



Subject card

Subject name and code	Atomic and molecular physics, PG_00064053						
Field of study	Technical Physics						
Date of commencement of studies	October 2025		Academic year of realisation of subject		2027/2028		
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		6.0		
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 -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. Radosław Szmytkowski				
	Teachers						
Lesson types	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						
	eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=2925						
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		70.0	150
Subject objectives	Familiarizing students with the fundamentals of atomic and molecular physics.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K6_U04] plans and conduct experiments, critically analyzes their results, draw conclusions and forms opinions, has laboratory work experience		Has the ability to perform simple experiments in atomic physics, analyze their results, and present them in a written report.		[SU4] Assessment of ability to use methods and tools		
	[K6_W02] has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics		Has basic knowledge of the quantum description of atomic structure and selected phenomena occurring at the atomic level.		[SW1] Assessment of factual knowledge		
	[K6_W08] has knowledge of planning and conducting physical experiments, and critical analysis of its results		Has basic theoretical knowledge of planning and conducting experiments in atomic physics, as well as principles for critically analyzing their results.		[SW1] Assessment of factual knowledge		

Subject contents

Course content – lecture

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 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.

	Course content – exercises Solving problems that illustrate the individual topics presented during the lecture.		
	Course content – laboratory 1. Determination of the elementary charge (Millikan's experiment).		
	2. Identification of atomic spectrum.		
	3. Determination of the Rydberg constant.		
Prerequisites and co-requisites	Knowledge of quantum mechanics within the scope of the course "Quantum Mechanics I".		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Exam	37.5%	66.67%
	Grade for laboratories	50.0%	33.33%
Recommended reading	Basic literature	B.H. Bransden, C.J. Joachain, Physics of atoms and molecules, 2nd ed., Prentice Hall, Harlow, 2003	
	Supplementary literature	W. Demtröder, Atoms, molecules and photons, 3rd ed., Springer, Berlin, 2018	
	eResources addresses		
Example issues/ example questions/ tasks being completed	1. Discuss the types of the Stark effect for a one-electron atom. 2. Present a description of the ground state of a two-electron atom using the variational method. 3. Present a description of the ground state of the hydrogen molecule.		
Practical activities within the subject	Not applicable		

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