

Subject card

Subject name and code	Monographic lecture - Introduction into quantum computer chemistry, PG_00080897						
Field of study	Chemistry						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2026/2027		
Education level	Master's studies		Subject group		Obligatory subject group in the field of study Optional subject group		
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		3.0		
Learning profile	academic		Assessment form		credit		
Conducting unit	Faculty of Chemistry -> Rector						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Janusz Rak				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30		5.0		40.0	75
Subject objectives	Preparing students to choose the appropriate method of computational chemistry for analyzing a specific chemical problem, designing an algorithm that ensures a fast solution to the problem, and evaluating the accuracy of the obtained numerical result.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[CHEMMU2_W05] Has extended knowledge in the field of the specialisation studied.		Has profound knowledge of the basic concepts, principles, and theories used in computational chemistry.		[SW4] test/exam - oral or written		
	[CHEMMU2_W11] Demonstrates general knowledge about the current trends in the development of chemistry as a science and the latest discoveries in this field.		Has knowledge about the directions of development and applications of computational chemistry.		[SW4] test/exam - oral or written		
	[CHEMMU2_K01] Knows the limitations of her/his own knowledge; understands the need for further education and can inspire other people to do so.		Is aware of knowledge and skills, understands the need for continuous professional development and personal growth, conducts self-assessment of competencies, and strives for improvement.		[SK4] test/exam - oral or written		
	[CHEMMU2_W01] Uses knowledge of spectroscopic methods of chemical compound analysis.		Understands and can explain the regularities, phenomena, and processes correctly, especially able to independently reproduce basic laws and theorems.		[SW4] test/exam - oral or written		

Subject contents	The Born-Oppenheimer approximation, time-independent Schrödinger equation. Single-electron approximation, Slater determinant, Hartree-Fock method (HF) and Hartree-Fock-Roothaan method (HFR), semi-empirical schemes of HFR method: CNDO, INDO, ND-DO, modified NDDO methods: MNDO, AM1, PM3, PM5, RM1, PM6, MNDO/d, SAM1, SAM1d. Basis sets. Electron correlation: Configuration interaction (CI) method, Møller-Plesset perturbation theory (MPn), Coupled-cluster method (CC). Density functional theory (DFT) methods. Applications of HFR method and correlated methods: basis set selection, geometry optimization of molecules, determination of reaction enthalpies, harmonic vibrational modes (IR spectrum), NMR shifts, and electronic spectra of molecular systems.		
Prerequisites and co-requisites	Physical chemistry, quantum chemistry, the ability to describe chemical reactions in terms of thermodynamics and kinetics, knowledge of the basics of molecular spectroscopy.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	test	51.0%	100.0%
Recommended reading	Basic literature	1. Lucjan Piela Idee chemii kwantowej, PWN 2003. 2. Frank Jensen Introduction to Computational Chemistry, Wiley, 2006. 3. Christopher J. Cramer Essentials of Computational Chemistry: Theories and Models, Wiley, 2004.	
	Supplementary literature	1. Attila Szabo, Neil S. Ostlund Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, Dover Publications, 1996.	
	eResources addresses		
Example issues/ example questions/ tasks being completed	1. Assumptions and approximations of the HF method. 2. Types of basis functions used in quantum chemical calculations their advantages and limitations. 3. What are diffuse functions? What is their mechanism of action and when are they used? 4. What is the ZDO approximation and what is its significance for semi-empirical methods? 5. Briefly describe the ideas of DFT methods.		
Work placement	Not applicable		

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