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 2023	Academic year of realisation of subject	2025/2026
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 Classes are conducted in Polish and English, and in the case of foreign students, exclusively in English.
Semester of study	6	ECTS credits	2.0
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 inż. Piotr Grygiel	
	Teachers	dr inż. Piotr Grygiel	

Lesson types

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_W02] Has systematized knowledge of the basics of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and particle physics, solid-state physics, nuclear and elementary particle physics.	Has structured knowledge of contemporary models of atomic nucleus structure, the course of certain nuclear reactions, the interaction of nuclear radiation with matter, the course of the chain reaction of atomic nucleus fission, nuclear fusion and the basics of dosimetry.	[SW1] Assessment of factual knowledge
[K6_U02] Can analyze and solve simple scientific and technical problems, based on possessed knowledge, using analytical, numerical, simulation and experimental methods.	Can solve and analyse basic problems concerning contemporary models of atomic nucleus structure, the course of certain nuclear reactions, the interaction of nuclear radiation with matter, the course of the chain reaction of atomic nucleus fission, nuclear fusion and the basics of dosimetry.	[SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td>Course content – lecture
1. Structure and properties of the atomic nucleus, Rutherford's experiment, terminology in nuclear physics. 2. Models of the atomic nucleus: liquid drop, shell, Fermi gas. 3. Radioactive decay: alpha, beta, gamma, electron capture, internal conversion. 4. Nuclear reactions: energy balance, cross section, mechanisms, types and examples. 5. Interaction of nuclear radiation (charged particles and gamma rays) with matter: specific ionisation, stopping power, relationship between energy and particle range, absorption, scattering, photoelectric effect, Compton effect, pair formation, attenuation when passing through matter. 6. Neutrons: sources, interaction with matter, slowing down, spatial distribution and diffusion. 7. Non-energy applications of nuclear technology: radiocarbon dating, defectoscopy, medicine. 8. Nuclear fission using the example of uranium-235: cross sections, reaction mechanism, energy balance of the reaction. 9. Chain reaction using the example of uranium-235 fission: mechanism, conditions of occurrence, control, ways of utilising controlled and uncontrolled reactions. 10. Operation and control of a nuclear fission reactor. 11. Thermonuclear reactions: mechanisms, conditions of occurrence, energy balance, controlled thermonuclear fusion and prospects for its application. 13. Ionising radiation detectors: ionisation chamber, cloud chamber, spark chamber, counters: G-M, Cherenkov, scintillation, semiconductor. 14. Basic dosimetric units. 15. Radioactive isotopes and their application in medicine, science and technology.

Course content – exercises
1. Derivation of 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: law of decay, radioactive activity, average lifetime, half-life. 4. Interaction of radiation with matter: linear and mass attenuation coefficients, half-thickness, range of charged particles in matter, Compton effect, photoelectric effect, pair formation. 5. Nuclear reactions: conservation principles in reactions, cross section, reaction efficiency, sample activation in a neutron flux, fission of nuclei using uranium-235 as an example, nuclear fusion.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>1. Basics of relativistic mechanics. 2. Basics of quantum mechanics. 3. Basics of chemistry. 4. Knowledge of physics in the field of university education.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lecture credit</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Tutorial credit</td><td>50.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
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<tr><td>Basic literature</td><td>J.S. Lilley,"Nuclear Physics and Applications", John Villey & Sons, 2001.</td></tr>
<tr><td>Supplementary literature</td><td>University Physics, https://openstax.org/subjects/science</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>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.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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