

Subject card

Subject name and code	Mathematical Methods of Quantum INformation, PG_00158897						
Field of study	Mathematical Methods of Quantum Information						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2025/2026		
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	1		ECTS credits		6.0		
Learning profile	academic		Assessment form		exam		
Conducting unit	Faculty of Mathematics, Physics and Informatics Office -> 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	30.0	30.0	0.0	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		30.0	90
Subject objectives	The aim of this lecture is to provide students with mathematical knowledge to understand basic concepts of quantum information theory as well as formulate and solve problems within this theory. Physical motivation and intuition behind the structures is provided in the accompanying course Introduction to Quantum Mechanics.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[QITL3_U06] is able to adapt to related scientific disciplines the knowledge and theoretical methods and methodology of physics		Student can model problems of communication, cryptography, secret sharing, measurement and computing.		[SU4] test/egzamin - ustny lub pisemny		
	[QITL3_W04] knows advanced methods of theoretical and mathematical physics necessary in creating models of quantum mechanics		Student knows and can apply structures of linear algebra and functional analysis in modeling quantum mechanics		[SW4] test/egzamin - ustny lub pisemny		
	[QITL3_W02] has in-depth knowledge in the field of advanced mathematics and mathematical and computer methods, necessary to solve physical problems of medium complexity, and advanced knowledge in the area of quantum information and its technological aspects		Student can model and solve problems associated with basic quantum systems using Mathematica software and QuTiP library		[SW4] test/egzamin - ustny lub pisemny		
Subject contents	Basic concepts of linear algebra: linear space, linear operator, matrix calculus Basic concepts of functional analysis: Banach and Hilbert spaces, bounded and unbounded operators, differe similar operators, spectral theorem, functional calculus, positive definite operators POVM and quantum measurement Tensor products of Banach spaces and Hilbert spaces, operators on tensor products, Schmidt decomposition mathematical definition of entanglement, PPT states Fock space, CCR and CAR relations Positive and fully positive maps on matrix algebras: k-positivity, decomposability, entanglement witnesses Quantum channels, capacity of quantum channels, additivity problem Tensor products of positive maps and entanglement distillation, bound entanglement						

Prerequisites and co-requisites	No formal requirements		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	tutorial part: test	51.0%	50.0%
	lecture part: exam	51.0%	50.0%
Recommended reading	Basic literature	O. Bratteli, D Robinson, Operator algebras and statistical mechanics vol. E. Stormer, Positive maps on operator algebras M. Hayashi, Quantum information theory. Mathematical foundation B.C. Hall Quantum theory for mathematicians"	
	Supplementary literature	None	
	eResources addresses		
Example issues/ example questions/ tasks being completed			
Work placement	Not applicable		

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