



## Subject card

Subject name and code	Solid state electronics and nanoelectronics, PG_00037203						
Field of study	Nanotechnology						
Date of commencement of studies	October 2020		Academic year of realisation of subject		2023/2024		
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	4		Language of instruction		Polish		
Semester of study	7		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						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Barbara Kościelska				
	Teachers		prof. dr hab. inż. Wojciech Sadowski 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	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		6.0		49.0	100
Subject objectives	The aim of the course is to gain knowledge, skills and competences of solid state electronics and nanoelectronics.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K6_U11		Ability to prepare written works and seminar presentations in the field of solid-state electronics and nanoelectronics.		[SU1] Assessment of task fulfilment		
	K6_W09		Knowledge of the construction and principles of operation of electronic circuit components.		[SW1] Assessment of factual knowledge		
	K6_W08		Knowledge in the field of solid state electronics and nanoelectronics.		[SW1] Assessment of factual knowledge		
	K6_K04		Ability to work in a team		[SK1] Assessment of group work skills		

Subject contents	<p>1. Introduction.</p> <p>2. Physics and properties of solids - a review</p> <p>2.1. Density of states in 0D, 1D, 2D and 3D materials.</p> <p>2.2. Band structure of solids: free electron, nearly free electron and tight binding model.</p> <p>2.3. Energy bands and carrier concentration in thermal equilibrium.</p> <p>2.4. Electrical and thermal conduction in solids: carrier transport phenomena.</p> <p>2.5. Kinetic phenomena in semiconductors.</p> <p>3. Metal-semiconductor junctions and p-n junctions.</p> <p>4. Diodes: Schottky diode, p-n diode, MIS, MOS, tunneling diode, resonant-tunneling diode.</p> <p>5. Transistors: bipolar, FET, hot-electron HET and THET, single-electron transistor.</p> <p>6. Light emitting diodes and lasers.</p> <p>6.1. Light emitting diodes.</p> <p>6.2. Semiconductor lasers.</p> <p>6.3. Quantum-cascade laser.</p> <p>7. Photodetectors and solar cells.</p> <p>8. Tunnel phenomena in superconductors: Josephson junction.</p> <p>9. Spintronic devices.</p> <p>10. Semiconductor technology.</p> <p>10.1. Crystal growth and epitaxy.</p> <p>10.2. Film formation.</p> <p>10.3. Lithography and etching.</p> <p>10.4. Impurity doping.</p> <p>11. Summary.</p>		
Prerequisites and co-requisites	Knowledge of 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%	66.0%
	Seminar and presence on lessons	50.0%	34.0%

Recommended reading	Basic literature	<p>1. Aldert van der Ziel Podstawy fizyczne elektroniki ciała stałego, WNT 1980</p> <p>2. C. Kittel Wstęp do fizyki ciała stałego, PWN</p> <p>3. S.O. Kasap "Principles of electronic materials and devices", McGraw-Hill, 2006, 3rd ed.</p> <p>4. S.M. Sze, M.K. Lee Semiconductor Devices, Physics and Technology, John Wiley &amp; Sons, 2012, 3rd ed.</p> <p>5. S.M. Sze, Kwok K. Ng, Physics of Semiconductor Devices, John Wiley &amp; Sons, 2007, 3rd ed.</p>
	Supplementary literature	1. O. Manasreh <i>Semiconductor Heterojunctions and Nanostructures</i>
	eResources addresses	<p>Adresy na platformie eNauczanie:</p> <p>Elektronika ciała stałego i nanoelektronika - Moodle ID: 32996</p> <p><a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=32996">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=32996</a></p>
Example issues/ example questions/ tasks being completed	<p>Crystalline structure of solids.</p> <p>Models of electrons in crystals.</p> <p>Semiconductors: band structure of semiconductors, carrier concentration; distribution functions.</p> <p>Kkinetic phenomenas in semiconductors.</p> <p>Contact phenomenas.</p> <p>Diodes.</p> <p>Transistors.</p> <p>Lasers.</p> <p>Tunneling processes in superconductors: Josephson junction.</p>	
Work placement	Not applicable	