GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Atomic and molecular physics, PG_00064053		
Field of study	Technical Physics		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
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_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
[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

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 Schr{\"o}dinger theory: a. separation of the Schr{\"o}dinger-Coulomb equation in spherical coordinates, b. the angular momentum, spherical harmonics, c. process of solving the radial Schr{\"o}dinger-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.

<table>
<tr><td></td><td>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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Knowledge of quantum mechanics within the scope of the course "Quantum Mechanics I".</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Exam</td><td>37.5%</td><td>66.67%</td></tr>
<tr><td>Laboratory assessment</td><td>50.0%</td><td>33.33%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>B.H. Bransden, C.J. Joachain, Physics of atoms and molecules, 2nd ed., Prentice Hall, Harlow, 2003</td></tr>
<tr><td>Supplementary literature</td><td>W. Demtr{\"o}der, Atoms, molecules and photons, 3rd ed., Springer, Berlin, 2018</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>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.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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