University of Gdańsk

Subject card

Subject name and code	Introduction to Quantum Mechanics, PG_00158044		
Field of study	Quantum Information Technology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2024/2025
Education level	postgraduate 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	6.0
Learning profile	academic	Assessment form	
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	dr Ankit Kumar	
	Teachers	Matthias Salzger dr Ankit Kumar	

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

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] has extended knowledge in the field of general physics and advanced knowledge in the area of quantum information theory; knows the history of the development of quantum information theory and its importance for the progress of science, knowledge of the world and social development	Students know history of Quantum Mechanics and understands its experimental manifestations. Student understands the difference between resources provided by classical and quantum systems.	[SW4] test/exam - oral or written
[QITL3_U01] is able to apply the scientific method in solving physical problems and reasoning in the field of quantum information theory	Student understands the connection between mathematical formalism and physical motivations of Quantum Mechanics, in particular is aware of quantum nature of photonic experiments	[SU4] test/exam - oral or written
[QITL3_W06] has knowledge of current directions in the development of physics, in particular in the field of quantum information theory	The student is aware about experiments, simullations and connection to mathematical formalism in the context of quantum correlations and Bell non-locality.	[SW4] test/exam - oral or written

<table>
<tr><td>Subject contents</td><td>* 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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>None.</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>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>Principles of Quantum Mechanics, Ramamurti Shankar

Quantum Computation and Quantum Information, Michael Nielsen, Isaac Chuang</td></tr>
<tr><td>Supplementary literature</td><td>None.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
</table></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>
</table>

Document generated electronically. Does not require a seal or signature.