

Subject card

Subject name and code	Magnetic properties of nanostructures and spintronics, PG_00020903								
Field of study	Nanotechnology								
Date of commencement of studies	February 2023		Academic year of realisation of subject			2023/2024			
Education level	second-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	1		Language of instruction			Polish			
Semester of study	2		ECTS credits			2.0			
Learning profile	general academic profile		Assessment form			assessment			
Conducting unit	Zakład Magnetyczny Faculty of Applied Ph	tycznych Właściwości Materiałów -> Instytut Nanotechnologii i Inżynierii Materiałowej -> lied Physics and Mathematics							
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Leszek Piotrowski						
	Teachers	dr hab. inż. Le	ski						
Lesson types and methods	Lesson type	Lecture	Tutorial	Laboratory	Projec	t	Seminar	SUM	
of instruction	Number of study hours	15.0	0.0	0.0	0.0		15.0	30	
	E-learning hours included: 0.0								
Learning activity and number of study hours	Learning activity Participation ir classes include plan		I didactic Participation in ed in study consultation hours		Self-study SUM				
	Number of study hours	30		2.0		18.0		50	
Subject objectives	Student learns about magnetic materials and about physical lows describing magnetic properties of materials from makro- to nano- scale.Student learns also about methods of testing magnetic properties of materials as well as application of magnetic materials in science and in technique. Student finds an idea of spintronic and learns about methods of spin government including application of spintronic at various area of science and technique.								
Learning outcomes	Course outcome		Subject outcome			Method of verification			
	K7_U10		Student knows how to search the bibligrafical databases (in English) in order to find information necessary for oral presentation preparation. Knows and applies rules of a good scientific presentation.			[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU5] Assessment of ability to present the results of task [SU1] Assessment of task fulfilment			
	K7_W02		Student knows how to describe the behaviour of spin in quantum mechanics, understand the concept of spinor and spin matrix. He also knows the problems associated with spin decoherence and manipulation of spin orientation.			[SW1] Assessment of factual knowledge			
	K7_W03		The student understands the principles of operation of spintronic devices. Student can explain such issues as e.g. the phenomenon of giant magnetoresistance (GMR) or the principle of operation of magnetic tunnel junctions (MTJ).			[SW1] Assessment of factual knowledge			

Subject contents	Lectures:						
	 Magnetic quantities. Magnetization state. Types of magnetic materials. Nanomagnetism. Magnetism of individual atoms. Impact of magnetic field on atom. Magnetism of atom systems. Dia, para and ferromagnetic phenomena. Ferromagnetic properties. Domain microstructure and magnetisation process. Magnetism of small volumes. Monodomains. Magnetism of thin layers. Methods of magnetic properties measurements. Magnetic state evaluation. Visualization of magnetic structure. Application of magnetic nanostructures. Magnetic memories. Biomagnetism. Spintronics. Spin transport in solids. Passive spintronics. Spine valves. Gigant maneto-resistivity. Active spintronics. Spintronic transitors. Monolitic spintronis. Quantum computing with spins. Seminar: During the seminar students are meant to prepare oral presentation on the basis of scientific papers choosen by them and dealing with the issues related to the lectures content. 						
Prerequisites and co-requisites	Basic knowledge of quantum mechanics (Schrödinger's equation) and solid state physics (charge transport in the solid state)						
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade				
	exam	50.0%	50.0%				
	oral presentation	50.0%	50.0%				
Recommended reading	Basic literature	 [1] Magnetic Nanostructures in Modern Technology, Ed. Bruno Azzerboni; Sprionger, 2008 2008 [2] Magnetic Microscopy of Nanostructures, Ed. H. Hopster, Springer, 2005 [3] J. Stohr, H.C. Siegmann; Magnetism From Fundamentals to Nanoscale Dynamics; Springer, 2006. 					
	Supplementary literature	[1] S. Bandyopadhyay, M. Cahay; Introductioon to spintronics, CRC Press, 2008					
	eResources addresses	Adresy na platformie eNauczanie: Magnetyczne właściwości nanostruktur i spintronika 23/24 - Moodle ID: 34158 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34158					
Example issues/ example questions/ tasks being completed	 On the basis of the Biot-Savart law calculate the induction of the magnetic field in the centre of conducting loop Discuss the construction of spin valve What criteria must meet the material used for the data storage Discuss the phenomena causing spin coherence in solid body. Explain the process of spin transfer torque 						
Work placement	Not applicable						