POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Atomic and Nuclear Physics [S1FT2>FAiJ]

Course

Field of study
Technical Physics

Year/Semester
2/4

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
30

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Knowledge of physics and mathematics as determined by the syllabus for the study program. Ability to obtain information from indicated sources, deep understanding and interpretation of conveyed messages. Recognition of the necessity for expanding one’s knowledge and competencies. Readiness to engage in teamwork.

Course objective

To impart fundamental knowledge of atomic and nuclear physics as defined by the curriculum for the study program. To develop students’ abilities to recognize examples of the application of atomic physics achievements in the operation and construction of research devices. To enhance students' skills in utilizing, with understanding, popular-scientific and scientific sources describing the achievements of contemporary physics and their applications. To foster teamwork skills.

Course-related learning outcomes

Knowledge:
The student will have knowledge in the following areas:
Can define basic concepts of atomic and nuclear physics

Can formulate and explain basic laws of atomic and nuclear physics and provide examples of their application to describe phenomena in the surrounding world
Can give simple examples of the application of atomic and nuclear physics achievements in the operation and construction of scientific devices

Skills:
The student will have the following skills:
Can apply basic laws of atomic and nuclear physics and simplified models to describe phenomena in the surrounding world and the operation of selected scientific devices
Can formulate simple conclusions based on obtained calculation results, conducted simulations, and mathematical analyses describing phenomena in atomic physics
Can use, with understanding, indicated sources of knowledge (list of basic literature) and acquire knowledge from other sources
Can prepare and present a presentation on the application of atomic physics achievements
Has the ability to self-learn

Social competences:
The student will acquire the following social competences:
Can actively engage in solving assigned problems, independently develop and expand their knowledge and competences
Can collaborate within a team, fulfilling responsibilities assigned within the division of work in the team

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written exam covering selected topics in atomic and nuclear physics.
Grading Criteria: 3.0 for 50.1%-70.0%, 4.0 for 70.1%-90.0%, 5.0 for above 90.1%.
Exercise sessions: Quiz on tasks from atomic physics.
Grading Criteria: Similar to the lecture component.
Classroom engagement: Volunteering for board work, explaining problems to other students.

Programme content

uantization of charge, light, and energy: Black-body radiation, photoelectric effect, Compton effect, X-ray radiation.
Nuclear model of the atom: Wave properties of particles, de Broglie hypothesis, measurement of particle wavelength, probabilistic interpretation of the wave function, Uncertainty principle.
Hydrogen atom: Schrödinger equation in three dimensions, quantization of orbital angular momentum and energy in the hydrogen atom, wave functions for the hydrogen atom.
Magnetic dipole moment and fine structure: Orbital magnetic dipole moment, Stern-Gerlach experiment, electron spin, total angular momentum, and spin-orbit interaction.
Historical models of the atom and spectra of hydrogen-like ions: Atomic spectra, Rutherford's nuclear model, Franck-Hertz experiment.
Two-electron system: Electrostatic interaction and exchange degeneracy, approximate methods for bound states: stationary perturbation theory, variational method, spin functions and Pauli exclusion principle.Multi-electron atoms: The central field approximation, Hartree theory for the description of multi-electron atoms.
General laws of optical transitions.
Interaction with static external fields: Atoms in a magnetic field.
X-ray spectra: Internal shells, characteristics of X-ray spectra.
Periodic system structure: Ground states of elements, the periodic table, and its structure based on electronic configurations.
Fine structure:
Influence of the atomic nucleus on atomic spectra.
Spin and magnetic moments of nuclei.
Hyperfine interactions.
Nuclear magnetic resonance (NMR) and its applications.
Nuclear electric quadrupole moment.
Contemporary methods of optical spectroscopy.
Introduction to nuclear physics.

Course topics

none

Teaching methods

Lecture: Multimedia presentation with examples provided in the presentation, engaging listeners in discussion based on knowledge from previous lectures.
Exercise sessions: Solving problems in atomic and nuclear physics on the board, discussion.

Bibliography

Basic:
1. R. Eisberg, R. Resnick, Fizyka kwantowa, PWN Warszawa 1983
2. H. Haken, H. Wolf, Atomy i kwanty, PWN Warszawa 2002
3. Paul A. Tipler, Ralph A. Llewellyn, Fizyka współczesna, PWN 2012
4. G.K. Woodgate, Struktura atomu, PWN Warszawa 1974

Additional:
1. W. Demtroeder, Spektroskopia Laserowa, PWN Warszawa 1993
2. https://openstax.org/details/books/fizyka-dla-szkół-wyższych-tom-3

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	38	1,50