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 2026	Academic year of realisation of subject	2028/2029
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

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

Introduction to the fundamentals of atomic and molecular physics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U04] is able, individually or in a team, to plan and conduct experiments in physics and related fields, including applied computer science or energy engineering, and to analyse and interpret results and formulate conclusions.	Is able to conduct experiments in atomic and molecular physics, analyze results, and draw conclusions.	[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K6_W04] has advanced knowledge of the principles of experimental design, experimental methods, measurement techniques and scientific equipment used in physics and related sciences, including their life cycle.	Has knowledge of experimental techniques and measurement instruments used in atomic and molecular physics.	[SW1] Assessment of factual knowledge
[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	Has knowledge of quantum-mechanical methods for describing the structure of atoms and simple molecules.	[SW1] Assessment of factual knowledge

Subject contents	Course content – lecture 1. Selected quantum mechanical tools of Physics of Atoms and Molecules: the virial theorem, the Hellmann-Feynman theorem, the time-independent perturbation theory, the variational method. 2. Isolated one-electron atom in the Schrödinger theory: separation of the Schrödinger-Coulomb equation in spherical coordinates, the angular momentum, spherical harmonics, process of solving the radial Schrödinger-Coulomb equation, the Coulomb wave functions in spherical coordinates, 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: the quadratic effect for the ground state, the linear effect (the first excited state as an example). 5. The Zeeman effect for the one-electron atom: with electron spin neglected, with electron spin taken into account. 6. The ground state of a two-electron atom: application of the perturbation theory, 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 illustrating 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. 4. Laser interferometry.
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
Written exam	37.5%	66.67%
Grade for laboratories	50.0%	33.33%

Recommended reading

Basic literature

1. B.H. Bransden, C.J. Joachain, Physics of atoms and molecules, 2nd ed., Prentice Hall, Harlow, 2003

2. C.E. Burkhardt, J.J. Leventhal, Topics in atomic physics, Springer, Berlin, 2006

3. H. Friedrich, Theoretical atomic physics, 3rd ed., Springer, Berlin, 2006

	Supplementary literature	1. C.J. Foot, Atomic physics, Oxford University Press, Oxford, 2005 2. H. Haken, H.C. Wolf, The physics of atoms and quanta, 3rd ed., Springer, Berlin, 1993
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Solution of a problem on the structure of an isolated one-electron atom. 2. Solution of a problem on the Stark effect. 3. Solution of a problem on the Zeeman effect. 4. Solution of a problem on the structure of an isolated two-electron atom.	
Practical activites within the subject	Not applicable	

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