



Subject card

Subject name and code	Magnetic properties of nanostructures and spintronics, PG_00071032						
Field of study	Nanotechnology, 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						
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_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. Student poznaje zasady rządzące transportem prądów spinowych.			[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject		
	[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 knows and understands the phenomenon of spin coherence, the spin Hall effect or the Rashba effect.			[SW1] Assessment of factual knowledge		

Subject contents	<p>Course content – lecture</p> <p>1 Magnetism of atoms and molecules, atoms in external magnetic fields</p> <p>2. Magnetic properties of materials (dia-, para-, and ferromagnetism)</p> <p>3. Ferromagnetism and domain structures</p> <p>4. Magnetism of small particles, single domain particles (Stoner Wohlfarth model) and thin films</p> <p>5. Spin transport spin polarization, spin filters, Rashba and Dresselhaus</p> <p>Interactions</p> <p>6. Two currents model, spin injection and coherence length, spin dependent Hall effects.</p> <p>7. Magnetoresistance anisotropic magnetoresistance (AMR), gigantic magnetoresistance (GMR), tunnelling magnetoresistance (TMR) and colossal magnetoresistance (CMR).</p> <p>8. Spin valves</p> <p>9. Magnetic data storage (HDDs)- storage media, read/write heads, construction issues.</p> <p>10 Spin transfer torque (STT) current induced magnetization switching, nano oscillators</p> <p>11. Magnetic random access memories (MRAM), STT-MRAMs</p> <p>12. Spin transistors, Data and Das transistor, spin valve transistor, spin Hall effect transistor</p> <p>13. Magnetic logic devices</p>								
Prerequisites and co-requisites									
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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Recommended reading	Basic literature	<p>Spintronics Materials, Devices and Applications Edited by Meiyin Yang and Jun Luo Handbook of Spin Transport and Magnetism; Ed. E.Y. Tsymbal, I. Žutić; CRC Press 20122. J. Stohr, H.C. Siegmann; Magnetism From Fundamentals to Nanoscale Dynamics; Springer, 2006.</p>							
	Supplementary literature	<p>1. S. Bandyopadhyay, M. Cahay; Introduction to spintronics, CRC Press, 2008</p>							
	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.  5. Explain the process of spin transfer torque
Practical activities within the subject	Not applicable

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