GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fundamentals of modern physics, PG_00049441		
Field of study	Technical Physics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2023/2024
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	2	Language of instruction	Polish
Semester of study	4	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Zakład Fizyki Organicznych i Perowskitowych Struktur Fotowoltaicznych -> Instytut Fizyki i Informatyki Stosowanej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Grażyna Jarosz	
	Teachers	dr inż. Ireneusz Linert dr hab. inż. Grażyna Jarosz	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	30.0	0.0	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	5.0	60.0	125

Subject objectives: The student knows and understands fundamentals of moder physics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_W01	The student becomes acquainted with the achievements of modern physics and understands its role in the development of technology.	[SW1] Assessment of factual knowledge
K6_W02	The student has knowledge of the basics of modern physics.	[SW1] Assessment of factual knowledge
K6_U01	The student is able to independently use textbooks and selected scientific literature.	[SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	1. Atomic structure of matter (4 h). Statistical physics. Boltzmann factor. Maxwell's statistics. Atom, atomic size, determination of atomic parameters based on the kinetic theory of gases, barometric formula, transport phenomena in gases, X-ray diffraction, atomic nucleus, measurement of atomic mass, passage of alpha particles through matter, Rutheford formula, cross section, electron, determination of the e/m ratio. 2. Emission and absorption of optical radiation (4 h). Black body, spontaneous emission, absorption and stimulated emission, lasers, black body emission, Planck distribution, Stefan-Boltzmann law, Wien's displacement law. 3. Theory of relativity (4 h) Michelson-Morley experiment. Einstein's postulates. Lorentz transformations. Time dilation and length contraction. Doppler effect. The twin paradox. Relativistic momentum. Relativistic energy. Conversion of mass into energy and binding energy. General theory of relativity. 4. Basic properties of matter (2 h). Matter waves, de Broglie hypothesis, Davisson and Germer experiment, properties of matter waves, wave-particle duality, photon, photoelectric effect, Compton effect, Heisenberg uncertainty principle, statistical description of particles, distribution functions, Fermi-Dirac statistics, Bose - Einstein and Boltzmann statistics. 5. Bohr's model of the hydrogen atom (2 h). Bohr's model and theory of the atom, Bohr's postulates, energy levels of the hydrogen atom, photon absorption and emission, ionization, hydrogen-like atoms, muon atoms, criticism of Bohr's theory. 6. Quantum mechanics (5 h). Postulates of quantum mechanics, wave function, energy and momentum operators, Schrödinger equation, particle in a potential well, eigenfunctions and eigenvalues, flux, passage of a particle through a potential battery, tunneling, examples, quantum harmonic oscillator. The hydrogen atom in quantum mechanics. Schrödinger equation in spherical coordinates, atomic magnetic moments, experimental confirmation of spatial quantization, electron spin, total angular momentum, fine and hyperfine structure, nuclear resonance. 7. Multi-electron atoms (2 h). Periodic table of elements, quantum numbers, Pauli exclusion principle, Zeeman effect. 8. Atomic spectra (2 h). X-rays, emission and absorption of X-rays, characteristic radiation, formation of electron-positron pairs, total mass absorption coefficient of electromagnetic radiation. 9. Atomic nucleus (2 h). Size and density of nuclear matter, nucleons, nuclear mass, nuclear models, droplet, shell and collective models. 10. Nuclear decays and nuclear reactions (4 h). Alpha, beta and gamma decay, average lifetime, radioactive equilibrium, Mössbauer phenomenon, nuclear reactions, cross section, excited states of nuclei, fusion reactions, thermonuclear reactions, natural and artificial radioactivity, uses of isotopes in medicine, geology, archeology and other fields. Nuclear radiation detection. 11. Classification of elementary particles and elements of astrophysics (1 h)
Prerequisites and co-requisites	
Assessment methods and criteria	see table below

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	40.0%
Tests during the semester	50.0%	45.0%
	0.0%	15.0%

Recommended reading	Basic literature	1. P. A. Tripler, R. A. LLewellyn, Fizyka Współczesna, PWN, Warszawa 2011. 2. R. Eisberg, R. Resnick, Fizyka kwantowa atomów, cząsteczek, ciał stałych, jąder i cząsteczek elementarnych, PWN, W-wa 1983 3. H. A. Enge, M.R. Wehr, J. A. Richards, Wstęp do fizykiatomowej, PWN, W-wa 1983 4. H. H. Haken, H. C. Wolf, Atomy i kwanty, PWN, W-wa 1997 5. V. Acosta, C. L. Cowan, B. J. Graham, Podstawy fizyki współczesnej, PWN, W-wa 1987 6. Halliday, Resnick, Walker, Podstawy Fizyki PWN, W-wa 2014.

	Supplementary literature	1. A. A. Czerwiński, Energia jądrowa i promieniotwórczość, Oficyna edukacyjna, W-wa 1998 2. Sz. Szczeniowski, Fizyka doświadczalna, tom V (fizyka atomu); tom VI (fizyka jądra i cząstek elementarnych), PWN, W-wa 1974 3. K.Wróblewski, J. A. Zakrzewski, Wstęp do fizyki, t. 1, Wydawnictwo Naukowe PWN, Warszawa 1984. 4. J. Massalski, Fizyka dla inżynierów. Część II. Fizyka współczesna, WNT, Warszawa 2018. 5. E. Skrzypczak, Z. Szafliński, Wstęp do fizyki jądra atomowego i cząstek elementarnych, PWN, W-wa 2002 6. H. H. Haken, H. C. Wolf, Atomy i kwanty, PWN, W-wa 1997 7. Matwiejew, Fizyka cząsteczkowa, W-wa 1989, PWN.
	eResources addresses	Adresy na platformie eNauczanie: Podstawy fizyki współczesnej - Moodle ID: 36910 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=36910
Example issues/ example questions/ tasks being completed	The problems for tutorials: 1. Using the energy distribution of molecules in an ideal gas, derive formulas for the energy corresponding to the mean energy of gas molecule. Calculate the value for the ideal gas in room temperature T=300 K. 2. What is the frequency of the photon absorbed when the hydrogen atom makes the transition from the ground state (n=1) to the n=4 state? The exam questions: Draw and explain the Maxwell-Boltzmann speed distribution function. Show in the graph the shape of that function for a given temperature and present how the graph is changing when the gas temperature increases. Present the method of determining the specific e/m of electron in the Thomson experiment.	
Work placement	Not applicable	