GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physics of condensed matter, PG_00069739		
Field of study	Nanotechnology		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2024/2025
Education level	second-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	1	Language of instruction	Polish
Semester of study	1	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Maria Gazda	
	Teachers		

Lesson types and methods of instruction

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	5.0	15.0	50

Subject objectives	Learning the basics of condensed phase physics, understanding the properties of materials

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W02] has enhanced, theoretically supported, detailed knowledge of selected branches of nanotechnology and, according to the needs, within the scope of related fields of science and technology.	has in-depth, theoretically based, detailed knowledge of the influence of size on electronic structure.	[SW3] Assessment of knowledge contained in written work and projects
[K7_K03] can cooperate and work as part of a team, adopting different roles. Can self-evaluate, and give constructive feedback on the work of others.	is able to cooperate and work in a student group solving problems in condensed phase physics, taking on various roles.	[SK2] Assessment of progress of work
[K7_W01] has extended and organized knowledge of materials science.	Possesses extended and structured knowledge of materials science, understands the relationship between the electronic configuration of atoms and the properties of a macroscopic solid.	[SW1] Assessment of factual knowledge

Subject contents

1. Introduction. Review and expansion of the basics, reciprocal lattice, atomic vibrations.
2. Free electron gas.
3. Electrons in a periodic potential.
4. Nearly free electron approximation, strongly bound electron approximation.
5. Energy bands, effective mass, the concept of a hole. Band filling classification of solids.
6. Semiconductors.
7. Transport phenomena.
8. Contact phenomena.
9. Superconductivity.
10. Dielectric and optical properties.

Prerequisites and co-requisites

no

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	written exam	52.0%	100.0%
Recommended reading	Basic literature	all textbooks on solid state physicsTransport phenomena : Physics of semiconductors P.S. Kiriejew, Introduction to Solid State Physics J.M. Ziman;	
	Supplementary literature	https://enauczanie.pg.edu.pl/moodle/course/view.php?id=13082	
	eResources addresses		
Example issues/ example questions/ tasks being completed	1. Describe the most important assumptions of the nearly free electron approximation. What are the most important results of this approximation? 2. What is the nature of the strongly bound electron approximation and what results does it lead to? 3. The free electron model does not account for the periodicity of the crystal lattice or its existence. Other models take the existence of the lattice into account in different ways. Identify the properties of electrons in a solid that result from the existence and periodicity of the crystal lattice (examples may be used). 4. Define the concept of effective mass. On what properties of the solid or other factors does effective mass depend (if so, how?)? NOTE: A drawing can and should be used. 5. A certain crystalline solid composed of a IV-valent element has a band structure as shown in the figure. This material is very pure and contains a negligible number of defects. Complete the table: What is a metal/semimetal/semiconductor/insulator? ...., because The chemical potential at T = 0 K, according to the energy scale in the diagram, is: m = ...eV The effective mass of an electron is mn* = 0.7 me, and that of a hole is mp* = 0.3 me, so the dependence of the chemical potential on temperature is: m The hole concentration in the valence band increases with temperature according to the function: p(T) = 6. Sketch on a graph and provide the appropriate expressions describing the dependence of electron concentration in the conduction band of an n-type doped semiconductor on temperature. Mark the appropriate temperatures on the graph. How does the hole concentration in the valence band of this semiconductor depend on temperature? 7. How do the chemical potentials of metals and intrinsic semiconductors depend on temperature? 8. How do the chemical potentials of a nondegenerate n/p/intrinsic semiconductor depend on temperature? 9. How does the concentration of majority/minority charge carriers in a nondegenerate n/p/intrinsic semiconductor depend on temperature?		
Work placement	Not applicable		