



Subject card

Subject name and code	Physics of Condensed Matter, PG_00067891						
Field of study	Technical Physics						
Date of commencement of studies	February 2027	Academic year of realisation of subject			2027/2028		
Education level	second-cycle studies	Subject group					
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			3.0		
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					
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		

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

Prerequisites and co-requisites	no		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written assessment	50.0%	40.0%
	written assessment	50.0%	60.0%
Recommended reading	Basic literature	Z. Kleszczewski, "Podstawy fizyczne elektroniki ciała stałego", Wydawnictwo Politechniki Śląskiej, Gliwice 2000. Ph. Hofmann, "Solid State Physics: An Introduction", Wiley-VCH, Weinheim 2022.	
	Supplementary literature	J. Spątek, "Wstęp do fizyki materii skondensowanej", PWN, Warszawa 2016. R.H. McKenzie, "Condensed matter physics. A very short Introduction.", Oxford University Press, Oxford 2023.	
	eResources addresses		
Example issues/ example questions/ tasks being completed	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.		
Practical activities within the subject	Not applicable		

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