GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physics of Condensed Matter, PG_00067891		
Field of study	Technical Physics		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Specialty 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	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Computational Chemical Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Jan Franz	
	Teachers	dr hab. Jan Franz dr Małgorzata Franz	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	0.0	0.0	0.0	45

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	45	5.0	50.0	100

Subject objectives

Acquiring knowledge of the basic phenomena, structure and properties of matter in the condensed phase and learning about contemporary problems in this field.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U01] can learn independently, obtain and integrate information from literature, databases and other properly selected sources,can critically analyze and select information, use patent information resources	independently acquires and critically evaluates information related to condensed matter physics and applies appropriate methods and tools to analyze physical properties of solids.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_W02] has enhanced, theoretically-founded, detailed knowledge of selected field of physics, and sufficient knowledge of related fields of science or technology	has theoretical knowledge of condensed matter physics and is able to relate it to concepts from materials science and other related fields.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture LECTURE 1. Introduction: Presentation of the course content, course requirements, condensed matter physics 2. Properties of an electron gas: an electron in an infinite potential well, degenerate level, density of states, an electron gas at a temperature near absolute zero 3. Free electron gas above absolute zero: the Fermi-Dirac distribution, the Fermi integral, the Fermi energy as a function of temperature, the specific heat of an electron gas, electrical conductivity and Ohm's law, thermal conductivity of metals 4. Structure of solids: states of matter, solid state, crystal, spatial lattice, atomic basis, Bravais lattices, unit cell, cell parameters 5. Defects in solids: definition of a defect, types of defects, significance of defects 6. Intrinsic and non-intrinsic defects, defect concentration: concentration of intrinsic defects, defect formation energy, influence of point defects on the physical properties of crystals 7. Vibrations of crystal lattice atoms, part I: monatomic chain, diatomic chain, acoustic and optical vibrations 8. Vibrations of crystal lattice atoms, part II: real crystals, vibrations in an N-atomic crystal, phonons, density of phonon states 9. Specific heat and energy of lattice vibrations: equipartition principle, DuLong-Petit law, specific heat of a solid, vibration energy, Einstein model, Einstein temperature, Debye model, Debye temperature and frequency, Debye density of states 10. Reciprocal lattice: 1D, 2D, 3D, primitive cell (Wigner-Seitz) 11. Approximations of nearly free and strongly bound electrons: periodicity, Bloch theorem, Brillouin zones 12. Consequences of the existence of energy bands: effective mass, hole concept, band structures 13. Superconductivity: history of discoveries, Meissner effect, London equations, Ginzburg-Landau theory, BCS (Bardeen-Cooper-Schrieffer) theory, types of superconductors, high-temperature superconductors EXERCISES 1. Properties of an electron gas: electron in an infinite potential well, density of states, electron gas at temperature T 0, Fermi energy, Fermi surface, Fermi temperature, Fermi-Dirac distribution, degenerate gas 2. Structure of solids: space lattice, basic lattice parameters, node indices, crystallographic planes, plane indices, examples of crystal structures 3. Defects in solids: cubic vacancy, octahedral vacancy, tetrahedral vacancy, vacancy concentration, Frenkel defects, Schottky vacancies 4. Lattice Vibrations: Atomic Vibrations in a Crystal Lattice 5. The Debye Model: Density of States for Phonons, Debye Frequency, Debye Temperature

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">no</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>written assessment</td><td>50.0%</td><td>40.0%</td></tr>
<tr><td>written assessment</td><td>50.0%</td><td>60.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">Z. Kleszczewski, "Podstawy fizyczne elektroniki ciała stałego", Wydawnictwo Politechniki Śląskiej, Gliwice 2000.

Ph. Hofmann, "Solid State Physics: An Introduction", Wiley-VCH, Weinheim 2022.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">J. Spałek, "Wstęp do fizyki materii skondensowanej", PWN, Warszawa 2016.

R.H. McKenzie, "Condensed matter physics. A very short Introduction.", Oxford University Press, Oxford 2023.</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">Sample Lecture Exam Question: Present the definition of the density of states function for an electron gas and derive its form for the one-dimensional case.

Sample Exercise Problem: Determine the coordination number, the number of atoms in the unit cell, the distance between the nearest atoms in the crystal, and the packing factor for cubic structures.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="3">Not applicable</td></tr>
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