GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	CHEMISTRY AND TECHNOLOGY OF DISPRESED SYSTEMS, PG_00048968		
Field of study	Green Technologies		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
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	English
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Department of Colloid and Lipid Science -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Adam Macierzanka	
	Teachers		

Lesson types and methods of instruction							
	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	0.0	0.0	60
	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	60	10.0	30.0	100

Subject objectives	
	The aim of the course is to provide a broad but detailed introduction to chemistry and technology of dispersed systems and an overview of some theoretical developments, up-to-date experimental advances and current industrial applications, with an emphasis on green technologies. This course will focus on the theories used in colloid science, their important applications and associated techniques.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_K01] is ready to solve the most common problems associated with the profession of engineer, correctly identifies and resolves dilemmas associated with the profession of engineer, assesses risks and is able to assess the effects of the activity	is able to use known mathematical and physical methods and models to describe and explain chemical phenomena and processes as well as solve simple research problems]	
	[K7_W02] a broader and deeper knowledge of the soil, air and water from pollution useful to formulate and solve complex tasks in the field of environmental technologies and modern analytical methods	has expanded and in-depth knowledge in the field of chemistry including general, inorganic, organic, physical and analytical chemistry, including the knowledge necessary to describe and understand chemical phenomena and processes occurring in environmental protection technologies, as well as to measure and determine the parameters of these processes	
	[K7_W03] will have a detailed knowledge of the theoretical basis of methods and types of apparatus used in chemical analysis of environmental pollutants and the technology of cleaning and neutralization of industrial waste and wastewater management and the design and supervision of environmentally friendly technologies	will have the knowledge described in K_W03	

Subject contents	The science of dispersed systems has applications and ramifications for many industries: from pharmaceuticals, foodstuffs and agrochemicals to printing inks, coatings and oil recovery. The course will provide a general introduction to the chemistry and technology of dispersed systems coupled with a more detailed illustration of the most important theoretical and experimental aspects. It will also provide students with a comprehensive look at emerging technologies in this field. The course will consist of a series of lectures and laboratory practical exercises. The lectures will focus on the theories used in colloid science, their applications and associated measuring techniques. Topics that will be covered are divided in two sections and include: 1. Fundamental theoretical knowledge of the chemistry and technology of dispersed systems as well as practical experimental science of dispersed systems, their properties and measuring techniques. These will include (but not be limited to) aspects such as: - Definition and classification of dispersed systems and preparation techniques (condensation and dispersion methods), - Different types of dispersed systems (foams, emulsions, microemulsions, aerosols, gels etc., characteristics of typical devices used to produce dispersed systems), - Interactions between molecules and in macroscopic systems (physical and specific interactions, structure and parameters of the double electric layer, mechanism of the surface charge formation, potential zeta, DVLO theory etc.), - Surface and interfacial tension, adsorption to interfaces (fundamentals of measuring techniques, wetting and contact angle phenomena etc.), - Fundamental characterisation and properties of surfactants (structure, classification, bio-surfactants, hydrophilic-lipophilic properties, HLB value, etc.), - Kinetic properties of dispersed systems (Brownian motion, diffusion, osmosis etc.), - Rheological properties of dispersed systems (viscosity, viscoelasticity, micro-rheology, measuring rheological and micro-rheological properties etc.), - Electrokinetic phenomena in dispersed systems and optical properties of dispersed systems, - Stability of dispersed systems: a. Emulsion stability (flocculation and mechanisms of its formation, coalescence, phase inversion etc.), b. Stability of foams and gels (phase migration, syneresis etc.), c. Particle size determination techniques, d. Measuring techniques for stability assessment of dispersed systems. - Association colloids (micellization, micelle structure, liposomes, solubilisation etc.), - Overview of conventional and modern microscopy methods in monitoring structural properties of dispersed systems. The information presented to students in this part will focus on techniques used in preparation of various dispersions and evaluation of their functional properties. Only necessary fundamental knowledge relevant to the above aspects will be discussed. This is in order to avoid delivering basic theoretical knowledge that has already been presented to the students in the Physical Chemistry class. 2. Industrial and scientific applications of dispersed systems and their importance in nano- and green technologies. These will include (but not be limited to) aspects such as: - Modern methods/equipment in characterising physical-chemical properties of dispersed systems, - Overview of dispersions as colloidal delivery systems of pharmaceutical, cosmetic and food bioactive substances, - Production and utilisation of gold and silver nanoparticles, - Bioadhesive microspheres and their biotechnological and pharmaceutical applications, - Microencapsulation of probiotic cells, - Dispersed systems containing liquid crystalline phases, - Multiple emulsions in biomedical and biotechnological applications, - Sol-gel materials for biotechnological and bioengineering applications, - Nono-structuring of food colloids for improving shelf-live and textural properties, - Nono-structuring of dispersed systems in foods for modulating digestion and nutrient absorption processes in disease prevention and treatment, - Structuring of cosmetic dispersions, - Dispersed systems as micro-bioreactors, - Emulsion polymerisation, - Nano-engineering of paints, inks and coatings for improved efficiency, - Microfluidic devices and their applications in science and technology of dispersed systems, - Overview of the treatment of waste dispersed systems (e.g. oil demulsification methods etc.). The theoretical knowledge gained by students will be finally evaluated in a written examination. The course will also focus on the translation of theoretical knowledge to practical applications through laboratory exercises. The exercises will be preceded by short written tests relevant to particular exercises. The laboratory exercises will be organised in the Department of Fats and Detergents Technology. They will cover topics such as: Data wydruku: 27.09.2019 09:41 Strona 4 z 5 - Determination of the hydrophilic-lipophilic properties of surfactants. The exercise aims at determining the HLB (hydrophylic-lipophylic balance) value of several surfactants, which differ in their affinity to oil and water phases, as a mean of characterising functional properties of surfactants. Students will apply the experimental method of 'optimal emulsion'. - Influence of the phase ratio and the temperature on the emulsion type, the phase inversion and the stability of emulsion systems. The aim of this exercise is to examine a phase inversion phenomenon occurring during the preparation of emulsions with different types of emulsifiers as well as determining stability of emulsions varying in the dispersed phase ratios. The stability/structure of emulsions will be assessed by methods such as measurements of backscattered laser light and the light transmitted through emulsions. Measurements will be done immediately after emulsion preparation and after 1-2 weeks of storage. - Microemulsions and methods for their preparation. The exercise aims at obtaining a different type of emulsion systems – i.e. transparent and thermodynamically stable microemulsions, and to teach students

