

Subject card

Subject name and code	Mathematical Methods of Quantum Information, PG_00205752						
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 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			English		
Semester of study	1	ECTS credits			7.0		
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	60.0	0.0	0.0	0.0	90
	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	90		0.0		85.0	175
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_W01] knows and understands in depth selected facts, objects, and phenomena, as well as the methods and theories explaining the complex relationships between them, constituting advanced general knowledge in the field of quantum information technologies.						
	[QITL3_U02] is able to use their knowledge of quantum information technologies – formulate and solve complex and unusual problems and perform tasks innovatively in unpredictable conditions by appropriately selecting sources and information derived from them, evaluating, critically analyzing, synthesizing, creatively interpreting, and presenting this information.						

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, different 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
	lecture part: exam	51.0%	50.0%
	tutorial part: test	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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