GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chemistry and technology of dye materials, PG_00048566		
Field of study	Chemical Technology		
Date of commencement of studies	October 2020	Academic year of realisation of subject	2023/2024
Education level	first-cycle studies	Subject group	Optional subject group
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	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		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Ewa Wagner-Wysiecka	
	Teachers	dr hab. inż. Ewa Wagner-Wysiecka	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	30.0	0.0	0.0	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	2.0	28.0	75

Subject objectives

Knowing the reasons colourfulness of organic compounds, learn the methods of synthesis of the main groups of dyes and their applications

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_K03	Student is able to work in a team and be responsible for the proper execution of tasks and development of experimental results.	[SK1] Assessment of group work skills

Subject contents

The basic concent of color. Color theories - the historical overview. The bases of electron theory of color. Color vision. The structure of the dye - color relation: chromophoric systems, substituents and ionizable substituents and sterical effects. Competing and crossing coupled systems. Complexes with metal ions. Specific properties of dyes: solvatochromism, photochromism and thermochromism. The synthetic dyes - chemical and technical classification. Azo dyes: diazotation, diazo salts transformations, diazocoupling. The examples of synthesis of the azo dyes. Other group of dyes (arylmethine, carbonyl) - the synthesis and properties. The structure and properties of optical and chemical brighteners. Dyes, pigments and lakes: definition and differences. Color mixing. The application of dyes in different fields of industry (textile, paints, pharmaceutical etc.). The use of dyes in analytical chemistry. Environmental aspects of dye technology. Modern strategies in dye synthesis.

Prerequisites and co-requisites

Knowledge of the basis of organic chemistry, physical chemistry and chemical technology.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Test on the ground of the first part of the lecture	50.0%	25.0%
Laboratory exercise	50.0%	50.0%
Test on the ground of the second part of the lecture	50.0%	25.0%

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.
	Supplementary literature	1. H. Zollinger: Color Chemistry. Synthesis, Properties, and Applications of Organic Dyes and Pigments, WILEY-VCH, Zürich 2003. 2. S. Paszyc: Podstawy fotochemii, PWN, Warszawa 1981.
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	Part I. 1. In what popular natural dyes there are 9,10-anthraquinone derivatives and what are these compounds (formulas)? 2. History of the discovery of mouveine. 3. Please define primary and complementary colors and give examples of such a pairs. 4. Basic (independent) spectral colors. Additive color mixing. Subtractive color mixing. 5. Color description. Please define the three basic psychophysical features of colors (color attributes). 6. Color scale: Munsell system. 7. *Color vision*. Ranges of spectral absorption of each of the photosensitive substances present in cones and rods. 8. *Color vision.* Light-absorbing compound present in photoreceptors and the reaction with its participation. 9. Theories of color: Witt's theory. 10. Electronic color theory: - * transitions in linear conjugate systems and compound color. K bands. 11. Condensed aromatic hydrocarbons and color. 12. Conjugated and non-conjugated aromatic rings: *p*-polyphenyls and *m*-polyphenyls. 13. Characteristics, formulas and comparison of Hydrol Michler (blue) and Bindschedler Green. 14. The influence of the electron donating and electron withdrawing substituents and the simultaneous influence of this type of substituents in the stilbene and azobenzene molecules on their color. 15. The influence of ionization of the hydroxyl, thiol and amine groups in benzene derivatives on the change in the position of the absorption bands and their intensity. 16. Ionization of electron withdrawing substituents and its influence on color. 17. Please compare the colors of Michler's Hydrol, Auramine and Acetylauramine. Justify the answer briefly. 18. Branching of a coupled system. Please briefly discuss this issue on the example of: Malachite Green, *p*-Methylmalachite Green, *p*-Methoxymalachite Green and Crystal Violet. 19. Influence of spatial factors on light absorption by organic compounds: flatness violation. 20. Please discuss the influence of disturbance of the flatness of organic compounds on the spectral absorption curves. Part II. 1. Terms: dye, pigment, lake. 2. Parameters characterizing dyes and pigments. 3. The criteria for the division of dyes. 4. Dyeing of materials. Characteristics of the dyeing process (affinity, dispersion in the dyed material, etc.), dyeing techniques. 5. Technical classification of dyes (division, groups, examples). 6. Azo dyes: general characteristics, properties, reactivity. 7. Strategy for the synthesis of azo dyes (diazotization, diazo coupling - including special cases of these processes; selection of conditions; apparatus). 8. Monoazo dyes structure and their properties (resistance to light, wet agents, etc.). Examples of dyes from different groups and their applications. 9. Polyzo dyes. Systems with isolated and conjugated azo bonds. Structure vs. color. 10. Strategy for the synthesis of polyazo dyes. 11. Carbonyl dyes: structure and general characteristics. 12. Indigo: structure, properties, production methods, indigo dyeing. Indigo derivatives. 13. Anthraquinone dyes: structure vs. color. 14. Preparation of anthraquinone dyes: substrates, conditions. Amino- and hydroxy- anthraquinone dyes. Production, properties, applications. 15. Arylmethine dyes: structure and properties. Examples of arylmethine dyes - synthesis, properties, applications. 16. General strategy for the synthesis of arylmethine dyes. 17. Xanthene and acridine dyes: structure, properties, application. 18. Photochromism: general basis of the phenomenon, examples of photochemically active compounds, applications. 19. Solvatochromism: solvatochromic effects. Applications. 20. Thermochromism: general basis of the phenomenon, types of systems used, examples of applications.	
Work placement	Not applicable	