GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Solid-State Electronics and Nanoelectronics, PG_00069716		
Field of study	Nanotechnology		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Optional 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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Solid State Physics -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Barbara Kościelska	
	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	15.0	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	4.0	51.0	100

Subject objectives

The aim of the course is to gain knowledge, skills and competences of solid state electronics and nanoeletronics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W01] has knowledge of materials science and understands its key role in the progress of civilization	The student has knowledge of materials used in electronics and understands its role in the progress of civilization.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
[K6_U11] can prepare dissertations, papers, oral presentations, in Polish and English, concerning detailed problems in physics and related fields and disciplines of science.	The student is able to prepare presentations and oral presentations in the field of solid-state electronics and nanoelectronics.	[SU5] Assessment of ability to present the results of task [SU1] Assessment of task fulfilment
[K6_W07] has systematic knowledge of the physical and chemical principles of nanotechnology (methods of obtaining nanostructures, types of nanostructures, their properties, basic research methods).	The student has knowledge of nanotechnology and its application in electronics	[SW1] Assessment of factual knowledge

Subject contents	**Lecture:** 1. Introduction. 2. Physics and properties of solids - a review 2.1. Density of states in 0D, 1D, 2D and 3D materials. 2.2. Band structure of solids: free electron, nearly free electron and tight binding model. 2.3. Energy bands and carrier concentration in thermal equilibrium. 2.4. Electrical and thermal conduction in solids: carrier transport phenomena. 2.5. Kinetic phenomena in semiconductors. 3. Metal-semiconductor junctions and p-n junctions. 4. Diodes: Schottky diode, p-n diode, MIS, MOS, tunneling diode, resonant-tunneling diode. 5. Transistors: bipolar, FET, hot-electron HET and THET, single-electron transistor. 6. Light emitting diodes and lasers. 6.1. Light emitting diodes. 6.2. Semiconductor lasers. 6.3. Quantum-cascade laser. 7. Photodetectors and solar cells. 8. Tunnel phenomena in superconductors: Josephson junction. 9. Spintronic devices. 10. Semiconductor technology. 10.1. Crystal growth and epitaxy. 10.2. Film formation. 10.3. Lithography and etching. 10.4. Impurity doping. 11. Summary. **Seminar:** Various technologies for obtaining thin films for electronics applications. Spintronics and examples of spintronic devices. "Non-standard" lasers. Microchannel light amplifiers. Optical fibers production and

	application examples. Materials and technologies for cooling electronic components. Logic circuits operating on the Josephson junction. Any number of interesting topics are available upon request.
Prerequisites and co-requisites	Knowledge od mechanics, electricity and magnetism, basics of nanophysics, quantum mechanics.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	50.0%
Seminar and presence on lessons	90.0%	30.0%
Participation in lectures	90.0%	20.0%

Recommended reading

Basic literature	1. Aldert van der Ziel *Podstawy fizyczne elektroniki ciała stałego*, WNT 1980 2. S.O. Kasap *Principles of electronic materials and devices,* McGraw-Hill, 2006, 3rd ed. 3. S.M. Sze, M.K. Lee *Semiconductor Devices, Physics and Technology* , John Wiley & Sons, 2012, 3rd ed. 4. S.M. Sze, Kwok K. Ng *Physics of Semiconductor Devices*, John Wiley & Sons, 2007, 3rd ed. The student searches for materials for the seminar independently.
Supplementary literature	1. C. Kittel *Wstęp do fizyki ciała stałego*, PWN 2. O. Manasreh *Semiconductor Heterojunctions and Nanostructures*, McGraw Hill
eResources addresses	

Example issues/ example questions/ tasks being completed

Crystalline structure of solids.

Models of electrons in crystals.

Semiconductors: band structure of semiconductors, carrier concentration; distribution functions.

Kkinetic phenomenas in semiconductors.

Contact phenomenas.

Diodes.

Transistors.

Lasers.

Tunneling processes in superconductors: Josephson junction.

Work placement	Not applicable

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