GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00059104		
Field of study	Nanotechnology		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
Education level	first-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	3	Language of instruction	Polish
Semester of study	6	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry, Technology and Biotechnology of Food -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Robert Tylingo	
	Teachers	dr hab. inż. Robert Tylingo dr inż. Szymon Mania mgr inż. Adrianna Banach-Kopeć	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	0.0	0.0	15.0	45
	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	45	5.0	50.0	100

Subject objectives	The aim of the course is to familiarize students with nanofluids, i.e. suspensions of nanoparticles in a base liquid, and their technical applications. The course will discuss the definitions and classification of nanofluids, their physicochemical properties, and methods of synthesis and stabilization of these colloidal systems. Students will learn how the addition of nanoparticles affects the properties of the liquid, which translates into numerous practical applications. The program emphasizes the development of skills in analyzing phenomena involving nanofluids, selecting appropriate modeling methods, planning experiments, and critically evaluating the obtained results. Thanks to this, participants will acquire the knowledge and competences necessary to use nanofluids in modern engineering and materials science.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	K6_U04	The student is able to plan and conduct experiments on the properties of nanofluids, including rheological and antibacterial properties and spectrophotometric measurements. He is able to critically analyze the obtained results, identify factors influencing the accuracy of measurements and interpret the data in the context of technical applications of nanofluids. Based on the conducted research, he formulates conclusions regarding potential applications in chemical engineering, biomedical engineering, cosmetics industry and other industries.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
	K6_W06	The student has basic knowledge of the structure and properties of nanofluids in the context of materials science. Understands the influence of the structure of crystalline bodies and amorphous nanoparticles on their interaction with base fluids and colloidal stability. Can explain the mechanisms of heat and mass transport in nanofluids, the role of crystal bonds, structural defects and lattice vibrations in shaping their physicochemical properties. In addition, knows the electronic phenomena affecting thermal conductivity and rheological mechanisms of nanofluids and can apply this knowledge to analyze their applications in engineering, biomedicine and energy.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
	K6_K05	The student is able to clearly and understandably present the results of analysis and research on the properties and applications of nanofluids, both orally and in writing. He is able to communicate effectively in the project team, present and justify his position and make a critical assessment of his own and other course participants' results. In addition, he is able to conduct self-assessment of his experimental and analytical work, taking into account technical and practical aspects of the use of nanofluids in engineering and industry.	[SK4] Assessment of communication skills, including language correctness [SK2] Assessment of progress of work
	K6_U02	The student is able to analyze and solve scientific and technical problems related to nanofluids, using analytical, numerical, simulation and experimental methods. Is able to calculate physicochemical properties of nanofluids, such as thermal conductivity, viscosity and colloidal stability, using model equations and computational tools. Is able to conduct laboratory experiments to determine the properties of nanofluids, critically analyze the obtained results and, on their basis, formulate conclusions regarding practical applications of nanofluids in engineering and industry.	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information

