GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Quantum Computing, PG_00048247		
Field of study	Informatics, Electronics and Telecommunications, Biomedical Engineering, Biomedical Engineering, Biomedical Engineering, Space and Satellite Technologies, Automatic Control, Cybernetics and Robotics		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Optional subject group Specialty subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Algorithms and Systems Modelling -> Faculty of Electronics Telecommunications and Informatics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Krzysztof Giaro	
	Teachers	prof. dr hab. inż. Krzysztof Giaro	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	15.0	0.0	0.0	0.0	30

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 1164 Obliczenia kwantowe 2025
https://enauczanie.pg.edu.pl/2025/course/view.php?id=1164

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	30	4.0	16.0	50

Subject objectives

As a result of a better understanding of the behavior of microscopic objects, scientists at the end of the twentieth century created concepts for the use of microscopic phenomena to the non-classical information processing, communication, computing. These ideas have been extensively developed in the following decades, giving rise to the theory of quantum computers and quantum cryptography. The aim of the course is to present the main ideas of these concepts.

Learning outcomes	

Course outcome	Subject outcome	Method of verification
[K7_W01] knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study	The student understands the geometric properties of unitary spaces, formalism of linear operators, description of the complex system as a tensor product of spaces and operators.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by: - appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation, - application of appropriate methods and tools	Student describes the conception of q-bit and quantum gates. Student explains quantum cryptographic protocols and quantum teleportation.	[SU4] Assessment of ability to use methods and tools
[K7_W02] knows and understands, to an increased extent, selected laws of physics and physical phenomena, as well as methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of technical sciences related to the field of study	The student understands the quantum description of states of physical systems and their evolution modeled using the formalism of Hilbert spaces and the operators.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U12] is able, to an increased extent, to analyze the operation of components and systems related to the field of study, as well as to measure their parameters and study their technical characteristics, and to plan and carry out experiments related to the field of study, including computer simulations, interpret the obtained results and draw conclusions	The student analyzes the operation of quantum gate circuits and the course of quantum protocols, interprets the impact of changes in the states of quantum systems on the results of measurements performed by the user.	[SU1] Assessment of task fulfilment

Subject contents	Course content – lecture 1. History of quantum computing. 2. Linear space. 3. Hilbert space. 4. Linear operators in Hilbert space. 5. Axioms of quantum physics. 6. Quantum bit and register. 7. Quantum gates. 8. Spin, EPR states and quantum and teleportation. 9. Quantum cryptographic protocols. 10. Probabilistic algorithms. 11. Computation with quantum gates. 12. Grovers search algorithm. 13. BBHT search algorithm. Course content – exercises 1. Unitary space geometry. 2. Algebra of matrices and operators. 3. Projections and unitary operators. 4. Subspaces of eigenvectors. 5. Tensor product of vectors and operators. 6. Quantum register and its states. 7. Probabilities of measurement results. 8. Quantum circuits and their functioning.
Prerequisites and co-requisites	Basics of: - Linear Algebra - Probability and Mathematical Statistics - Fundamentals of Algorithm Analysis
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Midterm colloquium	40.0%	100.0%

Recommended reading	Basic literature	N. Nielsen, I. Chuang, Quantum Computation and Quantum Information, Cambridge University Press 2000. J. Gruska, Quantum Computing, McGraw Hill 1999. K. Giaro, Elementy kwantowego modelu obliczeń i algorytmiki kwantowej, OWSIiZ, 2013. M. Hirvensalo, Algorytmy kwantowe, WSiP 2004.
	Supplementary literature	K. Giaro, M. Kamiński, Wprowadzenie do algorytmów kwantowych, Exit 2003 L. Tarasow, Podstawy mechaniki kwantowej, PWN 1984.
	eResources addresses	
Example issues/ example questions/ tasks being completed		

Practical activites within the subject	Not applicable

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