FACULTY OF PHYSICS AND ASTRONOMY
INSTITUTE OF PHYSICS

ECTS COURSE CATALOGUE

PHYSICS

FIRST DEGREE STUDIES

2014/2015

COMPUTER LABORATORY I - INFORMATION TECHNOLOGIES

Course code: **11.3-WF-FizP-PK1TI**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Laboratory	45	3	I	Grade	

COURSE AIM:

To introduce the basic features of open source operating systems and free scientific and editorial software that will enhance students scientific activities

ENTRY REQUIREMENTS:

Basic knowledge in computer science and operating systems

COURSE CONTENTS:

Linux operating systems basics is the main topic of interest durint the lab. Information on the server systems software, IT security and Linux as a desktop compose the course contents, which are: system installation, Bash shell scripting, text editors (Emacs, Vi), system users and resources, system daemons and initial scripts. The second important issue taken up during the course is the document preparation system – LaTeX.

TEACHING METHODS:

Lecture and computer lab, discussions, individual students readings of technical documentation

LEARNING OUTCOMES:

Student knows how to install, configure and customize Linux system and how to use advanced document edition and preparation system – LaTeX – to create publication-ready articles and reports.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
1. Linux operating systems, Information	K1A_W06	Discussion	Laboratory

on the server systems software, IT security.			
2. Linux as a desktop - system installation.	K1A_W04 K1A_U04	Exercise/task	Laboratory
3. Student can create reports in LATEX system.	K1A_W09 K1A_K03 K1A_K02 K1A_U08	Project	Laboratory
4. Student is able to generate scientific graphics using gnuplot system and is able to use the technical documentation and other technical resources available on the Internet.	K1A_U01 K1A_U07	Exercise/task	Laboratory

ASSESSMENT CRITERIA:

The positive evaluation of the tasks/effects: 1. (10%), 2. (25%), 3. (40%), 4. (25%)

Final grade: 100% laboratory

STUDENT WORKLOAD:

- Laboratory: 45 h
- Laboratory preparations: 35 h
- Consultations: 2 h

Total 82 h, 3 ECTS.

The workload requiring the participation of the teacher: 47 h., 2 ECTS.

RECOMMENDED READING:

[1] *UNIX and Linux System Administration Handbook* (4th Edition), Evi Nemeth, Garth Snyder, Trent R. Hein and Ben Whaley, 2010.

[2] *The Not So Short Introduction to LaTeX*, Tobias Oetiker, 2011.

PROGRAM PREPARATION:

Dr hab. Jarosław Kijak, prof. UZ

INTRODUCTION TO HIGHER PHYSICS AND MATHEMATICS

Course code: **13.2-WF-FizP-WdFMW**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the classes**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					0
Class	30	2	I	Pass/Fail	

COURSE AIM:

Students can use the mathematical apparatus at a level sufficient to participate in the lectures in physics and mathematics.

ENTRY REQUIREMENTS:

None – introductory classes.

COURSE CONTENTS:

Mathematics:

- Linear and quadratic equations,
- Systems of equations,
- Sequences and their limits,
- Derivatives, properties of functions,
- Series, the convergence of numerical series,
- Riemann integral.

Physics:

- Newton's equations,
- Friction force, the law of universal gravitation, inertia,
- Work, power, energy, conservation of energy and momentum,
- Electric field, Coulomb's law,
- Magnetic field, the Lorentz force,
- Laws of thermodynamics.

TEACHING METHODS:

Classes. Joint problem solving.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has the basic knowledge of calculus and linear algebra, and knows the basic laws of classical physics	K1A_W01 K1A_W02	tests during the semester, final test	classes
Student understands the need to supplement her or his knowledge during the lectures in physics and mathematics	K1A_K01		

ASSESSMENT CRITERIA:

The condition of positive assessment is a positive evaluation of all written tests.

STUDENT WORKLOAD:

- Classes: 30 h
- Self-learning on homework tasks: 30 h
- Consultations: 2 h

Total: 62 h, 0 ECTS.

Workload directly involving teacher: 32 h.

RECOMMENDED READING:

[1] R. Resnick i D. Halliday, *Fundamentals of Physics*, (8^{th} ed.), Wiley 2008.

[2] J. Kalisz, M. Massalska, J. Massalski, *Zbiór zadań z fizyki z rozwiązaniami,* cz. 1-2, PWN, Warszawa 1987.

[3] E. W. Swokowski, *Calculus with analitic geometry*, Prindle, Weber & Smiths 1983.

OPTIONAL READING:

[1] J. Orear, *Physics*, MacMillan Publishing Company 1979.

[2] A. Hennel, W. Krzyżanowski, W. Szuszkiewicz, K. Wódkiewicz, *Zadania i problemy z fizyki*, cz. 1, PWN, Warszawa 2002.

