GDAŃSK UNIVERSITY OF TECHNOLOGY

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 Magnetycznych Właściwości Materiałów -> Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Leszek Piotrowski	
	Teachers	dr hab. inż. Leszek Piotrowski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
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 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

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

<table>
<tr><td>Subject contents</td><td>Lectures:

1. Magnetic quantities. Magnetization state. Types of magnetic materials. Nanomagnetism.
2. Magnetism of individual atoms. Impact of magnetic field on atom.
3. Magnetism of atom systems. Dia, para and ferromagnetic phenomena.
4. Ferromagnetic properties. Domain microstructure and magnetisation process.
5. Magnetism of small volumes. Monodomains. Magnetism of thin layers.
6. Methods of magnetic properties measurements. Magnetic state evaluation. Visualization of magnetic structure.
7. Application of magnetic nanostructures. Magnetic memories. Biomagnetism.
8. 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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Basic knowledge of quantum mechanics (Schrödinger's equation) and solid state physics (charge transport in the solid state)</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>exam</td><td>50.0%</td><td>50.0%</td></tr><tr><td>oral presentation</td><td>50.0%</td><td>50.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>[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.</td></tr><tr><td>Supplementary literature</td><td>[1] S. Bandyopadhyay, M. Cahay; Introductioon to spintronics, CRC Press, 2008</td></tr><tr><td>eResources addresses</td><td>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</td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. On the basis of the Biot-Savart law calculate the induction of the magnetic field in the centre of conducting loop
2. Discuss the construction of spin valve
3. What criteria must meet the material used for the data storage
4. Discuss the phenomena causing spin coherence in solid body.
5. Explain the process of spin transfer torque</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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