Subject card

Subject name and code	Quantum Mechanics, PG_00182263					
Field of study	Physics					
Date of commencement of studies	October 2026		Academic year of realisation of subject		2028/2029	
Education level	Bachelor'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	3		Language of instruction		Polish	
Semester of study	5		ECTS credits		9.0	
Learning profile	academic		Assessment form		exam	
Conducting unit	Faculty of Mathematics, Physics and Informatics -> Rector					
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Wiesław Laskowski				
	Teachers					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	60.0	60.0	0.0	0.0	0.0	120
	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	120	0.0	105.0	225	
Subject objectives	Presentation of one of the most fundamental physical theories describing the microworld, together with its methods. The course includes learning the mathematical language of quantum theory. The postulates of quantum mechanics lead to a probabilistic description of phenomena, in contrast to the intuition of classical physics. Therefore, the lectures present numerous solved examples along with their interpretation, enabling students to develop the ability to analyze results and gradually acquire quantum-mechanical intuition.					

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_W06] knows and understands the principles of non-relativistic or relativistic mechanics	The student knows the basic elements of relativistic quantum mechanics (Klein–Gordon and Dirac equations) and their significance for the description of elementary particles.	[SW4] test/exam - oral or written
	[FIZL3_W10] has advanced knowledge of the elementary components of matter and the types of fundamental interactions between them, of the manifestations of these interactions in phenomena occurring on various scales from subatomic to astronomical, knows the time and energy scales associated with these phenomena	The student knows the Schrödinger equation and its applications to the description of free particles, bound states, and scattering processes; understands the quantum description of motion in a central potential, in particular the structure and spectrum of the hydrogen atom; knows basic approximate methods (perturbation theory, variational method, WKB approximation) and their applications to the description of real physical systems; understands the role of electromagnetic interactions in quantum systems, including the motion of a charged particle in an electromagnetic field;	[SW4] test/exam - oral or written
	[FIZL3_U06] can use the formalism of quantum physics to describe physical phenomena in the microworld	The student is able to apply the formalism of quantum mechanics to analyze and describe physical phenomena in the microworld, formulate and solve simple quantum problems, and interpret the obtained results in physical terms.	[SU4] test/exam - oral or written [SU5] implementation of a problem task
	[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world	The student knows the postulates of quantum mechanics and understands their consequences in the form of a probabilistic description of physical phenomena; understands the principle of superposition and its significance for the description of quantum states; knows the formalism of Hilbert space, operators, and observables, including the uncertainty principle; understands the significance of different formulations (Schrödinger, Heisenberg, and interaction pictures) for the development of quantum theory; knows the solution of the harmonic oscillator problem, the role of creation and annihilation operators, and the concept of coherent states; knows the theory of angular momentum, the properties of spin, and the rules of angular momentum addition; understands the significance of historical experiments (e.g. the double-slit experiment, the Elitzur–Vaidman experiment) for shaping the concepts of quantum mechanics.	[SW4] test/exam - oral or written

<table>
<tr><td>Subject contents</td><td colspan="2">

1. An intuitive introduction to quantum mechanics (double-slit experiment, composition of amplitudes, quantum interference illustrated by the ElitzurVaidman experiment).
2. Postulates of quantum mechanics. Hilbert space of quantum states. Principle of superposition. Quantum observables. Elements of measurement theory. Uncertainty principle. Time evolution of a system.
3. Wave function and the Schrödinger equation. Linearity of the Schrödinger equation and its consequences.
4. Time evolution of a quantum system in the case of time-independent and time-dependent Hamiltonians. Continuity equation. Schrödinger, Heisenberg, and interaction pictures.
5. Solutions of the Schrödinger equation: free particle, bound states in a potential well, scattering states.
6. The harmonic oscillator. Creation and annihilation operators. Coherent states.
7. Quantum theory of angular momentum. Spin. Addition of angular momenta.
8. Motion in a central potential. The hydrogen atom model.
9. Motion of a charged particle in an electromagnetic field.
10. Approximate methods of solving the Schrödinger equation: time-independent perturbation theory, variational method, WKB approximation.
11. Time-dependent perturbation theory.
12. Elements of relativistic quantum mechanics. KleinGordon and Dirac equations.

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<tr><td>Prerequisites
and co-requisites</td><td colspan="2">not applicable</td></tr>
<tr><td>Assessment methods
and criteria</td><td colspan="2">

Subject passing criteria	Passing threshold	Percentage of the final grade
	51.0%	50.0%
	51.0%	50.0%

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<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. S. Kryszewski, Mechanika kwantowa, Wydawnictwo UG, 2018
2. R. P. Feynman, The Feynman Lectures on Physics, Vol. III: Quantum Mechanics, AddisonWesley, 1965
3. J. J. Sakurai, Jim Napolitano Modern Quantum Mechanics, Cambridge University Press, 2017</td></tr>
<tr><td>Supplementary literature</td><td>not applicable</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="2">not applicable</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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