GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Coloured materials - from molecular chemistry to advanced technology, PG_00069289						
Field of study	Chemical Technology						
Date of commencement of studies	February 2025		Academic year of realisation of subject	2025/2026			
Education level	second-cycle studies		Subject group				
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	3.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry -> Wydziały Politechniki Gdańskiej						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Ewa Wagner-Wysiecka				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	10.0	10.0	10.0	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		25.0	75
Subject objectives	The aim of the course is to familiarize students with the properties, structure, and applications of colorants ranging from classical organic dyes to modern functional systems used in optoelectronics, medicine, and environmental chemistry. Students will explore the relationships between molecular structure and color, and will learn how to utilize colored compounds. The course integrates knowledge from various fields, including organic, inorganic, and physical chemistry, as well as materials science and materials technology.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U02] carries out experiments using properly selected techniques and apparatus, taking advantage of new developments in technology and related fields	The student is able to design and carry out experiments involving colored substances or materials, selecting appropriate synthesis and characterization techniques. The student is able to operate laboratory equipment used for studying the properties of colorants and colorant-based materials. The student takes into account current and modern approaches used in materials chemistry and related fields in their experimental work.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools
	[K7_K01] critically evaluates the content of cognitive and practical problems	The student is able to critically evaluate information concerning the properties and applications of colorant materials across various fields. The student can distinguish reliable scientific data from unverified or unreliable sources. The student demonstrates readiness to formulate their own opinions and assessments in discussions on the challenges and limitations of modern dye chemistry.	[SK3] Assessment of ability to organize work [SK5] Assessment of ability to solve problems that arise in practice
	[K7_W04] recognises scientific, technological, organisational and economic opportunities and constraints in technology and related fields	The student is familiar with the potential and limitations of using colorants in various areas of science and technology. They understand the technological, economic, and environmental factors involved in the design and implementation of functional dyes. The student has knowledge of current trends and development barriers related to colorant materials in both scientific research and industry.	[SW1] Assessment of factual knowledge

Subject contents

Lecture: 15 hours

1. Introduction to colorant materials.
   Fundamentals of color perception (eye, light). Color models (RGB, CMYK, CIE). Historical overview of color compounds: classification into dyes, pigments, and luminophores. *(2 hours)*
2. Chemical structure and color.
   Chromophores, auxochromes, resonance structures, influence of substituents, ionization, and steric factors. Spectroscopic characterization of colorants. *(2 hours)*
3. Chemical and technical classification of dyes.
   Selected groups of organic dyes: azo, triphenylmethane, and carbonyl dyes. *(3 hours)*
4. Modern colorant materials and their optical properties.
   Smart materials; phenomena such as photochromism, thermochromism, and electrochromism. Structural colors and photonic materials. *(3 hours)*
5. Application areas of colorant materials:
   Electronics and optoelectronics (OLEDs, displays, photodetectors, smart windows); medicine and diagnostics; analytical chemistry; textile industry. Optical markers. *(3 hours)*
6. Functional colorant materials:
   Synthesis, characterization, and application areas. *(2 hours)*

Seminar: 15 hours

1. Dyes in phototherapy and medical diagnostics fluorescent markers and photosensitizers
2. Colored compounds as chemical sensors selectivity, sensitivity, and environmental applications
3. Applications of colorants in forensic chemistry
4. Use of dyes in the protection of documents and valuable items
5. Color in functional packaging design smart labels, temperature sensors, food freshness indicators
6. Dyes in biodegradable materials prospects for sustainable development
7. Color as a psychological tool applications in public spaces, education, and marketing
8. Colorant materials in cosmetology dyes in makeup, hair coloring, and UV filters
9. Color as a functional factor photochemistry of dyes in solar energy conversion
10. Dyes in functional textiles from protective clothing to UV-smart garments
11. Applications of dyes in molecular biology DNA probes, intercalating dyes, fluorescent markers
12. Colorant materials and nanotechnology colored nanoparticles and their applications
13. Oxford-style debate
14. Oxford-style debate
15. Oxford-style debate

Laboratory: 15 hours (5 sessions × 3 hours)

1. Synthesis of classical carbonyl and azo dyes
2. Characterization of dyes: structurecolor relationship
3. Application of colorants in forensic science
4. Electrochromism fundamentals and applications
5. Thermochromism fundamentals and applications

Prerequisites and co-requisites

Knowledge of organic and inorganic chemistry.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory – completion of all practical exercises; passing five short written tests	51.0%	30.0%
Seminar – preparation of a presentation on a selected topic; active participation in Oxford-style debate	51.0%	30.0%
Lecture – written test	51.0%	40.0%

Recommended reading

Basic literature

1. J. Gronowska: Podstawy fizykochemii barwników, Wyd. UMK, Toruń, 1997.

2. B. I. Stiepanow: Podstawy chemii i technologii barwników organicznych, WNT, Warszawa 1980.

3. W. Czajkowski: Laboratorium z technologii barwników, Wyd. PŁ,. Łódź 1993.

The materials include original, up-to-date publications from leading scientific journals, made available through multimedia lecture resources.

	Supplementary literature	Publications in English: 1. P. Bamfield, M. G. Hutchings, Chromic Phenomena: Technological Applications of Colour Chemistry, 3rd Edition, Royal Society of Chemistry, 2018. 2. A. Zollinger, Color Chemistry: Syntheses, Properties and Applications of Organic Dyes and Pigments, 3rd Edition, Wiley-VCH, 2003.
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Define the following terms: dye, pigment, lake. 2. Photochromism: general principles of the phenomenon, examples of photochemically active compounds, and their applications. 3. Discuss the influence of substituents: electron-donating and electron-withdrawing groups, as well as the simultaneous effects of such substituents in stilbene and azobenzene molecules, on their color.	
Work placement	Not applicable	

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