

**Subject card**

<b>Subject name and code</b>	Signatures of Nonclassicality, PG_00199713						
<b>Field of study</b>	Quantum Information Technology						
<b>Date of commencement of studies</b>	October 2026	<b>Academic year of realisation of subject</b>			2026/2027		
<b>Education level</b>	Master's studies	<b>Subject group</b>			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
<b>Mode of study</b>	full-time studies	<b>Mode of delivery</b>			at the university		
<b>Year of study</b>	1	<b>Language of instruction</b>			English		
<b>Semester of study</b>	2	<b>ECTS credits</b>			6.0		
<b>Learning profile</b>	academic	<b>Assessment form</b>			exam		
<b>Conducting unit</b>							
<b>Name and surname of lecturer (lecturers)</b>	<b>Subject supervisor</b>		dr Beata Zjawin				
	<b>Teachers</b>						
<b>Lesson types</b>	<b>Lesson type</b>	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	<b>Number of study hours</b>	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
<b>Learning activity and number of study hours</b>	<b>Learning activity</b>	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	<b>Number of study hours</b>	60		0.0		90.0	150
<b>Subject objectives</b>	Get acquainted with the concept of nonclassical phenomena as a fundamental property of Nature. Learn about the traditional phenomena of Entanglement and Bell nonclassicality, the recently reformulated notions of Steering and Kochen-Specker contextuality, and the newly identified phenomena of Spekkens contextuality and Network nonclassicality. Understand not only the foundational implications of these nonclassical phenomena, but also their role as resources for information processing.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[QITL3_W02] knows and understands on deepened level key and selected advanced detailed issues in the field of quantum information technology, including methods of their research and development, and their applications in the context of dynamic technological changes, in particular in the area of information processing, cryptography and the development of advanced computing systems		
	[QITL3_U02] is able to use their knowledge of quantum information technology – formulate and solve complex and unusual problems and innovatively perform tasks in unpredictable conditions by appropriately selecting sources and information derived from them, evaluating, critically analyzing, synthesizing, creatively interpreting, and presenting this information, as well as by selecting and applying appropriate methods and tools, including advanced information and communication techniques and adapting existing methods and tools or developing new ones		
	[QITL3_W01] knows and understands in depth selected facts, objects and phenomena, as well as the methods and theories related to them, explaining the complex relationships between them, constituting advanced general knowledge in the field of quantum information technology, as well as the scientific research methodology specific to this discipline and its importance in the context of contemporary directions of development of science and technology		
Subject contents	<p>Entanglement theory: bipartite and multipartite entanglement; separability criteria; entanglement distillation and monogamy; applications (e.g., teleportation). Bell nonclassicality: Bells theorem; Fines theorem; Bell inequalities; Entanglement vs. Bell nonclassicality; bipartite and multipartite Bell scenarios; activation of Bell nonclassicality; the geometry of correlations (No-Signalling and Classical polytopes, the quantum set); applications. Contextuality: Kochen-Specker contextuality; state dependent vs. state independent contextuality; inequalities from hypergraphs; Spekkens contextuality; applications. Steering: bipartite and multipartite steering; steering inequalities; applications. Network nonclassicality: brief introduction to networks, examples, and applications</p>		
Prerequisites and co-requisites	None.		
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	R. Horodecki, P. Horodecki, M. Horodecki, and K. Horodecki. Quantum entanglement, Rev. Mod. Phys. 81, 865 (2009).N. Brunner, D. Cavalcanti, S. Pironio, V. Scarani, and S. Wehner. Bell nonlocality, Rev. Mod. Phys. 86, 419 (2014).D. Cavalcanti and P. Skrzypczyk. Quantum steering: a review with focus on semidefinite programming, Rep. Prog. Phys. 80, 024001 (2017).A. Cabello, S. Severini, and A. Winter. (Non-)Contextuality of Physical Theories as an Axiom, arXiv: 1010.2163 (2010).A. Acín, T. Fritz, A. Leverrier, and A. B. Sainz. A Combinatorial Approach to Nonlocality and Contextuality, Comm. Math. Phys. 334, 533 (2015).R. W. Spekkens. Contextuality for preparations, transformations, and unsharp measurements, Phys. Rev. A 71, 052108 (2005).C. Branciard, D. Rosset, N. Gisin, and S. Pironio. Bilocal versus non-bilocal correlations in entanglement swapping experiments, Phys. Rev. A 85,032119 (2012).T. Van Himbeeck, et al. Quantum violations in the Instrumental scenario and their relations to the Bell scenario, Quantum 3, 186 (2019).
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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