledge in some areas of mathematics, including elements of mathematical analysis, stochastic processes, optimization methods and numerical methods necessary for applications in quantum calculations[K2_W01].
2. Has broadened and deepened knowledge of modern solutions related to quantum computing and

communication [K2_W02]
3. Has knowledge in the development of quantum techniques for teleinformatics [K2_W07]
4. Knows advanced methods, techniques and tools used to solve complex engineering tasks and conduct research in a selected area of ICT using quantum techniques [K2_W11]

Skills:
1. Is able to prepare detailed documentation of the results and their discussion for the purposes of applying quantum techniques for teleinformatics [K2_U03]
2. Is able to plan and conduct research experiments in the field of quantum techniques using various theoretical tools [K2_U07]
3. Is able to assess the usefulness and possibility of using new achievements in the field of quantum techniques for teleinformatics [K2_U10]

Social competences:
1. Due to the rapid development of quantum technologies, he is ready to recognize the importance of knowledge in solving non-trivial problems [K2_K01]
2. Is ready to take actions aimed at popularizing the idea of quantum communication [K2_K04]
3. Is able to assess the usefulness and possibility of using new achievements in the area of quantum techniques [K2_U16]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge acquired during the lecture is verified on the basis of a written or oral assessment. It consists of several open questions (typically 4-5) from a list of provided issues, scored differently. The passing threshold is 51% of points.
The skills acquired during laboratory classes are verified on the basis of completed exercises, tasks and mini-projects. It is required to obtain at least 50% of the maximum number of points.
Grading scale: <50% - 2.0 (ndst); 50% to 59% - 3.0 (dst); 60% to 69% - 3.5 (dst+) ; 70% to 79% - 4.0 (db); 80% to 89% - 4.5 (db+); 90% to 100% - 5.0 (bdb).

Programme content

The course focuses on the foundations of quantum techniques, with the main attention paid to quantum computing and communications.

Course topics

Lectures:
1. Basics of quantum techniques: elements of quantum mechanics (quantum states, superposition of states, qubits, evolution of the quantum state, entanglement, decoherence)
2. Quantum software and hardware (quantum gates, basic quantum algorithms, quantum error correction, quantum computer)
3. Quantum cryptography
4. Quantum communication
Laboratory project:
1. Matrices 2. Quantum gates 3. Quantum measurements 4. Schmidt decomposition 5. Discrete Fourier transform
6. An application demonstrating the use of location-based services.

Teaching methods

A traditional form will be used as a basis for presenting lecture content, where the presentations will be displayed using a projector. However, interactive approaches will also be implemented, using problem-based lectures and discussion.

Bibliography

Basic:
1. J. Stolze, D. Suter, "Quantum Computing. A Short Course from Theory to Experiment", Wiley-VCH, 2004

2. M. Le Bellac, "Wstęp do informatyki kwantowej", Wydawnictwo Naukowe PWN, 2011
3. Gawron: Rewolucja Stanu, IITiS PAN, 2016.
4. Zygelman: A First Introiduction to Quantum Computing and Information, Springer 2019.
5. Bernhardt: Quantum Computing for everyone, MIT Press, 2019.
6. Mathematics of Quantum Computing, An Introduction, Springer, 2019

Additional:
1. Wykłady Preskilla: http://theory.caltech.edu/~preskill/ph229
2. Lectures on quantum information, Eds. D. Brus, G. Leuchs, Wiley-Vch 2007
3. M.A. Nielsen, M.A. Chuang, Quantum Information and Computation, Cambridge University Press 2000

Breakdown of average student's workload

	Hours	ECTS
Total workload	103	4,00
Classes requiring direct contact with the teacher	38	1,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50