

Subject card

Subject name and code	Elements of solid state physics and crystallography, PG_00153914						
Field of study	Physics						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2026/2027		
Education level	Bachelor's studies		Subject group		Obligatory subject group 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 not applicable		
Semester of study	6		ECTS credits		2.0		
Learning profile	academic		Assessment form		credit		
Conducting unit	Division of Condensed Matter Spectroscopy -> Institute of Experimental Physics -> Faculty of Mathematics, Physics and Informatics -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Tadeusz Leśniewski				
	Teachers						
Lesson types	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		0.0		30.0	60
Subject objectives	The aim of the course is to provide fundamental knowledge of crystallography and the band structure of solids , essential for understanding the properties and applications of materials.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[FIZL3_K01] knows the limitations of his own knowledge and understands the need for further education	The student is aware of the limitations of their knowledge in solid state physics and crystallography and understands the need for further education and continuous self-development.	[SK4] test/exam - oral or written
	[FIZL3_U04] can apply the formalism of phenomenological thermodynamics and statistical physics to describe complex systems	The student is able to apply the formalism of phenomenological thermodynamics and statistical physics to describe selected issues in solid state physics, in particular related to the electrical properties of complex systems, such as electrical conductivity, density of states, and the distribution of electrons in the free electron gas model.	[SU4] test/exam - oral or written
	[FIZL3_U05] can describe electric and magnetic fields in vacuum and in material media, as well as physical phenomena occurring in electric circuits; can classify material media by the way they interact with an external electromagnetic field	The student is able to describe electric and magnetic fields in vacuum and in solids, physical phenomena occurring in simple electric circuits, and classify materials according to their interaction with an external electromagnetic field, in particular as conductors, semiconductors, and insulators.	[SU4] test/exam - oral or written
	[FIZL3_W02] understands the role of physical experiments, mathematical theoretical models approximating reality and computer simulations in the methodology of scientific research; is aware of technological, equipment and methodological limitations in scientific research	The student understands the role of physical experiments in studying the structure of solids, knows the importance of theoretical models (such as the free electron gas and band structure) and computer simulations in describing material properties, and is aware of the technological, instrumental, and methodological limitations encountered in solid state physics and crystallography.	[SW4] test/exam - oral or written
	[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world; knows and understands fundamental dilemmas of the civilization	The student has knowledge of the fundamental concepts of solid state physics and crystallography, including types of chemical bonding in solids, crystallographic systems and Bravais lattices, the unit cell (including the Wigner-Seitz cell), Miller indices, the reciprocal lattice, Bragg's law, the Brillouin zone, the packing factor, the free electron gas model, and the concept of the band structure of solids.	[SW4] test/exam - oral or written
	[FIZL3_U16] can independently plan and implement his own learning	The student is able to independently plan and carry out their own learning, using literature and electronic sources, and develop skills by recognizing basic crystallographic structures, using point representation in the Brillouin zone, determining Miller indices, and explaining the principles of structure prediction based on X-ray diffraction.	[SU4] test/exam - oral or written
	[FIZL3_U08] can use mathematical apparatus and numerical methods to describe and model physical phenomena and processes	The student is able to use mathematical tools and basic numerical methods to describe and model phenomena in solid state physics and crystallography, in particular related to band structure, electrical properties, and X-ray diffraction.	[SU4] test/exam - oral or written

	Course outcome	Subject outcome	Method of verification
	[FIZL3_U06] can use the formalism of quantum physics to describe physical phenomena in the microworld	The student is able to use the formalism of quantum physics to describe phenomena in the microscopic world, in particular the properties of electrons in solids and band structure, as well as to recognize basic crystallographic structures, use point representation in the Brillouin zone, determine Miller indices, and explain the principles of structure prediction based on X-ray diffraction.	[SU4] test/exam - oral or written
	[FIZL3_W10] has knowledge about the elementary components of matter and the types of fundamental interactions between them, about the manifestations of these interactions in phenomena occurring at various scales from subatomic to astronomic, knows the time and energy scales associated with these phenomena	The student has knowledge of the elementary constituents of matter and the fundamental interactions between them and their manifestations in solid state physics phenomena, and is familiar with the energy and time scales characteristic of electronic processes, phonons, and radiation-matter interactions.	[SW4] test/exam - oral or written
	[FIZL3_U01] can formulate basic physical laws using mathematical formalism	The student is able to formulate the fundamental laws of solid state physics and crystallography using mathematical formalism, recognize basic crystallographic structures (e.g., NaCl, diamond, zinc blende, graphite, graphene), use the representation of points in the Brillouin zone, determine Miller indices and draw lattice planes for simple structures, and explain the principle of predicting structures based on X-ray diffraction.	[SU4] test/exam - oral or written
	[FIZL3_K08] is able to speak competently on basic problems of physics and its applications	The student is able to competently discuss the fundamental issues of solid state physics and crystallography and their applications, in particular concerning crystal structure, electrical properties, and band structure of materials.	[SK4] test/exam - oral or written
	[FIZL3_K02] can precisely formulate problems to deepen understanding of a given topic	The student is able to precisely formulate problems in the field of solid state physics and crystallography, aimed at deepening the understanding of issues such as crystal structure, band properties, and methods of material investigation.	[SK4] test/exam - oral or written
Subject contents	1. Structure of solids – chemical bonding and crystal structures. 2. X-ray diffraction in crystals. 3. Growth of crystals and thin films. 4. Electromagnetic properties of matter. 5. Electrical properties of metals and insulators – band structure and electrical conductivity. 6. Intrinsic and doped semiconductors – charge carriers, doping, Hall effect. 7. p–n junctions – charge transport, photovoltaic effect. 8. Interaction of electromagnetic and nuclear radiation with matter. 9. Thermal properties of solids, superconductivity.		
Prerequisites and co-requisites			
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written or oral exam	51.0%	100.0%

Recommended reading	Basic literature	C. Kittel, <i>Introduction to Solid State Physics</i> , Wiley. N.W. Ashcroft, N.D. Mermin, <i>Solid State Physics</i> , Holt, Rinehart and Winston.
	Supplementary literature	
	eResources addresses	
Example issues/ example questions/ tasks being completed	not applicable	
Work placement	Not applicable	

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