	about the role of co-surfactants in stabilizing such systems. - Determination of the critical micelle concentration (CMC) in aqueous solutions of surfactants. The exercise aims at determining the CMC values of several surfactants that are commonly used in industry to stabilise dispersed systems. The CMC will be assayed by methods such as the stalagmometric method and the measurements of the conductivity of surfactant solutions. - Wettability and contact angle. The aim of the exercise is to investigate wettability of solid surfaces by surfactant solutions at various surfactant concentrations. The wettability will be assayed by methods such as capillary method and the measurements the contact angles of sessile drops. - Examination of basic rheological properties of gels and emulsions. The exercise aims to produce model gels and emulsions with different ratios of dispersed phases. These will be then then analysed in a rheometer in order to determine functional properties of dispersed systems such as changes in viscosity in the function of shear rate and the yield stress required to break structure of a system and make it flow. - Properties of dispersed systems used in everyday life. The students will use their theoretical knowledge in assessing some functional properties of dispersed systems. The tasks will involve determining the foaming efficiency and the foam stability of systems such as detergent preparations or a beer. In the next part, students will produce a mayonnaise and a cosmetic emulsion and investigate their stabilities. - Destabilisation of waste emulsions/dispersions. The aim of this exercise is to make students aware of a common problem of the neutralisation of waste emulsions/dispersions produced in industrial processes. The students will try to accelerate phase separation in such systems by using methods that involve for example heating and the use of demulsifies in order to make the systems suitable for safe disposal. It is anticipated that seven of the above exercises will require 4 hours each, and one exercise will be 2-hour long (all together, it gives 30 hours). One of the evaluation criteria, apart from the short written tests, will be preparation of a written report for each exercise, containing a description of the aim of exercise and a discussion of the results obtained. The reports have to be accepted by a supervising teacher.
Prerequisites and co-requisites	Basic knowledge of physical chemistry, chemical technology and biotechnolog

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture (written examination)	50.0%	60.0%
Laboratory practical exercises (attendance, written tests and exercise reports)	100.0%	40.0%

Recommended reading

Basic literature	M. Fanun, Colloids in biotechnology, CRC Press 2011; I.D. Morrison, Colloidal dispersions, Wiley 2002; J. Sjoblom, Emulsions and emulsion stability, CRC Press 2006; L.D. Rhein, Surfactants in personal products and decorative cosmetics, CRC Press 2007; B.P. Binks, Modern aspects of emulsion science, RCS 1998; S.E. Friberg, Food emulsions, Marcel Dekker 1997; J.J. Wille, Skin delivery systems, Blackwell 2006; IFSCC, Introduction to cosmetic emulsions and emulsification, Micelle Press 1997; R. Zana, Dynamics of surfactant self-assemblies, Taylor & Francis 2005; G.L. Hasenhuettl, Food emulsifiers and their applications, Chapman & Hall 1997; K. Holmberg, Applied surfaces and colloid chemistry, Wiley 2002; D. Myers, Surfaces, interfaces, and colloids, Wiley-VCH 1999; M.J. Rosen, Industrial utilization of surfactants, AOCS 2000; N. Garti, Thermal behaviour of dispersed systems, Marcel Dekker 2001; L.H Tan Tai, Formulating detergents and personal care products, AOCS Press 2000; P. Ghosh, Colloid and interface science, PHI Learning Private Ltd., New Delhi, 2009; E.S. Hedges, Colloids, Hedges Press, 2007; Recent review articles in relevant scientific journals.
Supplementary literature	C.E. Stauffer, Emulgatory, WNT, Warszawa 2001; H. Sonntag, Koloidy, PWN, 1982; E.T. Dutkiewicz, Fizykochemia powierzchni, WNT, Warszawa 1998; R. Zieliński, Surfaktanty, WAEP, Poznań 2000; G. Schramm, Reologia – podstawy i zastosowania, OWN, Poznań 1998; L. Sobczyk, A. Kisza, Chemia fizyczna dla przyrodników, PWN, Warszawa 1977; P. W. Atkins, Podstawy chemii fizycznej, PWN, Warszawa 1999; H. Buchowski, W. Ufnalski, Roztwory, WNT, Warszawa 1995.
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed	Those will be directly related to the topics described above in the class structure section.
Work placement	Not applicable