University of Gdańsk

Subject card

Subject name and code	Categorical Quantum Mechanics, PG_00158052		
Field of study	Quantum Information Technology		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	Master's studies	Subject group	
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	English
Semester of study	3	ECTS credits	6.0
Learning profile	academic	Assessment form	exam
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. John Selby	
	Teachers	dr hab. John Selby Matthias Salzger Sina Soltani	

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

This course aims to introduce you to an exciting new approach to understanding and using quantum theory, based entirely on a pictorial representation of quantum processes. On the one hand, these diagrams prove an intuitive way to understand quantum phenomena and protocols, and, on the other hand, they provide powerful mathematical techniques for proving new results. This diagrammatic approach to quantum theory finds important applications both within the foundations of physics as well as increasingly within the quantum industry.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[QITL3_W06] has knowledge of current directions in the development of physics, in particular in the field of quantum information theory	The student knows and understands the basic concepts and terminology used in diagrammatic quantum theory.	[SW4] test/exam - oral or written
[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	The student has advanced knowledge of the mathematical foundations of categorical quantum mechanics and of formal methods for describing quantum processes using monoidal categories and string diagrams, enabling the analysis of problems in quantum information.	[SW4] test/exam - oral or written

Subject contents

1. The basics of diagrams
2. Pure quantum theory in diagrams
3. ZX calculus as a complete diagrammatic tool
4. Mixed quantum theory in diagrams
5. Interacting quantum and classical theory in diagrams

<table>
<tr><td>Prerequisites and co-requisites</td><td></td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<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>
</table>
</td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Coecke, B., & Kissinger, A. (2017). Picturing Quantum Processes: A First Course in Quantum Theory and Diagrammatic Reasoning. Cambridge: Cambridge University Press. doi: 10.1017/9781316219317
2. Coecke, B., & Gogioso, S. (2023). Quantum in Pictures: A New Way to Understand the Quantum World. Cambridge Quantum. ISBN-10:1739214714</td></tr>
<tr><td>Supplementary literature</td><td>None.</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td></td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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