Subject contents	"1. LecturesIntroduction to nanofluids definition, classification and development of technology.Physicochemical and structural properties of nanofluids colloidal stability, effect of nanoparticles on rheological and thermal properties.Methods of synthesis and stabilization of nanofluids techniques for preparation of single- and multi-component systems, prevention of agglomeration.Applications of nanofluids in chemical, biomedical, cosmetic, food and energy engineering.Modeling and numerical simulations of heat flow and transport in nanofluids.Experimental research techniques measurements of viscosity, thermal conductivity, stability and biological properties of nanofluids.Lecture by a specialist from industry applications of nanofluids in industrial practice, market prospects and implementation barriers.2. Seminars Discussion of global issues related to nanofluidsSeminars will be conducted in the form of moderated discussions, in which students will analyze key challenges related to the use of nanofluids in various sectors of industry and science.Suggested topics:Nanofluids and ecology are they environmentally friendly or are they another source of micro- and nanoplastics?Legal regulations and safety of nanofluids how do the European Union and global institutions regulate the use of nanofluids in food, cosmetics and biomedicine?Industrial challenges in the production of nanofluids why, despite their promising properties, are they not yet widely used?Nanofluids and water management can nanofluids improve water purification and pollution removal technologies?Nanofluids as a breakthrough in energy are they a key solution for improving the cooling efficiency of energy systems?Ethics and social perception of nanotechnology is society ready for products containing nanofluids in food, cosmetics and pharmaceuticals?Each seminar will be based on students' previous preparation through reading scientific literature and analyzing selected industrial cases.3. Exercises Study of selected properties of nanofluidsDuring laboratory classes, students will gain practical skills in the preparation, analysis and characterization of nanofluids.Suggested exercises:Release profile of active substances from nanofluids analysis of the kinetics of release of bioactive substances from nanofluid systems using the spectrophotometric method.Antimicrobial activity of nanofluids assessment of the ability of nanofluids (e.g. containing nanosilver) to inhibit the growth of bacteria and fungi using the diffusion-disk method.Study of colloidal stability of nanofluids analysis of zeta potential and sedimentation tests for different types of nanoparticles.Rheology of nanofluids viscosity measurements and rheological analyses as a function of temperature and nanoparticle concentration.Study of thermal conductivity of nanofluids experimental determination of thermal conductivity using the hot wire method. Nanofluid flow simulation use of CFD (Computational Fluid Dynamics) tools to model flow and heat transport in systems with nanofluids.
Prerequisites and co-requisites	• Basic knowledge of mathematics and physics (especially thermodynamics and fluid mechanics) and physical chemistry at the engineering level. • Knowledge of basic materials science, including the structure of condensed matter and the properties of solids (e.g., completed courses in materials science or solid state physics). • Laboratory experience in physical or chemical measurements would be helpful (e.g., completed labs in fluid mechanics or chemical engineering).

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Prezentacja	60.0%	20.0%
Exercise report	60.0%	40.0%
Exam after lectures	60.0%	40.0%

Recommended reading

Basic literature

Podstawowa:

- S.K. Das, S.U.S. Choi, W. Yu, T. Pradeep *Nanofluids: Science and Technology*, John Wiley & Sons, 2008.
- S.S. Sonawane, H.A. Mohammed, A.K. Mungray, S.H. Sonawane (red.) *Applications of Nanofluids in Chemical and Bio-medical Process Industry*, Elsevier, 2022.

Supplementary literature

- S.S. Sonawane, M. Malika (red.) *Hybrid Nanofluids: Heat and Mass Transfer Processes*, CRC Press, 2025.
- W. Yu, H. Xie **A Review on Nanofluids: Preparation, Stability Mechanisms, and Applications**, *Journal of Nanomaterials*, vol. 2012, Article ID 435873 (a scientific review article discussing the methods of obtaining and properties of nanofluids).
- O. Mahian, L. Kleinstreuer, Y. Feng, A. Al-Sharafi i in. **Recent advances in modeling and simulation of nanofluid flows Part I: Fundamentals and theory**, *Physics Reports*, vol. 790, 2019, s. 148 (a comprehensive review of theoretical models and simulation methods for nanofluids).

	eResources addresses	Adresy na platformie eNauczanie: Zastosowania techniczne nanocieczy - Moodle ID: 45533 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=45533
Example issues/ example questions/ tasks being completed	• Definition and classification of nanofluids how do nanofluids differ from conventional colloidal systems? • Physicochemical properties of nanofluids how do viscosity, thermal conductivity and stability change in the presence of nanoparticles? • Methods of nanofluid synthesis how to prepare stable suspensions of nanoparticles? • Nanofluids in chemical engineering how do they increase the efficiency of heat and mass transfer? • Applications of nanofluids in biomedicine can they serve as drug carriers and therapeutic agents? • Nanofluids in the food and cosmetics industry are they safe and will consumers accept them? • Experimental methods and numerical modelling of nanofluids how to simulate their properties? • Safety and legal regulations of nanofluids what restrictions are introduced by the EU and FDA?	
Work placement	Not applicable	

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