COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modern physics

Course

Field of study	Year/Semester
Technical Physics	1/1
Area of study (specialization)	Profile of study
	general academic
Level of study	Course offered in
Second-cycle studies	polish
Form of study	Requirements
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
30		
Tutorials	Projects/seminars	
30		

Number of credit points

3

Lecturers

Responsible for the course/lecturer:	Responsible for the course/lecturer:
dr Gustaw Szawioła, docent dydaktyczny	

Prerequisites

Knowledge and skills consistent with the directional learning outcomes of engineering studies in the field of technical physics (1st degree education), in particular in the field of: classical physics (mechanics and electromagnetism) and non-relativistic quantum physics, higher mathematics (linear algebra, integral calculus, probability calculus) . The ability to analytically solve problems in the field of classical physics and non-relativistic quantum physics, atomic and molecular physics and condensed phase physics. Openness to expand one's competences in the field of physics. Ability to critical thinking and substantive discussion.

Course objective

- Transfer of knowledge and development of skills covering various levels of description, model construction and theory of modern physics.

- Shaping an open attitude towards the effectiveness of the modern physics paradigm, based on the synergy of observations, experiences, physical facts and mathematical models.

Course-related learning outcomes

Knowledge

1.The student identifies the appropriate level of description of a physical problem (discrete, statistical, field) depending on the complexity of the physical system and indicates adequate mathematical models for solving a specific problem within the issues included in the module's programming content. (K2_W01)

2. The student indicates the scope of applicability and limitations of theories and formalisms within which the models of analyzed physical systems and processes are constructed, according to classical-quantum, non-relativistic-relativistic schemes. (K2_W02)

Skills

1.The student is able to formulate a hypothesis of solving a physical problem in the form of a mathematical model within the scope of the issues included in the program content. (K2_U01, K2_U05, K2_U07)

2. The student is able to propose a solution strategy and solve analytically selected specific problems of modern physics with the use of appropriate formalism and mathematical apparatus. (K2_U05, K2_U01, K2_U12)

3. The student is able to use analogies in the analysis of physical systems and phenomena from various areas of modern physics, expressed by mathematically identical models. [K2_U07, K2_U12, K2_U01, K2_U04]

Social competences

1.The student is able to pose hypotheses regarding the search for a solution to a complex physical problem, both independently and in a team. (K2_K01)

2. The student is actively looking for new ideas, problems and their solutions in the field of modern physics. (K2_04).

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

1. Lecture (learning outcome: W01, W02, U02, K02):

- form and components (percentage) of assessment: written exam - test and problem tasks (80%), oral exam (20%) ;

- assessment criteria /grade: 96% - /5,0; 86%- 95% /4,5; 76%-85% /4; 66 -75% /3,5; 50%-65.0% /3; < 50% /2.

2. Classes(learning outcome: U01, U02, U03, K01):

- form and components (percentage) of assessment: current tests during classes (100%);

- assessment criteria /grade: 96% - /5,0; 86%- 95% /4,5; 76%-85% /4; 66 -75% /3,5; 50%-65.0% /3; < 50% /2.

Programme content

1) Dynamics of complex systems.

a) The principle of least action and the Lagrange and Hamilton formalism. Symmetries and conservation laws.

b) Lagrange and Hamilton formalism in the presence of electromagnetic fields with examples describing the motion of charged particles in Penning and Paul traps.

c) Relativistic applications of the Hamiltonian formalism.

2) Selected issues of statistical physics

a) Microcanonical team.

b) Canonical team.

c) The great canonical ensemble.

3) Quantum physics in phase space.

a) Formulation of quantum mechanics using the Wigner function.

b) Discussion of the boundary between the classical and quantum domains of physical phenomena using the Wigner function.

c) Strategy of quantum state tomography (wave function) and examples of its experimental implementation - experimental study of the classical-quantum boundary.

4) Relativistic quantum physics.

a) Justification of the Dirac equation. Solution of the Dirac equation for simple quantum systems. Discussion of the Klein Paradox.

b) Dirac equation in the presence of non-zero electromagnetic potentials.

c) Dirac equation in applications to the analysis of one- and two-dimensional structures.

5) Elements of quantum field theory - the second quantization.

a) Second quantization for bosons

b) Second quantization for fermions.

c) Selected applications of the second quantization.

Teaching methods

1. Lecture: multimedia presentation supplemented with examples given on the blackboard.

2. Classes: individual and team problem solving; guided and independent case studies of topical issues in modern physics.

Bibliography

Basic

1. Armin Wachter, HenningHoeber, Compendium of TheoreticalPhysics, Springer 2011

2. Armin Wachter, Relativistic Quantum Mechanics, Springer 2006

Additional

Selected articles in scientific journals:

1. Contemporary Physics http://www.tandfonline.com/toc/tcph20/current

2. European Journal of Physics http://iopscience.iop.org/journal/0143-0807

3. American Journalof Physics http://aapt.scitation.org/journal/ajp

4. Reviews of Modern Physics http://journals.aps.org/rmp/

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	3,0
Classes requiring direct contact with the teacher	64	2,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	36	1,0

[1] delete or add other activities as appropriate