



Subject card

Subject name and code	Magnetic properties of nanostructures and spintronics, PG_00071037						
Field of study	Nanotechnology						
Date of commencement of studies	February 2027		Academic year of realisation of subject			2026/2027	
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			assessment	
Conducting unit	Division of Magnetic Properties of Materials -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Leszek Piotrowski				
	Teachers		dr hab. inż. Leszek Piotrowski				
Lesson types	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		2.0		18.0	50
Subject objectives	The student should acquire the widest possible knowledge of magnetism at the macro, micro and nano scale. He learns about such phenomena as spin-orbit coupling and the related phenomena of magnetocrystalline anisotropy and magnetostriction. He learns the basic mechanisms of coercion and models describing the magnetic hysteresis loop. He gets acquainted with phenomena occurring on the nano scale giant magnetoresistance, spin valves, spin angular momentum transfer. He also learns about magnetic random access memories and spin transistors.						
Learning outcomes	Course outcome		Subject outcome			Method of verification	
	[K7_W02] has in-depth, theoretically grounded and detailed knowledge of phenomena, methods, and theories related to nanotechnology, as well as of related and allied fields of science or engineering		The student learns the principles governing the transport of spin currents. He/she knows and understands the phenomenon of spin decoherence, the spin Hall effect or the Rashba effect.			[SW1] Assessment of factual knowledge	
	[K7_W03] has knowledge of current development trends and the latest discoveries in the fields of physics, chemistry, technology, and applications of nanostructures		The student is able to give examples of practical application of magnetic nanostructures and explain the principle of operation of those structures.			[SW1] Assessment of factual knowledge	
	[K7_U06] is able to apply acquired specialist knowledge to problems in other physical, natural, or technical sciences and to critically analyze and evaluate the functioning of the adopted solutions		The student is aware of the limitations resulting from the miniaturization of nanostructures in and understands its impact on magnetic properties of nanomaterials. He is aware of the influence of temperature on the properties of magnetic materials, especially on permanent magnets.			[SU2] Assessment of ability to analyse information	

Subject contents	<p>Course content – lecture</p> <ol style="list-style-type: none"> Short repetition on fundamentals of magnetism <ul style="list-style-type: none"> Magnetism of atoms and molecules, atoms in external magnetic fields Magnetic properties of materials (dia-, para-, and ferromagnetism) Ferromagnetism and domain structures Magnetism of small particles, single domain particles (Stoner Wohlfarth model) and thin films Spin transport spin polarization, spin filters, Rashba and Dresselhaus <p>Interactions</p> <ol style="list-style-type: none"> Two currents model, spin injection and coherence length, spin dependent Hall effects. Magnetoresistance anisotropic magnetoresistance (AMR), gigantic magnetoresistance (GMR), tunnelling magnetoresistance (TMR) and colossal magnetoresistance (CMR). Spin valves Magnetic data storage (HDDs)- storage media, read/write heads, construction issues. Spin transfer torque (STT) current induced magnetization switching, nano oscillators Magnetic random access memories (MRAM), STT-MRAMs Spin transistors, Data and Das transistor, spin valve transistor, spin Hall effect transistor Magnetic logic devices 								
Prerequisites and co-requisites	Basic knowledge of magnetic properties of atoms, molecules and solid bodies. Knowledge of differences between diamagnetism, paramagnetism and ferromagnetism.								
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>Written test</td> <td>50.0%</td> <td>100.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Written test	50.0%	100.0%
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Written test	50.0%	100.0%							
Recommended reading	Basic literature	<ol style="list-style-type: none"> J. Stohr, H.C. Siegmann; Magnetism From fundamentals to Nanoscale Dynamics; Springer, 2006. Spintronics: Materials, Devices and Applications Ed. Kaiyou Wang, Meiyin Yang and Jun Luo WILEY 2022 							
	Supplementary literature	<ol style="list-style-type: none"> Handbook of Spin Transport and Magnetism; Ed. E.Y. Tsymlal, I.Žutić; CRC Press 2012 							
	eResources addresses								

Example issues/ example questions/ tasks being completed	1. Anisotropy and coercivity, what do they have in common? 2. Discuss the operational principle of spin valve 3. What criteria must meet the material used for the data Storage 4. Discuss the phenomena causing spin decoherence in solid body.
Practical activities within the subject	Not applicable

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