GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Magnetic properties of nanostructures and spintronics, PG_00069750		
Field of study	Nanotechnology		
Date of commencement of studies	February 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Specialty 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	Division of Magnetic Properties of Materials -> Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Leszek Piotrowski	
	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	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	5.0	15.0	50

Subject objectives	The student learns the basics of magnetism, the laws and equations that determine the parameters describing the magnetic field. He learns about the influence of magnetic fields on macro-, micro- and nanoscale materials. The student learns the methods of magnetic properties determination and possibilities of using magnetic materials in practice. The student also learns about spin, theoretical foundations of spintronics and practical ways of manipulation of the spin of electrons. Studies the practical applications of spintronics, e.g. spin valves and tunnelling junctions.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W02] has enhanced, theoretically supported, detailed knowledge of selected branches of nanotechnology and, according to the needs, within the scope of related fields of science and technology.	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_U10] has enhanced ability to prepare Polish and English oral presentations, including those that contain the results of their own research, and the ability to write various papers.	Student is capable of preparation of an oral presentation dealing with spintronics. He can do that either on the baisis of a ltierature search or his own reserch. He can also prepare a written work on that subject	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_W03] has general knowledge on current development directions and discoveries in physics, chemistry, technology and applications of nanostructures.	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	1 . Basic magnetic quantities 2 . Magnetism of atoms and molecules , atoms in external fields Magnetic 3 . Magnetism in solids , types of magnetic materials (dia - para - and ferromagnetics) 4 . Ferromagnetism , Domain Structure 5 . Small particle magnetism , single particle domain (Stoner Wohlfarth model), thin layers 6 . Experimental techniques for determining properties magnetic and magnetic . Visualization and analysis of the domain structure . 7 . Spin transport , filters spin effects , Rashba and Dresselhaus interactions 8 . Dual current model , spin injection , length coherence , spin Hall effects . 9 . Magnetoresistance anisotropic magnetoresistance (AMR), giant magnetoresistance (GMR), tunnel magnetoresistance (TMR) and colossal magnetoresistance (CMR). 10 . Spin valves 11 . Data storage - hard disk drives (HDDs), magnetic information carriers , read and write heads , construction issues . 12 . Spin angular momentum transfer (STT) magnetization change caused by current flow , nanooscillators . 13 . Magnetic RAM (MRAM , ST - MRAM) 14 . Spin Transistor , Data & Das Transistor , Spin Valve Transistor , Transistor using the spin Hall effect . 15 . Magnetic logic gates .
Prerequisites and co-requisites	
Assessment methods and criteria	Subject passing criteria: written exam; Passing threshold: 50.0%; Percentage of the final grade: 100.0%

Subject passing criteria	Passing threshold	Percentage of the final grade
written exam	50.0%	100.0%

Recommended reading		
	Basic literature	1. Handbook of Spin Transport and Magnetism; Ed. E.Y. Tsymbal, I.Žutić; CRC Press 20122. J. Stohr, H.C. Siegmann; 2. Magnetism From Fundamentals to Nanoscale Dynamics; Springer, 2006.
	Supplementary literature	1. S. Bandyopadhyay, M. Cahay; Introductioon to spintronics, CRCPress, 2008
	eResources addresses	

Example issues/ example questions/ tasks being completed	1 . Based on Biot - Savart 's law, determine the induction of the magnetic field in the interior of e circular loop with current 2 . Discuss the construction of the spin valve 3 . What criteria must the material meet used as a data carrier 4 . Discuss the phenomena that cause spin decoherence in a solid . 5 . Explain the spin transfer process
Work placement	Not applicable