University of Gdańsk

Subject card

Subject name and code	Introduction to Quantum Mechanics, PG_00205751						
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							
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 course is to provide the student with the motivation behind postulates and tools of Quantum Mechanics, starting with two level photonic systems: polarization of a monochromatic electromagnetic wave and Malus law. Rigorous mathematical constructions are provided in the accompanying course Mathematical Methods of Quantum Information.						

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 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	The student understands the fundamental concepts, models, and phenomena of quantum mechanics and their significance for quantum information science, quantum technologies, and contemporary scientific research.	[SW4] test/exam - oral or written
[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	The student is able to apply the mathematical formalism of quantum mechanics to formulate and solve problems involving quantum states, measurements, and the dynamics of quantum systems, selecting appropriate theoretical methods and computational tools for their analysis.	[SU4] test/exam - oral or written

Subject contents

* Inconsistencies in Classical Physics: Blackbody Radiation. Quantum Theory of Light and Plancks distribution, Photoelectric Effect, Compton Effect.

* Wave Nature of Matter : De Broglie Hypothesis. Wave-Particle Duality. Probability. Wave Amplitude and Wave Functions. Heisenbergs Uncertainty Principle. Single slit diffraction and the double slit experiment. MachZehnder interferometer.

* Basic Postulates and Formalism: Energy and Momentum Operators. Schrödinger Wave Equation. Properties and Interpretation of Wave Function and Probabilities. Linearity, Superposition and Collapse of wave functions. Eigenvalues, Eigenfunctions and Expectation Values.

* Applications of Schrodinger Equation: One dimensional box, Harmonic Oscillator, and Hydrogen Atom.

* Scattering Problems: Probability current and continuity equation. Tunnelling through Finite Potential Step, Attractive and Repulsive potential barriers.

* Approximation methods for stationary states: Time independent perturbation theory and its applications in atomic physics. Space quantization of angular momentum, Zeeman Effects and Spin angular momentum. Larmors precession.

* Diracs matrix Notation. Second quantization of harmonic oscillator. Ladder operators and their algebra.

* Quantum Entanglement and Bell Inequality. PPT criterion for entangled states and negativity.

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	Principles of Quantum Mechanics, Ramamurti Shankar Quantum Computation and Quantum Information, Michael Nielsen, Isaac Chuang
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed	**1. Foundations of Quantum Mechanics: From Classical Physics to the Schrödinger Equation** Discuss how the failure of classical physics led to the development of quantum mechanics. **2. Quantum Dynamics, Bound States, and Approximation Methods** Discuss the mathematical formalism used to describe quantum systems and its application to typical quantum-mechanical problems. 3. **Quantum Transport, Interference, and Quantum Correlations** Explain how quantum mechanics predicts phenomena that have no classical counterpart.	
Work placement	Not applicable	

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