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 2025 | Academic year of realisation of subject | 2027/2028 |
| Education level | first-cycle studies | Subject group | Optional subject group<br>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<br>Classes are conducted in Polish and English; in the case of foreign students, classes are conducted 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 | | |

**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] analyzes and solves 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<br><br>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.<br><br>Course content – exercises<br>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>Tutorial credit</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Lecture credit</td><td>50.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<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.<br><br>Discuss the Compton phenomenon.<br><br>Derive the formula for the half-life of radioactive isotope.<br><br>Discuss the operating conditions of the reactor<br><br>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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