



Subject card

Subject name and code	Atomic and molecular physics, PG_00037283						
Field of study	Technical Physics						
Date of commencement of studies	October 2022	Academic year of realisation of subject			2024/2025		
Education level	first-cycle studies	Subject group			Optional subject group 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	6	ECTS credits			5.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Division of Atomic, Molecular and Optical Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Radosław Szmytkowski					
	Teachers	prof. dr hab. Radosław Szmytkowski dr Piotr Weber					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	15.0	0.0	0.0	75
	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	75		5.0		45.0	125
Subject objectives	To acquaint students with fundamentals of atomic and molecular physics.						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K6_W08	Is able to critically analyze the results of an experiment.			[SW3] Assessment of knowledge contained in written work and projects		
	K6_U04	Knows the basic principles of experimental work in the atomic and molecular physics laboratory.			[SU1] Assessment of task fulfilment		
	K6_W02	Possesses basic knowledge of the quantum description of the atomic structure and of selected phenomena occurring at the atomic level.			[SW1] Assessment of factual knowledge		

Subject contents

1. Selected quantum mechanical tools of Physics of Atoms and Molecules:

- a. the virial theorem,
- b. the Hellmann-Feynman theorem,
- c. the time-independent perturbation theory,
- d. the variational method.

2. Isolated one-electron atom in the Schrödinger theory:

- a. separation of the Schrödinger-Coulomb equation in spherical coordinates,
- b. the angular momentum, spherical harmonics,
- c. process of solving the radial Schrödinger-Coulomb equation,
- d. the Coulomb wave functions in spherical coordinates,
- e. the Bohr-Schrödinger energy levels and their degeneration.

3. Fundamental physical constants of atomic and molecular physics. Systems of units.

4. The Stark effect for the one-electron atom:

- a. the quadratic effect for the ground state,
- b. the linear effect (the first excited state as an example).

5. The Zeeman effect for the one-electron atom:

- a. with electron spin neglected,
- b. with electron spin taken into account.

6. The ground state of a two-electron atom:

- a. application of the perturbation theory,
- b. application of the variational method.

7. Excited states of a two-electron atom.

8. Many-electron atoms.

9. The hydrogen molecular ion.

10. The hydrogen molecule.

Prerequisites and co-requisites	Knowledge of quantum mechanics at the level of the course "Quantum Mechanics I".		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Grade for laboratories	50.0%	33.33%
	Exam	37.5%	66.67%
Recommended reading	Basic literature	B.H. Bransden, C.J. Joachain, Physics of atoms and molecules, 2nd ed., Prentice Hall, Harlow, 2003	
	Supplementary literature	1. Z. Leś, Podstawy fizyki atomu, PWN, Warszawa, 2014 2. W. Demtröder, Atoms, molecules and photons, 3rd ed., Springer, Berlin, 2018 3. Lecture notes provided by the lecturer (in Polish).	
	eResources addresses	Uzupełniające Adresy na platformie eNauczanie: Fizyka atomu i cząsteczki (semestr letni 2024/25) - Moodle ID: 43467 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=43467	
Example issues/ example questions/ tasks being completed	1. Present types of the Stark effect for the one-electron atom. 2. Describe the ground state of a two-electron atom using the variational method. 3. Describe the ground state of the hydrogen molecule.		
Work placement	Not applicable		

Document generated electronically. Does not require a seal or signature.