GDAŃSK UNIVERSITY OF TECHNOLOGY

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

<table>
<tr><td>Subject contents</td><td>1. Quantum mechanics - reminder of the basic knowledge.
2. The Dirac delta potential.
3. The double Dirac delta potential.
4. The Dirac comb potential.
5. Band structure.
6. Free electron gas, degeneracy pressure.
7. Quantization of the angular momentum.
8. Symmetry and antisymmetry of the wave function.
9. Exchange.
10. The WKB approximation.
11. Density functional theory.
12. The Kohn-Sham method.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of mathematical analysis and algebra at the basic level. Knowledge of quantum mechanics at the basic level.</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>attendance (bonus points)</td><td>0.0%</td><td>0.0%</td></tr>
<tr><td>exam</td><td>50.0%</td><td>100.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>[1] D. J. Griffits, D. F. Schroeter, Introduction to quantum mechanics, 3rd edition, Cambridge University Press, 2018.
[2] W. Koch, M. C. Holthausen, A Chemist's guide to density functional theory, 2nd edition, Wiley, 2001.</td></tr>
<tr><td>Supplementary literature</td><td>[3] E. Kaxiras, Atomic and Electronic Structure of Solids, Cambridge University Press, 2003.</td></tr>
<tr><td>eResources addresses</td><td>Uzupełniające
Adresy na platformie eNauczanie:
Teoretyczne podstawy nanotechnologii - Moodle ID: 30387
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=30387</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Discuss conclusions originating from solving the Schrodinger equation for the double Dirac delta potential.
2. Discuss conclusions originating from solving the Schrodinger equation for the Dirac comb potential.
3. Discuss the quantization of angular momentum.
4. Characterize the exchange interaction.
5. Present the Hohenberg-Kohn theorems and discuss their practical consequences.
6. Discuss the Kohn-Sham method.</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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