



## Subject card

Subject name and code	Quantum mechanics, PG_00064044						
Field of study	Technical Physics						
Date of commencement of studies	October 2026	Academic year of realisation of subject				2028/2029	
Education level	first-cycle 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				5.0	
Learning profile	general academic profile	Assessment form				exam	
Conducting unit	Department of Theoretical Physics and Quantum Computing -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Marek Czachor					
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	30.0	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		5.0		30.0	125
Subject objectives	Introduction to basic structures of quantum mechanics						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_U02] is able to analyse and solve complex and non-standard scientific and technical problems using appropriate analytical, computational, numerical, simulation or experimental methods.	Student: Derives the basic properties of the Schrödinger equation Solves the Schrödinger equation for a harmonic oscillator and 1/r potential using the method of creation and annihilation operators Derives the basic properties of the orbital angular momentum operator and related eigenproblems Derives the properties of the tensor product using the example of n q-bits			[SU1] Assessment of task fulfilment		
	[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	Quantum mechanics is a common element of many fields of science and facilitates a structured approach to them.			[SW1] Assessment of factual knowledge		

Subject contents	<p>Course content – lecture</p> <ol style="list-style-type: none"> <li>1. Introduction to quantum structures in classical systems (Schrödinger and Heisenberg equations, commutators, complex representation of states, rules of conservation of scalar products - all of these as structures appearing in classical mechanics).</li> <li>2. Methods for solving the Schrödinger equation using matrix examples.</li> <li>3. Probabilistic interpretation of quantum states. Quantum random variables and the spectral theorem. The principle of superposition.</li> <li>4. Tensor product using matrix examples.</li> <li>5. Elements of quantum cryptography and quantum gates. Interferometers as 2x2 problems, the Elitzur-Vaidman paradox.</li> <li>6. Infinite potential well as an infinite-dimensional example - the role of boundary conditions.</li> <li>7. Quantum harmonic oscillator (creation/annihilation operator method, coherent states). Momentum representation.</li> <li>8. Superpotential method applied to harmonic oscillator and 1/r potential.</li> <li>9. Uncertainty principle for standard deviations. Coherent states minimize the uncertainty principle.</li> <li>10. Conservation laws and symmetries - classical and quantum versions. Continuity equation for probability current.</li> <li>11. Greater number of degrees of freedom. The two-body problem.</li> <li>12. Orbital angular momentum and spin.</li> <li>13. Hydrogen atom supplementary material for independent study, lectures in mp4 format and links to other materials on the hydrogen atom available on the e-Nauczanie platform</li> </ol>											
	<p>Course content – exercises</p> <ol style="list-style-type: none"> <li>1. Bra and ket bases. Bases in finite-dimensional spaces. Change of basis.</li> <li>2. Matrix Schrödinger equation. Solution using the spectral theorem.</li> <li>3. Tensor products. Entangled states, singlet state, EPR correlations.</li> <li>4. Probabilities: several different methods of calculation.</li> <li>5. Creation and annihilation operator algebra. Various excited states of a 1D oscillator in position representation.</li> <li>6. Uncertainty principles for various observables and states.</li> <li>7. Simple interferometric systems (Mach-Zehnder interferometer in various configurations, quantum optics elements in matrix form).</li> <li>8. Elements of angular momentum algebra. Representations and relationships between observables and generators using simple examples</li> </ol>											
	<p>Course content – laboratory</p> <p>Numerical methods in quantum mechanics.</p> <ol style="list-style-type: none"> <li>1. Solving the Schrödinger equation for various potentials.</li> <li>2. Scattering of wave packets at barriers and potential wells.</li> <li>3. WKB method.</li> <li>4. Perturbation methods.</li> <li>5. Variational method.</li> </ol>											
Prerequisites and co-requisites	Theoretical mechanics and mathematical methods of physics											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Oral exam</td> <td>50.0%</td> <td>50.0%</td> </tr> <tr> <td>Practical exercise</td> <td>50.0%</td> <td>50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Oral exam	50.0%	50.0%	Practical exercise	50.0%	50.0%
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Recommended reading	<p>Basic literature</p> <p>Supplementary literature</p> <p>eResources addresses</p>	<p>I. Białynicki-Birula i in., Teoria kwantów, PWN, 1994 R. Schankar, Mechanika kwantowa, PWN, 2005 L. Landau, E. Lifszyc, Mechanika kwantowa - teoria nierelatywistyczna, PWN, 1980</p> <p>No requirements</p>										
Example issues/ example questions/ tasks being completed	<p>Qubinary coding</p> <p>Superpotential</p>											

Practical activities within the subject	Not applicable
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