GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Atomic and nuclear physics, PG_00037282		
Field of study	Technical Physics		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
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	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Molecular Photophysics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Piotr Grygiel	
	Teachers	dr inż. Piotr Grygiel	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	15.0	0.0	0.0	0.0	30

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	30	2.0	18.0	50

Subject objectives

Learning the basics of nuclear physics with particular emphasis on the applications of nuclear physics in nuclear energetics, medicine and other fields of science.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U02	[K6_U02] Is able to analyze and solve simple scientific, technical and application problems in the field of nuclear physics. [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
K6_W02	Possesses ordered knowledge regarding the basics of nuclear physics and its applications in eneretics, medicine and some other fields of science. [SW1] Assessment of factual knowledge	[SW1] Assessment of factual knowledge

Subject contents	The lecture: 1. Structure and properties of the atomic nucleus: Rutherford experiment, components of the nucleus, the size of atomic nuclei, density of nuclear matter, nuclear forces. 2. The models of atomic nucleus: the drop-, shell- , Fermi gas- and collective model. 3. Spontaneous nuclear transformations: alpha-, beta-, gamma radioactive decay, electron capture. 4. Nuclear reactions: energy balance, cross-section, reaction mechanisms, types and examples. 5. Passage of charged particles through matter: interaction of particles with matter, specific ionization, stopping power, relationship between the energy and range of particles in a medium. 6. The passage of gamma rays through matter: interaction with matter, absorption, scattering, photoelectric effect, Compton effect, pair production, attenuation when passing through matter. 7. Neutrons: sources, interaction with matter, deceleration, spatial distribution and diffusion. 8. Nuclear fission on the example of uranium 235: cross sections, reaction mechanism, reaction energy balance. 9. Chain reaction on the example of uranium 235 nuclear fission: reaction mechanism, necessary conditions, controlling, means of using controlled and uncontrolled reactions. 10. Operation and control of a nuclear fission reactor: basic reactor components, multiplication factor, subcritical, critical and supercritical reactor, reactor equations. 11. Nuclear reactors: fuel, moderator, neutron reflector, control system, coolant, biological shield, types of nuclear reactors, spent fuel management. 12. Thermonuclear reactions: mechanism, necessary conditions, energy balance, controlled thermonuclear fusion and perspectives of its application. 13. Detection of ionizing radiation: ionization chambers, spark chambers, G-M-, Cherenkov-, scintillation counters, semiconductor detectors, cloud chamber. 14. Basic dosimetry units: radioactivity, exposure dose, absorbed, equivalent, effective dose rate, dose limit. 15. Radioactive isotopes and their application in medicine, science and technology. Tutorials: 1. Derivation of the Rutherford's formula. 2. Structure and properties of the atomic nucleus: binding energy per nucleon, energy of nuclear reactions including fusion and fission. 3. Natural radioactivity: decay law, radioactive activity, average life time, the half life. 4. Interaction of radiation with matter: linear and mass attenuation coefficient, half thickness, range of charged particles in the material, Compton- and photoelectric effect, pair production. 5. Nuclear reactions: principles of conservation in reactions, cross-section, reaction efficiency, sample activation in the neutron flux, nuclear fission.
Prerequisites and co-requisites	1. Basics of relativistic mechanics. 2. Basics of quantum mechanics. 3. Basics of chemistry. 4. Knowledge of physics in the field of university education.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture credit	50.0%	50.0%
Tutorial credit	50.0%	50.0%

Recommended reading

Basic literature	J.S. Lilley,"Nuclear Physics and Applications", John Villey & Sons, 2001.
Supplementary literature	University Physics, https://openstax.org/subjects/science
eResources addresses	Adresy na platformie eNauczanie: Fizyka i technika jądrowa - Moodle ID: 45592 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=45592

Example issues/ example questions/ tasks being completed	Give the theory of alpha decay. Discuss the Compton phenomenon. Derive the formula for the half-life of radioactive isotope. Discuss the operating conditions of the reactor Applications of radioactive isotopes in technology and medicine.
Work placement	Not applicable

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