University of Gdańsk

Subject card

Subject name and code	Quantum Computation, PG_00199115						
Field of study	Quantum Information Technology						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study		
Mode of study	full-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		English		
Semester of study	2		ECTS credits		6.0		
Learning profile	academic		Assessment form		exam		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Paweł Mazurek				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	E-learning hours included: 0.0						
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	60		0.0		90.0	150
Subject objectives	To provide the student with information about current state of art in quantum computing, basic algorithms and subroutines, nature of quantum advantage, and operational challanges.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[QITL3_U02] is able to use their knowledge of quantum information technology – formulate and solve complex and unusual problems and innovatively perform tasks in unpredictable conditions by appropriately selecting sources and information derived from them, evaluating, critically analyzing, synthesizing, creatively interpreting, and presenting this information, as well as by selecting and applying appropriate methods and tools, including advanced information and communication techniques and adapting existing methods and tools or developing new ones	The student is able to design, analyze, and implement quantum algorithms and quantum circuits by selecting appropriate computational models, analytical methods, and programming tools, and to critically evaluate their correctness, computational complexity, and applications in quantum information processing.	[SU5] implementation of a problem task
[QITL3_W01] knows and understands in depth selected facts, objects and phenomena, as well as the methods and theories related to them, explaining the complex relationships between them, constituting advanced general knowledge in the field of quantum information technology, as well as the scientific research methodology specific to this discipline and its importance in the context of contemporary directions of development of science and technology	The student has an advanced understanding of the fundamental quantum algorithms as well as their significance for the development of quantum information science, modern quantum technologies, and scientific research in this field.	[SW4] test/exam - oral or written
[QITL3_W02] knows and understands on deepened level key and selected advanced detailed issues in the field of quantum information technology, including methods of their research and development, and their applications in the context of dynamic technological changes, in particular in the area of information processing, cryptography and the development of advanced computing systems	The student has an advanced understanding of quantum computation models, quantum algorithms, quantum error correction, and methods for implementing quantum computation, as well as their significance for the development of information processing technologies and cryptography	[SW4] test/exam - oral or written

Subject contents

Current state of art in quantum computing and challanges. No cloning and basics of quantum error correction. Sets of universal gates for quantum computation. The Deutsch-Josza and Bernstein-Vazirani algorithms. Simon's algorithm and applications to cryptography. The Quantum Fourier Transform. Shor's quantum factoring algorithm. Grover search and approximate counting. Variational Quantum Eigensolver algorithm

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
lecture part: exam	51.0%	50.0%
tutorial part: test	51.0%	50.0%

Recommended reading

Basic literature	Quantum Computation and Quantum Information. Michael A. Nielsen & Isaac L. Chuang (2010). Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge: Cambridge University Press. ISBN: 978-1-107-00217-3.
Supplementary literature	None.
eResources addresses	

Example issues/ example questions/ tasks being completed	1. No-cloning theorem, approximate quantum cloning. 2. Single-qubit gates: representation as rotations on the Bloch sphere, composition of single-qubit operations. 3. Universality of the gate set consisting of Pauli X, Pauli Z, and CNOT — proof. 4. Universality of the gate set {H, S, T, CNOT}, where H is the Hadamard gate, S is the phase gate, and T is the π/8 gate. 5. Simulation of unitary operations up to precision ε: the Solovay–Kitaev theorem and its derivation. 6. Quantum circuit model. 7. Black-box (oracle) model. 8. Deutsch and Deutsch–Jozsa problems. Classical and quantum algorithms, and their computational complexity.
Work placement	Not applicable

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