



Subject card

Subject name and code	Quantum Mechanics, PG_00069337						
Field of study	Nanotechnology						
Date of commencement of studies	October 2025	Academic year of realisation of subject				2026/2027	
Education level	first-cycle studies	Subject group					
Mode of study	Full-time studies	Mode of delivery				at the university	
Year of study	2	Language of instruction				Polish	
Semester of study	4	ECTS credits				4.0	
Learning profile	general academic profile	Assessment form				exam	
Conducting unit	Department of Solid State Physics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Szymon Winczewski				
	Teachers		dr inż. Szymon Winczewski				
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						
eNauczanie source address: https://enauczanie.pg.edu.pl/moodle/course/view.php?id=47738							
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	4.0		36.0		100
Subject objectives	The aim of the course is to familiarize students with the quantum mechanics, which is the basis for a theoretical description of phenomena occurring at the atomic level. The subject is also aimed at preparing students for further education (higher years/degrees) in the field of theoretical description and modeling of materials and nanostructures (courses such as: Computer modelling of materials, Physical fundamentals of nanotechnology, Theoretical basis of nanotechnology, Computational nanotechnology).						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K6_U01] can learn independently, obtain information from literature, databases and other properly selected sources		The student is able to independently study the given literature. In particular, the student is able to find content about issues discussed during the lecture, in order to re-study them in depth.		[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject		
	[K6_W03] has systematic knowledge within the scope of all branches of general physics (mechanics and study of heat, electricity and magnetism, waves, optics, elements of modern physics).		The student has knowledge of quantum mechanics, which is a branch of modern physics. The student is able to present the laws of quantum mechanics. The student knows how to use the mathematical formalism of quantum mechanics to solve exemplary problems.		[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		

Subject contents	<p>Course content – lecture</p> <ol style="list-style-type: none"> 1) Introduction (historical outline, analogies and differences in classical and quantum description, importance and applications of quantum mechanics). 2) Probability theory (discrete and continuous variables, probability, probability density distribution function, mean (average) value, deviation, variance, standard deviation). 3) Basics of quantum mechanics (time-dependent Schrödinger equation, wave function, statistical interpretation, normalization, position and momentum operators, expected values, collapse of wave function, uncertainty principle). 4) Procedure for solving time-dependent Schrödinger equation (separation of variables, stationary states and their properties, general solution, initial condition, time-independent Schrödinger equation). 5) Infinite square well (problem formulation, solution of Schrödinger equation, form and properties of the solutions). 6) Harmonic oscillator (problem formulation, solution with the ladder operators, commutator of two operators, commutation relations, tunneling effect). 7) Free particle (problem formulation, plane waves, wave packet). 8) Dirac delta potential (bound and scattering states, problem formulation, solutions and their properties, transition and reflection). 9) Mathematical formalism of quantum mechanics (Hilbert space, inner product, Schwarz inequality, observables, Hermitian operators, eigenvalue problem, eigenfunctions, eigenvalues, generalized form of the uncertainty principle, Dirac notation). 10) Hydrogen atom (problem formulation, Schrödinger equation in spherical coordinates, separation of variables, angular equation and radial equations, solutions of the angular equation, associated Legendre polynomials, spherical harmonics, solutions of the radial equation, associated Laguerre polynomials, quantum numbers, shells, subshells, orbitals). <p>Course content – exercises</p> <p>Exercises: example problems related to the topics/problems discussed during the lecture.</p>											
Prerequisites and co-requisites	<p>Knowledge of mathematics and physics at the level of the first two years of study, in particular, a good knowledge of the following branches of mathematics and physics: differential calculus, integral calculus, probability theory, classical mechanics, electrostatics and magnetism, basics of modern physics.</p>											
Assessment methods and criteria	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Subject passing criteria</th> <th style="width: 33%;">Passing threshold</th> <th style="width: 33%;">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>written exam in theory</td> <td>50.0%</td> <td>50.0%</td> </tr> <tr> <td>two written tests in problem solving</td> <td>50.0%</td> <td>50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	written exam in theory	50.0%	50.0%	two written tests in problem solving	50.0%	50.0%
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two written tests in problem solving	50.0%	50.0%										
Recommended reading	Basic literature	David J. Griffiths, Introduction to quantum mechanics, 2nd edition, Pearson Prentice Hall, 2005.										
	Supplementary literature	Ramamurti Shankar, Principles of quantum mechanics, Plenum Press, 2011.										
	eResources addresses											
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> 1. Discuss analogies and differences between classical and quantum mechanics. 2. What is the probability density function? What properties does it have? 3. Present the time-dependent Schrödinger equation. 4. Discuss the statistical interpretation of the wave function. 5. Formulate Heisenberg's uncertainty principle for position and momentum operators and discuss its consequences. 6. Discuss the procedure used for solving the time-dependent Schrödinger equation. 7. Present the time-independent Schrödinger equation. 8. Explain why the stationary states are so important in quantum mechanics. 9. Solve the time-independent Schrödinger equation for an infinite potential well that extends between points 0 and a. 10. Express the Hamiltonian of the quantum harmonic oscillator in terms of ladder operators. 11. Explain what is the wave packet? What is the significance of this concept in quantum mechanics? 12. What does tunnelling mean? What are the consequences of this phenomenon? 13. What is the physical meaning of transmission T and reflection R coefficients? How are they defined? How are they related? 14. Discuss the properties of operators used in quantum mechanics. 15. Discuss Dirac notation. 16. Explain what is eigenproblem, eigenvector and eigenvalue. Give examples of eigenproblems in quantum mechanics. 17. Starting with Schwarz inequality derive the generalized uncertainty principle. 18. What are orbitals? What are shells? What are subshells? How do these concepts are related to quantum numbers n, l and m? 19. Discuss quantization of angular momentum. 20. For the given wave function calculate the following expectation values. Check if Heisenberg's uncertainty principle is satisfied. 											
Practical activities within the subject	Not applicable											

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