



Subject card

Subject name and code	Methods of Structural Analysis, PG_00054717						
Field of study	Biotechnology						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2026/2027		
Education level	first-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	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Department of Organic Chemistry -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Maria Milewska				
	Teachers		prof. dr hab. inż. Maria Milewska				
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	E-learning hours included: 0.0						
	eNauczenie source address: https://enauczenie.pg.edu.pl/2025/course/view.php?id=7006						
	Moodle ID: 7006 METODY BADAŃ STRUKTURALNYCH https://enauczenie.pg.edu.pl/2025/course/view.php?id=7006						
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 teach students how to interpret spectra by leveraging the synergistic information provided by NMR, IR, and electronic spectroscopy, as well as mass spectrometry. These spectroscopic techniques utilize electromagnetic radiation of varying energies, with the resulting spectra representing the sample compound's response to the applied radiation. The lectures will cover: (1) the theoretical principles and acquisition methods for infrared spectra; (2) the fundamentals of nuclear magnetic resonance (NMR), including proton, carbon, and fluorine resonance; (3) the theoretical basis of electronic transitions; and (4) molecular ionization methods and the fragmentation pathways of ionized compounds. Laboratory sessions will focus on methods for identifying the structures of chemical compounds based on spectroscopic and mass spectra.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K6_U01		is able to interpret NMR (¹ H and ¹³ C), IR, and mass spectrometry spectra by applying previously acquired knowledge in chemistry, physics, and mathematics.		[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information		
	K6_W09		has knowledge of the basics of spectroscopic methods; knows and understands the principle of operation and application of the most important spectroscopic methods to analyze the structure of organic compounds		[SW1] Assessment of factual knowledge		
	K6_U02		is able to apply previously acquired knowledge of physical, organic, and quantum chemistry to understand the fundamentals of spectroscopy used to characterize chemical compounds and to interpret the spectra of chemical compounds		[SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment		

Subject contents	Course content – lecture		
	Principles of spectroscopy – electromagnetic radiation, energy levels in molecules, absorption of radiation, line shape, selection rules, application of the Fourier transformation in spectroscopy. NMR spectroscopy – magnetic properties of atomic nuclei, the chemical shift, the spin-spin coupling, diamagnetic anisotropy of molecules, spin systems, the Karplus equation, dynamic effects, NOE, the Fourier transformation (FT-NMR), two-dimensional spectra (2D-NMR), basics of ^{19}F and ^{13}C NMR. Infrared spectroscopy (IR) – harmonic and anharmonic oscillator, vibrations of multiatom molecules, the normal vibrations, transition probability, group frequencies, hydrogen bonds in the IR spectroscopy, the Raman spectroscopy. Mass spectroscopy (MS) – physical basis of the MS spectroscopy, methods of sample ionization including electro- ant thermospray, ion types in MS, determination of molecular mass and molecular formula, fragmentation of molecules. Electronic spectra (UV-vis) – electronic levels, spectrometers, selection rules, band shape, vibronic transitions, simple chromophores, aromatic chromophores, influence of substituents, steric effects, solvent effects.		
	Course content – laboratory		
	The aim of the course is to acquire the skills to determine the structure of organic compounds based on spectra obtained via NMR, IR, and UV-Vis spectroscopy and mass spectrometry: • interpretation of the proton and carbon NMR spectra • measurements of the IR spectra; interpretation of the IR spectra • interpretation of mass spectra – determination of molecular mass; description of ion fragmentation		
Prerequisites and co-requisites	1. Knowledge of theoretical basis of spectroscopy 2. Knowledge of structures of organic compounds 3. Knowledge of nomenclature of organic compounds		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Lecture: teoretical colloquium	60.0%	50.0%
	Laboratory: midterm colloquium H and C NMR, IR, MS, UV	60.0%	50.0%
Recommended reading	Basic literature	1. R. M. Silverstein, F. X. Webster, D. J. Kiemle "Spektroskopowe metody identyfikacji związków organicznych", PWN, Warszawa, 2012. 2. "Spektroskopowe metody badania struktury związków organicznych", praca zbiorowa red. A. Rajca, WNT, Warszawa, 1996 lub 2000. 3. J. B. Lambert, H. F. Shurvell, D. A. Lightner, R. G. Cooks "Organic Structural Spectroscopy' Prentice-Hall, Inc., 1998	
	Supplementary literature	1. R. A.W. Johnstone, M. E. Rose "Spektrometria mas podręcznik dla chemików i biochemików", PWN, Warszawa, 2001. 2. A. Zschunke "Spektroskopia magnetycznego rezonansu jądrowego w chemii organicznej", PWN Warszawa, 1976. 3. Z. Kęcki "Podstawy spektroskopii molekularnej", PWN, Warszawa, 1972. 4. H. Günther "Spektroskopia magnetycznego rezonansu jądrowego", PWN, Warszawa, 1983. 5. M. Gensicka-Kowalewska, M. J. Milewska "Podstawy metod badań struktury związków organicznych w zadaniach" , Wydawnictwo PG, Gdańsk, 2024 6. Z. Głowacki "Podstawy spektroskopowych metod badania struktury związków organicznych. Wademekum wraz z zadaniami" Tutor, 2022	

	eResources addresses	Basic https://chem.pg.edu.pl/node/32/dla-studentow/chemia/metody-badan-strukturalnych - The files contain lecture slides and materials for use in laboratory classes — for example, tables of spin-spin coupling constants, characteristic functional group frequencies, spectra, etc.
Example issues/ example questions/ tasks being completed	1. The pair of protons at C-3 of <i>cis</i>-1,2-dichlorocyclopropane are diastereotopic. Explain. 2. Characterize the indicated protons as being homotopic, enantiotopic, or diastereotopic ; magnetically equivalent or nonequivalent.. For example: 1-fluoro-1-iodoethene 3. Write out the rotamers of 2-chloroethanol. What is the spin notation at slow rotation for each rotamer and at fast rotation for the average?	
Practical activities within the subject	Not applicable	

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