GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modern Atomic and Molecular Physics, PG_00072603		
Field of study	Technical Physics, Materials Engineering, Mathematics, Materials Engineering, Nanotechnology, Nanotechnology, Materials Engineering		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Optional subject group
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	English
Semester of study	3	ECTS credits	1.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	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	dr hab. Jan Franz	
	Teachers	dr hab. Jan Franz	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	0.0	0.0	15
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	15	2.0	8.0	25

Subject objectives

The aim is to develop fundamental knowledge of the structure and behaviour of atoms and molecules through quantum mechanics and to investigate how this knowledge explains spectroscopic phenomena, chemical bonding and interactions with electromagnetic fields, providing a basis for applications in physics, chemistry and materials science.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods	is able to identify and explain key objects and phenomena in modern atomic and molecular physics, and relate them to the theories and models used to describe atomic and molecular systems.	[SW1] Assessment of factual knowledge
[K7_U101] is able to formulate complex research problems and adopts appropriate methods, obtaining innovative solutions, cooperating with other people, both as a leader and a team member	is able to analyse complex problems in atomic and molecular physics, propose suitable methods for their investigation, and work effectively both independently and in a team.	[SU1] Assessment of task fulfilment
[K7_K101] acknowledges the importance of knowledge related to the field of study in solving cognitive and practical problems, critically assessing the information obtained	acknowledges the importance of knowledge of quantum-mechanical concepts, atomic and molecular structure, molecular symmetry, and molecular properties in solving cognitive and practical problems, and critically assesses information related to modern atomic and molecular physics.	[SK5] Assessment of ability to solve problems that arise in practice

Subject contents	Course content – lecture 1. Fundamentals of quantum mechanics 2. Mathematical methods 3. Angular momentum 4. Simple atoms (hydrogen and helium) 5. Multi-electron atoms 6. Molecular structure 7. Molecular symmetry 8. Molecular orbitals 9. Molecular rotation 10. Molecular vibrations 11. Electronic states of molecules 12. Electrical properties of molecules 13. Magnetic properties of molecules 14. Further directions of development and applications 15. Summary
Prerequisites and co-requisites	Knowledge of the basics of quantum mechanics.
Assessment methods and criteria	see table below
Recommended reading	Basic literature: W. Demtröder, "Atoms, Molecules and Photons", Springer, Cham, 2019. Supplementary literature: I. V. Hertel, C.-P. Schulz, "Atoms, Molecules and Optical Physics 1", Springer, Berlin, 2015 I. V. Hertel, C.-P. Schulz, "Atoms, Molecules and Optical Physics 2", Springer, Berlin, 2015 eResources addresses:
Example issues/ example questions/ tasks being completed	Explain the difference between vibrational and rotational energy levels in a diatomic molecule. How does the bond length of a diatomic molecule affect its rotational spectrum? Explain in terms of the moment of inertia. How would the rotational spectrum of a molecule change if the molecule were to undergo isotopic substitution (e.g., replacing H with D in HCl)? Justify your answer with appropriate equations. Explain the Born-Oppenheimer approximation. What assumptions are made about the motion of the nuclei and electrons in the molecule?
Practical activites within the subject	Not applicable

Assessment methods and criteria:

Subject passing criteria	Passing threshold	Percentage of the final grade
Homework	50.0%	100.0%

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