University of Gdańsk

Subject card

Subject name and code	Probability and Information Theory, PG_00205753		
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	1	ECTS credits	7.0
Learning profile	academic	Assessment form	exam
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Marek Winczewski	
	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 specific knowledge of probability theory and statistics necessary to understand some aspects of quantum mechanics and quantum information theory. The student will also acquire basic knowledge in the field of application of the main concepts of information theory such as entropy, mutual information or relative entropy and their properties. The student will also learn the capacities of communication channels and methods of estimating them.

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	1. Basic notions of probability: probability space, standard normal distribution, random variable, expected value, variance.2. Density function and the cumulative distribution function, independence of random variables.3. Bayes theorem.4. Law of large numbers and the central limit theorem for indenepent and identically distributed random variables.5. Shannon entropy function, its interpretation and properties.6. Entropy functions of many variables, including conditional entropy, mutual information, relative entropy, conditional mutual information and theirproperties, including data processing inequality and the chain principle for conditional mutual information.7. Asymptotic Equipartition Property theorem, compression codes , error correction codes.8. The concept of typical and total typical sequences, Shannon's theorem on the capacity of a communication channel, random code technique9. Capacities of selected communication channel and Slepian-Wolf theorem on joint coding10. Kraft and Mc Millan inequality
Prerequisites and co-requisites	None.
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	E. Shannon, W. Weaver The Mathematical Theory of CommunicationThomas M. Cover, Joy A. Thomas Elements of Information theoryR. W. Yeung A First Course in Information TheoryM. Nielsen, I. Chuang Quantum Information and Computation
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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