



Subject card

Subject name and code	, PG_00059468						
Field of study	Nanotechnology						
Date of commencement of studies	February 2023	Academic year of realisation of subject			2023/2024		
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	2	ECTS credits			2.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Michał Winiarski					
	Teachers	dr inż. Michał Winiarski					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	0.0	0.0	15
	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	15		0.0		0.0	15
Subject objectives	The aim of the course is to introduce selected methods for analyzing the electronic structures of solids, including the tight binding method, Wannier representation and techniques for analyzing the electron density						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K7_W04	The student is able to compare the results of model calculations with experimental data (eg. ARPES)			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		
	K7_W02	The student can apply the introduced methods to analyze the electronic structure of nanostructures			[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects		
	K7_W01	The student knows the tight binding method and Wannier representation and can use them to create simple models of the electronic structures of solids.			[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects		
Subject contents	1 Tight binding method applied to electronic structure analysis - introduction and mathematical background - calculations and analysis of simple 2D and 3D models using the Python 3.x programming language2 Description of electronic structure using Wannier representation - Bloch and Wannier functions - calculations employing Quantum Espresso and Wannier90 packages3 Methods electron density visualization and analysis - electron density and ELF - Quantum theory of atoms in molecules						
Prerequisites and co-requisites							

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Homeworks	50.0%	50.0%
	Colloquia	50.0%	50.0%
Recommended reading	Basic literature	1. W. A. Harrison, <i>Electronic structure and the properties of solids : the physics of the chemical bond</i> , New York : Dover Publications, Inc., 1989 2. R.F.W. Bader, <i>Atoms in molecules : a quantum theory</i> , Oxford : Clarendon Press, 2003	
	Supplementary literature	C M Goringe <i>et al</i> 1997 <i>Rep. Prog. Phys.</i> 60 1447	
	eResources addresses	Podstawowe https://www.youtube.com/watch?v=T8r_3vzWCUM&list=PLYc-eBoIpXTJIIUVgoqhJMa2CunCTUReR - Lecture on Wannier functions Uzupełniające Adresy na platformie eNauczenie: Metody Analizy Struktury Elektronowej - Moodle ID: 34408 https://enauczenie.pg.edu.pl/moodle/course/view.php?id=34408	
Example issues/ example questions/ tasks being completed	Draw a band structure of an infinite chain of s orbitals. Explain the instability of the model towards structural distortion,		
Work placement	Not applicable		