

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	<p>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 independent 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 their properties, 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</p>											
Prerequisites and co-requisites	None.											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>lecture part: exam</td> <td>51.0%</td> <td>50.0%</td> </tr> <tr> <td>tutorial part: test</td> <td>51.0%</td> <td>50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	lecture part: exam	51.0%	50.0%	tutorial part: test	51.0%	50.0%
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Recommended reading	<p>Basic literature</p> <p>Supplementary literature</p> <p>eResources addresses</p>	<p>E. Shannon, W. Weaver The Mathematical Theory of Communication Thomas M. Cover, Joy A. Thomas Elements of Information theory R. W. Yeung A First Course in Information Theory M. Nielsen, I. Chuang Quantum Information and Computation</p> <p>None.</p>										
Example issues/ example questions/ tasks being completed												
Work placement	Not applicable											

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