Elements of modern physics - course description

General information

Course name	Elements of modern physics
Course ID	13.2-WF-FizP-EMP-S17
Faculty	Faculty of Physics and Astronomy
Field of study	WFiA - oferta ERASMUS
Education profile	-
Level of studies	Erasmus programme
Beginning semester	winter term 2023/2024

Course information

Semester	2
ECTS credits to win	3
Available in specialities	Physics
Course type	obligatory
Teaching language	english
Author of syllabus	• dr hab. Maria Przybylska, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Credit with grade

Aim of the course

Learning students of basic concepts, facts and methods of such modern physics fields as: elementary interactions and particles, elements of cosmology, elements of contemporary optics with laser physics, certain selected topics of advanced quantum physics.

Prerequisites

Fundamentals of physics I-IV, classical and relativistic mechanics, fundamentals of quantum physics, elements of atomic and nuclear physics

Scope

1. Elements of elementary particle theory: four basic interactions, classification of elementary particles, conservation laws of elementary particles, particle interactions and particle decays, elementary particle detection, energy and momentum in particle decays, quark structure of mesons and baryons, standard model, Higgs boson
2. Elements of cosmology. Universe expansion, Hubble's law, background radiation, dark matter, principles of general relativity, space-time of general relativity, Einstein's equation, tests of general relativity, light deflection, perihelium precession, gravitational waves, relativistic effects in everyday life, evolution stars and the formation of black holes, the Friedmann equation, the cosmology of the Big Bang, the formation of nuclei and atoms of elements, experimental cosmology, the problems of the composition and age of the Universe.
3. Elements of contemporary optics. Interaction of electromagnetic radiation with matter - microscopic description (Einstein coefficients), macroscopic description (dielectric function and measurable quantities: transmission and reflection). Lasers: principle of operation, types of lasers, properties of laser light, selected applications of lasers, atomic clocks, optical fibers and fiber lasers, holography, metamaterials

4. Advances in quantum physics. Principle of superposition, Schroedinger's cat, decoherence, entanglement, EPR paradox, Bell inequalities, Bell inequality tests, quantum computer, nanostructures (two-dimensional quantum wells, quantum wires, quantum dots).

Teaching methods

Conventional lecture with elements of discussion

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
The student can talk about problems of contemporary physics with an understandable, colloquial language		• a discussion	• Lecture

Outcome description	Outcome symbols	Methods of verification	The class form
After completing the course, the student has the acquired knowledge of current physics problems from the areas of elementary particle physics, relativity in application to cosmology, contemporary optics and selected current problems of quantum physics. The student knows that modern physics is widely used in everyday life		• an exam - oral, descriptive, test and other	• Lecture
The student can use a mathematical apparatus to describe and model phenomena and physical processes.		• an exam - oral, descriptive, test and other	• Lecture
The student uses a variety of materials in Polish and English, provided both by leecturer and self-found using modern technologies. Acquires a critical attitude towards materials of poorly established origin found on the web		• an exam - oral, descriptive, test and other	• Lecture

Assignment conditions

Lecture: Positive passing of exam (written)

Recommended reading

[1] K. Krane, Modern Physics, 3rd edition, John Wiley & Sons, Inc, 2012

[2] S.T. Thornton, A. Rex, Modern Physics for Scientists and Engineers, 4th edition, Cengage Learnng, 2013

[3] P.A. Tipler, L.A. Llewellyn, Modern Physics, 6th edition, W.H. Freeman and Company, New York, 2012

[4] K.F. Renk, Basics of laser physics, 2nd edition, Springer International Publishing AG 2017

[5] O. Svelto, Principles of lasers, 5th edition, Springer Science+Business Media, LLC 2010

[6] W. Cai, V. Shalaev, Optical metamaterials, Springer Science+Business Media, LLC 2010

[7] H. Haken, H.Ch. Wolf, The Physics of Atoms and Quanta, Springer, Berlin, 2015

[8] E.L. Wolf, Nanophysics and nanotechnology, Wiley-VCH Verlag, Weinheim, 2004

[9] Materials provided by a lecturer.

Further reading

[1] R.A. Serway, C.J. Moses, C.A. Moyer, Modern Physics, 3rd edition, Thomson Learning, Inc. 2005

[2] W.T. Silfvast, Laser Fundamentals, 2nd edition, Cambridge University Press, 2004

Notes

Modified by dr Marcin Kośmider (last modification: 06-02-2023 22:54)