University of Gdańsk

Subject card

Subject name and code	Laboratory of Quantum Information, PG_00182344						
Field of study	Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study 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	2		Language of instruction		Polish		
Semester of study	4		ECTS credits		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector						
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	0.0	0.0	30.0	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		0.0	45.0		75
Subject objectives	Familiarizing students with available software for studying the properties of quantum systems for information processing and performing computations.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZMU2_W05] knows the theoretical foundations of computational methods and IT techniques used to model and simulate physical systems	The student knows/understands: – the basic formalism used in quantum information theory, – the basic quantum protocols used for information transfer, cryptography, and computation, – the concepts of quantum computing along with the differences compared to classical computing, – online platforms for numerical and symbolic analysis of quantum systems in the context of quantum information theory.	[SW5] implementation of a problem task
	[FIZMU2_U04] can find the necessary information in professional literature, both in databases and in other sources; can reconstruct the reasoning or the course of an experiment described in the literature, taking into account the assumptions and approximations made	The student is able to: – apply the theory presented during the lecture to numerically solve problems in quantum information, – use available online software to study basic quantum systems in the context of quantum information theory, – independently write basic numerical codes in Python to analyze the properties of simple quantum systems in the context of information-theoretic applications.	[SU5] implementation of a problem task
	[FIZMU2_K01] knows the limitations of his own knowledge and skills; can formulate questions precisely; understands the need for further education and other	The student: – has practical competences to engage in discussions on quantum information theory, – is able to carry out reasoning that demonstrates the importance of the development of quantum theories together with their experimental applications for modern society, – understands the important role played by numerical methods and open-source software in disseminating knowledge and skills in quantum information theory within society, – understands the need for continuous education, improvement of computer skills, and the ability to use them also in the context of teaching others and advancing the discipline.	[SK1] oral statement/conversation/ discussion
	[FIZMU2_U09] can work independently or in a team	The student is able to: – use available online software to study basic quantum systems in the context of quantum information theory, – independently write basic numerical codes in Python to analyze the properties of simple quantum systems in the context of information-theoretic applications.	[SU5] implementation of a problem task
	[FIZMU2_W01] has advanced knowledge of general physics and in-depth knowledge of various areas of physics; knows the history of the development of physics and its importance for the progress of exact and natural sciences, cognition of the world and social development	The student knows/understands: – the basic formalism used in quantum information theory, – the basic quantum protocols used for information transfer, cryptography, and computation, – the concepts of quantum computing, including differences compared to classical computing, – the limitations of the methods discussed, – online platforms for numerical and symbolic analysis of quantum systems in the context of quantum information theory.	[SW5] implementation of a problem task

Course outcome	Subject outcome	Method of verification
[FIZMU2_U07] is able to present the results of research (experimental, theoretical or numerical) in written, oral, multimedia presentation or poster form	The student is able to: – use available online software to study basic quantum systems in the context of quantum information theory, – independently write basic numerical codes in Python to analyze the properties of simple quantum systems in the context of information-theoretic applications.	[SU5] implementation of a problem task
[FIZMU2_U03] is able to make a critical analysis of the results of measurements, observations or theoretical calculations along with the assessment of the accuracy of the results	The student is able to: – perform testing of numerical programs for studying basic quantum systems in the context of quantum information theory.	[SU5] implementation of a problem task
[FIZMU2_W07] knows the principles of occupational health and safety to the extent that allows for independent work in the area corresponding to the discipline	The student knows the rules of working in a computer laboratory.	[SW1] oral statement/ conversation/discussion
[FIZMU2_W06] has knowledge of the current directions of development of physics and fundamental dilemmas of modern civilization	The student knows the basic algorithms of Quantum Computing and their complexity.	[SW5] implementation of a problem task
[FIZMU2_W04] knows the principle of operation of measuring systems and research equipment specific to the area of physics related to the selected specialization or knows advanced methods of theoretical and mathematical physics	The student knows/understands: – the basic quantum protocols used for information transfer, cryptography, and computation, – online platforms for numerical and symbolic analysis of quantum systems in the context of quantum information theory.	[SW5] implementation of a problem task
[FIZMU2_U01] is able to apply the scientific method in solving physical problems, conducting experiments and reasoning	The student is able to: – use available online software to study basic quantum systems in the context of quantum information theory, – independently write basic numerical codes in Python to analyze the properties of simple quantum systems in the context of information-theoretic applications.	[SU5] implementation of a problem task
[FIZMU2_W03] knows experimental, observational and numerical techniques to plan and perform a complex physics experiment or computer simulation	The student knows/understands: – the basic formalism used in quantum information theory, – the basic quantum protocols used for information transfer, cryptography, and computation, – the concepts of quantum computing, including differences compared to classical computing, – the limitations of the methods discussed, – online platforms for numerical and symbolic analysis of quantum systems in the context of quantum information theory.	[SW5] implementation of a problem task

Subject contents	**Using available online software (e.g., Qiskit) to implement basic algorithms and processes presented in the lectures, including:** visualization of the Bloch sphere and qubit states, along with their transformations, numerical determination of qubit energy levels, numerical simulation of quantum gate dynamics and measurement, two-qubit quantum gates, quantum teleportation and dense coding, key distribution, Shors and Grovers algorithms, phase estimation.
Prerequisites and co-requisites	Knowledge of the basics of quantum mechanics, including fundamentals of algebra and mathematical analysis. Knowledge of the basics of classical information theory. Ability to program in Python.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
not applicable	51.0%	100.0%

Recommended reading	Basic literature	Nielsen and Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press; Michel Le Bellac, *Introduction to Quantum Computing*, Państwowe Wydawnictwo Naukowe; John Watrous, Lecture Notes, https://cs.uwaterloo.ca/~watrous/QC-notes/; Selected scientific articles provided by the lecturer(s).
	Supplementary literature	None
	eResources addresses	
Example issues/ example questions/ tasks being completed	none	
Work placement	Not applicable	

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