GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physics of materials , PG_00061913		
Field of study	Materials Engineering		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2024/2025
Education level	first-cycle studies	Subject group	Obligatory subject group in the field of study 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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Nanomaterials Physics -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Barbara Kościelska	
	Teachers	dr inż. Sebastian Wachowski prof. dr hab. inż. Barbara Kościelska	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	30.0	0.0	0.0	60

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	60	5.0	35.0	100

Subject objectives

The goal is to gain fundamental knowledge in materials physics (metals, semiconductors, dielectrics)

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_K01] Understands the need to improve professional and personal competencies; is conscious of own limitations and knows when to turn to experts, properly establishes priorities helping to accomplish tasks defined by oneself or others.	Understanding the need to improve competences, awareness of one's own knowledge and the ability to use the knowledge of experts.	[SK5] Assessment of ability to solve problems that arise in practice
[K6_W03] Has knowledge of materials science and can relate the properties of materials with their structure and composition, knows the theoretical description of phenomena occurring in materials subjected to external factors.	Knowledge of the physics of materials, allowing one to approach the material as a whole, characterized by various properties.	[SW1] Assessment of factual knowledge
[K6_U01] Can properly use selected analytical, simulation and experimental methods, as well as devices for measuring the fundamental properties of materials and technological processes.	The ability to select and use methods enabling the measurement of basic quantities characterizing materials and technological processes.	[SU4] Assessment of ability to use methods and tools
[K6_U06] Can integrate obtained information, interpret it and draw conclusions, as well as formulate and justify opinions.	The ability to integrate information and, based on it, the ability to draw and formulate conclusions and opinions.	[SU3] Assessment of ability to use knowledge gained from the subject

<table>
<tr><td>Subject contents</td><td>1. A short introduction to atomic and quantum physics.2. Crystal binding energy. Bonds: ionic, covalent, metallic, molecular. Crystal structure.3. Thermal properties of solids. Atomic vibrations in crystals - phonons. Phonon statistics. Density of states. Specific heat: Dulong-Petit law, Einstein and Debye models. Thermal conductivity of solids. Thermal expansion.4. Classical theory of free electrons in metal. Electrical conductivity of metals. Quantum models of electrons in a crystal. Density of electronic states. Band structure of a crystal. Electronic thermal conductivity and specific heat.5. Semiconductor crystals. Electron statistics - concentration of intrinsic carriers. Fermi level in an intrinsic semiconductor. Intrinsic conductivity. Impurity states. The equation of electrical neutrality of a semiconductor. The Fermi level in a doped semiconductor. The ionization energy of the dopant. Dopant conductivity.6. Examples of semiconductor devices.7. Glasses and amorphous materials and their preparation. Short-range ordering, transition from the liquid phase to the glass phase.8. Dielectrics. Macroscopic and microscopic description of dielectrics. Polarization. Piezoelectrics and ferroelectrics.9. Magnetic materials. Microscopic and macroscopic description of magnetic materials. Diamagnetism, paramagnetism, ferromagnetism.10. Superconductivity, properties of the superconducting state, type I and II superconductors, Cooper pairs, high-temperature superconductors. Josephson phenomena.

LABORATORY EXERCISES: Students realize laboratory exercises connecting with the topics of the lectures</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge in physics and analytical mathematics</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>Written exam</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Passing all laboratory exercises</td><td>50.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>B.N. Buszmanow, J.A. Chromow, Fizyka Ciała Stałego Wyd. N-T 1973

C. Kittel, Wstęp do fizyki ciała stałego PWN (or any other book)

P.A.Tipler, R.A. Llewellyn, Fizyka współczesna PWN 2012 (or any other book)

D. Halliday, R. Resnick, J. Walker, PodstawyFizyki t.5 PWN 2003</td></tr>
<tr><td>Supplementary literature</td><td>S.O. Kasap "Principles of electronic materials and devices", McGraw-Hill, 2006, 3rd ed.</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:
Fizyka materiałów - Moodle ID: 44095
https://enauczanie.pg.edu.pl/moodle/course/view.php?id=44095</td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>Amorphous and crystalline solids. Bonding energy in crystals. Types of bonds: Ionically and covalently bonded solids. Metallic and molecular bonding.Thermal properties of solids. Atomic vibrations in crystals. Phonons. Heat capacity, thermal expansion, thermal conductivity of solids. Classical theory of free electrons in metals. Fundamentals of band theory. Quantum model of free electrons in metals. Fermi-Dirac distribution. Density of states. Band theory of electrical conduction in metals. Specific heat capacity of the electrons. Thermal conductivity in metals. Superconductivity. Macroscopic properties of superconductors. Classification of solid in the frame of band theory of solids. Intrinsic and extrinsic semiconductors. Effective mass. The role of doping. Electrical conductivity. Magnetic properties of materials. Lasers</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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