University of Gdańsk

Subject card

Subject name and code	Introduction to Modern Physics, PG_00182573						
Field of study	Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject		2027/2028		
Education level	Bachelor's studies		Subject group		Obligatory subject group in the field of study 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	2		Language of instruction		Polish		
Semester of study	3		ECTS credits		5.0		
Learning profile	academic		Assessment form		credit		
Conducting unit							
Name and surname of lecturer (lecturers)	Subject supervisor		dr Agata Lazarowska				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	15.0	30.0	0.0	0.0	60
	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	60		0.0		65.0	125
Subject objectives	The aim of the course is to familiarize students with breakthrough experiments and discoveries that revolutionized physics and initiated the development of quantum theory. The course also develops students skills in conducting experiments, analyzing data, and interpreting results in the context of physical theory.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZL3_W03] knows, on the advanced level, how to plan and perform a physical experiment and analyze the results obtained; knows the elements of the theory of measurement uncertainty in application to advanced physics experiments, knows the basic units of the SI system and its most important derived units; knows other systems of units of measurement	Upon completion of the course, the student: - understands the regulations concerning health and safety in the laboratory and is able to use appropriate personal protective equipment and safety devices. - is able to assess the risks associated with experiments and takes preventive measures to ensure safety and health protection. - can properly organize a workstation for conducting experiments in accordance with ergonomic principles, ensuring safe and efficient working conditions.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report
[FIZL3_W14] knows the principles of ergonomics and occupational health and safety	Upon completion of the course, the student: - understands the regulations concerning health and safety in the laboratory and is able to use appropriate personal and equipment-based protective measures. - is able to assess the risks associated with experiments and take preventive actions to ensure safety and health protection. - can properly organize a workstation for conducting experiments in accordance with ergonomic principles, ensuring safe and efficient working conditions.	[SW1] oral statement/ conversation/discussion
[FIZL3_U13] is able to present the latest achievements in physics in an accessible way	Upon completion of the course, the student: - is able to clearly explain the essence of fundamental physical phenomena whose interpretation led to the development of quantum mechanics (photoelectric effect, Compton effect, wave–particle duality, electron diffraction). - can present the significance of selected experiments (Franck–Hertz, Millikan, electron diffraction) for the development of modern physics. - is able to demonstrate the applications of physical phenomena in modern technologies, such as lasers, electron microscopy, and X-ray diagnostics and imaging. - can analyze and present the results of laboratory experiments in a form understandable to individuals outside the field of physics.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU3] text preparation/written work

Course outcome	Subject outcome	Method of verification
[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world; knows and understands fundamental dilemmas of the civilization	Upon completion of the course, the student: - possesses knowledge of the historical development of key physical concepts that led to the emergence of quantum mechanics (blackbody radiation, photoelectric effect, Compton effect, electron diffraction, Franck–Hertz experiment, Millikan experiment). - knows the basic physical models and theories describing the structure of matter and the interaction of radiation with matter (Bohr's model of the hydrogen atom, atomic properties, the structure of the periodic table, X-ray radiation, principles of laser operation). - understands the significance of classical experiments and physical theories for the development of modern technologies (electron microscopy, X-ray diagnostics, optoelectronics). - recognizes the connections between the development of physics and other natural sciences, e.g., the impact of quantum discoveries on chemistry, biology, and materials science. - understands that physics explains natural phenomena and provides the foundation for the development of modern technologies and other sciences.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report [SW3] text preparation/written work
[FIZL3_K02] is ready to formulate problems precisely, which serves to deepen understanding of a given topic	Upon completion of the course, the student: -is able to formulate research questions related to observed physical phenomena (e.g., the photoelectric effect, electron diffraction) in order to deepen their understanding. -can identify interpretative problems that arise when attempting classical explanations of certain experiments (e.g., Franck–Hertz, Millikan) and formulate them in a way that encourages discussion. -is able to precisely describe the limitations of physical models (e.g., Bohr's model of the hydrogen atom).	[SK1] oral statement/conversation/ discussion [SK2] presentation/project/paper/ report [SK3] text preparation/written work
[FIZL3_U09] can extrapolate the results obtained in the terrestrial laboratory to describe phenomena in the Universe	The student is able to apply the laws of quantum and atomic physics, as well as the results of laboratory experiments, to describe the properties of matter and phenomena occurring in the Universe.	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU3] text preparation/written work

Course outcome	Subject outcome	Method of verification
[FIZL3_U15] can work in a team, plan and organize his/her own work and in a team	Upon completion of the course, the student: - understands the importance of communication in teamwork, is able to clearly formulate and present their ideas, and responds constructively to suggestions and feedback from other team members. - demonstrates the ability to manage time and solve problems in cooperation with others, ensuring the efficient completion of tasks.	[SU1] oral statement/conversation/ discussion
[FIZL3_W02] understands, on the advanced level, the role of physical experiments, mathematical theoretical models that bring reality closer and computer simulations in the methodology of scientific research; is aware of technological, instrumental and methodological limitations in scientific research	Upon completion of the course, the student is aware of the technological, instrumental, and methodological limitations in conducting experiments and is able to assess their impact on research results and the interpretation of experimental data.	[SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report

Subject contents

- The problem of blackbody radiation. Emergence of the concept of energy quanta (Planck, 1900)
- The photoelectric effect and its interpretation by Einstein (1905
- The Compton effect
- Wave-particle duality (de Broglie waves) and its experimental confirmation (e.g. electron diffraction)
- Interaction of an electron beam with matter. Scanning electron microscope principle of operation
- Bohrs model of the hydrogen atom
- Experimental confirmation of the quantum nature of atoms (FranckHertz experiment)
- Properties of atoms
- Structure of the periodic table
- X-ray radiation: formation of continuous and characteristic spectra, ordering of elements
- Interaction of X-ray radiation with matter
- Spontaneous and stimulated emission. Principle of operation of a laser
- The Lorentz force
- Description of the motion of charged particles in electric and magnetic fields
- Determination of the elementary charge of the electron (Millikan experiment)
- Determination of the charge-to-mass ratio of the electron
- Maxwells equations and selected consequences

Laboratory topics

1. Diffraction of an electron beam on a polycrystalline graphite layer.
2. Determination of excitation potentials of Hg and Ne atoms in the Franck-Hertz experiment.
3. Determination of the specific charge (e/m) of the electron.
4. Photoelectric effect and determination of Plancks constant.
5. Determining the position and dimensions of a metal object based on a radiographic image.
6. Surface topography analysis of materials using a scanning electron microscope (SEM).
7. Determination of the elementary charge in the Millikan oil drop experiment.

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
experiment reports	51.0%	50.0%
tests	51.0%	50.0%

Recommended reading	Basic literature	1. Halliday, Resnick, Walker *Physics, Vol. 3 / Vol. 4 / Vol. 5*, PWN Scientific Publishers, Warsaw, 2015. 2. Zofia Leś *Fundamentals of Atomic Physics*, PWN Scientific Publishers, Warsaw, 2021. 3. K. Dasiak *Electron Diffraction on a Polycrystalline Graphite Layer* Masters thesis, University of Gdańsk, Gdańsk, 2007. 4. T. Wicka *Determination of the Electron Charge-to-Mass Ratio (e/m)* Masters thesis, University of Gdańsk, 2009. 5. A. Barbacki *Electron Microscopy*, Poznań University of Technology Press, 2007.
	Supplementary literature	1. PHYWE company catalog, description of experimental set P25113000. 2. PHYWE Systeme GmbH & Co *Physics Laboratory Experiments*, manuals: 06959.00, 06960.00, set P2510200.
	eResources addresses	
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	

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