



## Subject card

Subject name and code	Theoretical basis of nanotechnology, PG_00049321						
Field of study	Nanotechnology						
Date of commencement of studies	February 2023		Academic year of realisation of subject		2022/2023		
Education level	second-cycle studies		Subject group		Optional subject group 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		Polish		
Semester of study	1		ECTS credits		2.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Solid State Physics -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Szymon Winczewski				
	Teachers		dr inż. Szymon Winczewski				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30		2.0		18.0	50
Subject objectives	The aim of the course is to familiarize students with more advanced problems of quantum mechanics, in particular, to show how, in a description based on first principles, various phenomena and quantum-mechanical effects that affect (and determine) the properties of real nanostructures are explained.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K7_W04		The student knows how various measures/properties considered theoretically can be measured experimentally.		[SW1] Assessment of factual knowledge		
	K7_U01		The student is able to study the indicated literature, analyze the information contained therein and prepare a synthesis/summary of key information.		[SU2] Assessment of ability to analyse information		
	K7_W02		The student knows how theoretically (starting from the first principles) various quantum-mechanical effects occurring in nanostructures are explained. The student is aware of the physical properties whose theoretical description requires referring to the quantum-mechanical description.		[SW1] Assessment of factual knowledge		
	K7_K09		The student is aware of the risks that nanotechnology brings.		[SK4] Assessment of communication skills, including language correctness		

Subject contents	<ol style="list-style-type: none"><li>1. Quantum mechanics - reminder of the basic knowledge.</li><li>2. The Dirac delta potential.</li><li>3. The double Dirac delta potential.</li><li>4. The Dirac comb potential.</li><li>5. Band structure.</li><li>6. Free electron gas, degeneracy pressure.</li><li>7. Quantization of the angular momentum.</li><li>8. Symmetry and antisymmetry of the wave function.</li><li>9. Exchange.</li><li>10. The WKB approximation.</li><li>11. Density functional theory.</li><li>12. The Kohn-Sham method.</li></ol>		
Prerequisites and co-requisites	Knowledge of mathematical analysis and algebra at the basic level. Knowledge of quantum mechanics at the basic level.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	attendance (bonus points)	0.0%	0.0%
	exam	50.0%	100.0%
Recommended reading	Basic literature	<p>[1] D. J. Griffiths, D. F. Schroeter, Introduction to quantum mechanics, 3rd edition, Cambridge University Press, 2018.</p> <p>[2] W. Koch, M. C. Holthausen, A Chemist's guide to density functional theory, 2nd edition, Wiley, 2001.</p>	
	Supplementary literature	[3] E. Kaxiras, Atomic and Electronic Structure of Solids, Cambridge University Press, 2003.	
	eResources addresses	Uzupełniające Adresy na platformie eNauczanie: Teoretyczne podstawy nanotechnologii - Moodle ID: 30387 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30387">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30387</a>	
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"><li>1. Discuss conclusions originating from solving the Schrodinger equation for the double Dirac delta potential.</li><li>2. Discuss conclusions originating from solving the Schrodinger equation for the Dirac comb potential.</li><li>3. Discuss the quantization of angular momentum.</li><li>4. Characterize the exchange interaction.</li><li>5. Present the Hohenberg-Kohn theorems and discuss their practical consequences.</li><li>6. Discuss the Kohn-Sham method.</li></ol>		
Work placement	Not applicable		