



Subject card

Subject name and code	Methods of Structural Studies, PG_00036275						
Field of study	Green Technologies						
Date of commencement of studies	October 2020	Academic year of realisation of subject			2021/2022		
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	2	Language of instruction			Polish		
Semester of study	4	ECTS credits			4.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Department of Organic Chemistry -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. Sławomir Makowiec				
	Teachers		dr hab. Sławomir Makowiec prof. dr hab. inż. Maria Milewska				
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						
	Adresy na platformie eNauczenie:						
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	5.0		35.0		100
Subject objectives	A main goal is to teach students basic spectroscopic methods including: NMR, IR, UV, and MS, and their application in the analysis of the structure of organic compounds						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	[K6_W01] has a basic knowledge from some branches of mathematics and physics useful for formulating and solving simple problems in the field of environmental technologies and modern analytical methods	The student knows the physical basis of IR, NMR and MS spectroscopy.			[SW1] Assessment of factual knowledge		
	[K6_W02] has a basic knowledge of chemistry including general chemistry, inorganic, organic, physical, analytical, including the knowledge necessary to describe and understand the phenomena and chemical processes occurring in the environment; measurement and the determination of the parameters of these processes.	The student knows the physical basis of IR, NMR and MS spectroscopy.			[SW1] Assessment of factual knowledge		
	[K6_U03] is able to use information and communication technologies relevant to the common tasks of engineering, is able to use known methods and mathematical-physical models to describe and explain phenomena and chemical processes	Student is able to analyze the IR, NMR, MS spectra and assign the appropriate structural formula of the compound.			[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment		

Subject contents	<p>Principles of spectroscopy – electromagnetic radiation, energy levels in molecules, absorption of radiation, line shape, selection rules, application of the Fourier transformation in spectroscopy.</p> <p>NMR – magnetic properties of atomic nuclei, the chemical shift, the spin-spin coupling, diamagnetic anisotropy of molecules, interpretation of the proton NMR spectra, spin systems, the Karplus equation, dynamic effects, NOE, the Fourier transformation (FT-NMR), two-dimensional spectra (2D-NMR), basics of ¹⁹F and ¹³C NMR, elements of NMR of other nuclei.</p> <p>Infrared spectroscopy (IR) – harmonic and anharmonic oscillator, vibrations of multiatom molecules, the normal vibrations, transition probability, group frequencies, measurements of the IR spectra, interpretation of the IR spectra, hydrogen bonds in the IR spectroscopy, the Raman spectroscopy.</p> <p>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.</p> <p>Electronic spectra (UV-vis) – electronic levels, spectrometers, selection rules, band shape, vibronic transitions, simple chromophores, aromatic chromophores, influence of substituents, steric effects, solvent effects.</p>											
Prerequisites and co-requisites	<ol style="list-style-type: none"> 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	<table border="1"> <thead> <tr> <th data-bbox="453 1274 794 1305">Subject passing criteria</th> <th data-bbox="799 1274 1141 1305">Passing threshold</th> <th data-bbox="1145 1274 1482 1305">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 1312 794 1339">theoretical test</td> <td data-bbox="799 1312 1141 1339">60.0%</td> <td data-bbox="1145 1312 1482 1339">50.0%</td> </tr> <tr> <td data-bbox="453 1346 794 1393">Midterm tests ¹H and ¹³C NMR, IR, MS, UV</td> <td data-bbox="799 1346 1141 1393">60.0%</td> <td data-bbox="1145 1346 1482 1393">50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	theoretical test	60.0%	50.0%	Midterm tests ¹ H and ¹³ C NMR, IR, MS, UV	60.0%	50.0%
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Recommended reading	Basic literature	<ol style="list-style-type: none"> 1. R. M. Silverstein, F. X. Webster, D. J. Kiemle "Spektroskopowe metody identyfikacji związków organicznych", PWN, Warszawa, 2007. 2. "Spektroskopowe metody badania struktury związków organicznych", praca zbiorowa red. A. Rajca, WNT, Warszawa, 1996 lub 2000. 3. R. M. Silverstein, G. C. Bassler "Spektroskopowe metody identyfikacji związków organicznych", PWN, Warszawa, 1970. 4. L. K. Kazicyna, N. B. Kuplarska "Metody spektroskopowe wyznaczania struktury związków organicznych", PWN, Warszawa, 1974 5. M. J. Milewska, Wykłady, http://www.pg.gda.pl/chem/Katedry/Organa/dydaktyka.htm 										

	Supplementary literature	<p>1. R. A.W. Johnstone, M. E. Rose "Spektrometria mas – podręcznik dla chemików i biochemików", PWN, Warszawa, 2001.</p> <p>2. A. Zschunke "Spektroskopia magnetycznego rezonansu jądrowego w chemii organicznej", PWN Warszawa, 1976.</p> <p>3. Z. Kęcki "Podstawy spektroskopii molekularnej", PWN, Warszawa, 1972.</p> <p>4. H. Günther, "Spektroskopia magnetycznego rezonansu jądrowego", PWN, Warszawa, 1983.</p> <p>5. M. Szafran, Z. Dega-Szafran "Określenie struktury związków organicznych metodami spektroskopowymi", PWN, Warszawa, 1988</p>
Example issues/ example questions/ tasks being completed	eResources addresses	
Work placement	Not applicable	