



Subject card

Subject name and code	, PG_00066247						
Field of study	Technical Physics						
Date of commencement of studies	October 2024	Academic year of realisation of subject				2026/2027	
Education level	first-cycle studies	Subject group				Optional 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	3	Language of instruction				Polish	
Semester of study	5	ECTS credits				2.0	
Learning profile	general academic profile	Assessment form				assessment	
Conducting unit	Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor						
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30		2.0		18.0	50
Subject objectives	Introduction to basic ideas and aspects of quantum information						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, nuclear and elementary particle physics	The student knows and understands the mathematical foundations of quantum mechanics, with particular emphasis on quantum discrete variables. Knows and understands the elements of quantum entanglement description, including their physical specificity, the LOCC paradigm, and Bell's inequalities. Can explain quantum compression, quantum teleportation, and dense coding protocols, selected quantum algorithms, selected quantum cryptography protocols, the concept of quantum channel capacity, and quantum metrology. Can present selected issues of quantum information theory and solve simple problems within its scope			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		
	[K6_U09] uses technical literature in English	The student is able to conduct a search in specialist English language literature on quantum information. He is able to familiarize himself with the content of a specialist article, in particular to identify the most important information from the point of view of current scientific needs.			[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools		

Subject contents

Course content – lecture

Elements of the Hilbert space formalism.

Axioms of quantum mechanics

Quantum interference and its consequences.

The concept of qubit

Complementary bases and quantum uncertainty principle

No-cloning theorem

BB84 protocol. Bennett-Brassard-Mermin (BBM 1992) protocol

Quantum systems consisting of subsystems quantum entanglement and quantum witnesses .

The concept of quantum state and its two interpretations

Bloch sphere and purity of a quantum state

Entanglement measures

Paradigms of LOCC i SLOCC.

Quantum teleportation and quantum dense coding.

Multipartite quantum information. The classes of W and GHZ.

Distillation of quantum entanglement

Local hidden variable model and Bell inequalities.

Scheme of quantum compression of Shumacher.

Quantum channels and their capacity.

Universal quantum gates.

Deutsch-Jozsa algorithm

Bernstein-Vazirani algorithm

Grover's algorithm and remarks on other quantum algorithms

The concept of quantum metrology and quantum Fisher information.

Metrological bounds of (i) shot noise limit (ii) Heisenberg limit.

Prerequisites and co-requisites	Fundamentals of algebra and mathematical analysis. Knowledge of the basic course in quantum mechanics.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	passing the class	50.0%	100.0%
Recommended reading	Basic literature	1) Quantum computing and quantum information (ang.), Michael Nielsen and Isaac Chuang, Cambridge University Press (2000) 2) An introduction to quantum algorithms, Krzysztof Giaro, Marcin Kamiński, Akademicka Oficyna Wydawnicza, EXIT, Warszawa 2003.	
	Supplementary literature	Quantum metrology from a quantum information science perspective, Geza Toth, Iago Apellaniz, J. Phys. A: Math. Theor. 47, 424006 (2014), https://iopscience.iop.org/article/10.1088/1751-8113/47/42/424006	
	eResources addresses		
Example issues/ example questions/ tasks being completed	<p>Discuss the steps of the protocol of quantum teleportation</p> <p>Present Grover's algorithm and explain how it works.</p> <p>Discuss Bell-CHSH inequality together with the concept of local hidden variables.</p>		
Practical activities within the subject	Not applicable		

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