PROGRAM PREPARATION:

Dr Tomasz Masłowski

MATHEMATICAL ANALYSIS I

Course code: **11.1-WF-FizP-AMat1**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **dr Bogdan Roszak**

Name of lecturer: **dr Bogdan Roszak**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					10
Lecture	60	4	I	Exam	
Class	60	4		Grade	

COURSE AIM:

Familiarize students with the basic concepts, theorems and methods used in the differential and integral calculus and their application in dealing with selected physical problems.

ENTRY REQUIREMENTS:

Knowledge of mathematics at the secondary school level.

COURSE CONTENTS:

Lecture.

I. Elements of logic and set theory.

1. Sentential and predicate calculus, operations on sets, Cartesian product of sets.
2. The set theory in equation and inequality solving.

II. Functions of one variable.

1. Elementary functions and their properties. The composite and the inverse function.
2. Inverse trigonometric functions. Elementary transformations of function graphs.

III. The limit of number sequences and functions.

1. The definition of a number sequence. Monotonicity and boundedness of sequences and functions.
2. Convergence of sequences. Theorems on limits of sequences. The so called sandwich rule in convergence checking.
3. Limits and continuity of functions. Properties of continuous functions.

IV. Series of numbers

1. The concept of the sum of infinite series. The criteria for convergence of the series.

V. Differential calculus of functions of one variable

1. The definition of a derivative, geometric and physical interpretation, the basic rules of differential calculus.
2. Differential of function. Differentiability of functions.
3. The mean value theorems and their applications.
4. De L'Hospital rule and its application in the limits of functions.
5. Taylor and Maclaurin formula.

6. The monotonicity. Local and global extremes.
7. Convex and concave functions. Inflection points of the graph.
8. Examination of a function.
9. Physical applications of differential calculus.

VI. Integral calculus of functions of one variable

1. Antiderivative. The property of indefinite integrals. The rules of integration.
2. Methods for calculating indefinite integrals - integration by parts, integration by substitution, integration of rational functions, integration of trigonometric and irrational function.
3. Definite integral and its properties.
4. The applications of integral calculus in geometry and physics.
5. Improper integrals.

VII. Differential equations.

1. Differential equations with separated variables.
2. Homogeneous equations. Inhomogeneous equation.
3. Linear equations of the first and the second order. Bernoulli's equations.
4. Applications of differential equations.

VIII. Vector function of one variable.

1. The definition of vector function of one variable.
2. Calculating the derivatives of vector functions (material should be accomplished by the student her or him-self on the basis specified by the lecturer).

IX. Elements of the topology

1. Definition of basic topological concepts.

Exercises

I. Elements of logic and set theory.

1. Performing operations on sentials and sets. Study tautology.
2. Solving equations and inequalities in real numbers domain.

II. Functions of one variable

1. Determining the domain and the range of the function. Checking the properties of the function. Determining the composite and the inverse functions.
2. Constructing and transforming graphs of functions.

III. The limit of number sequences and functions.

1. Testing properties of sequences.
2. Calculation of limits of sequences and functions.
3. Checking the properties of continuous functions.

IV. Series of numbers

1. Checking the necessary condition of convergence of the series. Studying the convergence of the series.

V. Differential calculus of functions of one variable

1. Calculating the derivative.
2. The use of de L'Hospital rule to calculate limits of functions.
3. Development of functions in Taylor and Maclaurin series.
4. Studying the slope. Determination of local and global extremes of functions.
5. Determination of inflection points and concavity and convexity intervals.
6. Examination of a function.
7. The usefulness of calculus in dealing with physical problems.

VI. Integral calculus of functions of one variable

1. Integration of functions by the methods from the lecture.
2. Calculation of definite integrals and their geometrical and physical interpretation.
3. Studying convergence of improper integrals.

VII. Differential equations

1. Solving differential equations with separated variables.
2. Solving homogeneous and inhomogeneous equations.

3. Solving linear equations of I and II-order and the Bernoulli equations.
4. The application of differential equations to physical problems.

TEACHING METHODS:

Conventional lectures, exercises auditorium, group work, problem-classical method, the discussion, the use of multimedia.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
1. After completing the course a student has gained the ability to: - examine the logical value of a sentence, to use the mathematical logic and set theory in solving equations and inequalities, - determine the limit of sequences and functions, to examine the convergence of series, - calculate derivatives and using them in the study of monotonicity, extremes and the concavity intervals of a function, the student can make pictures of progress of a function and can solve selected optimization problems arising in different branches of science, - the student is able to calculate the several types of indefinite integrals, he or she uses the method of integration by parts and by substitution and can apply integral calculus to the appropriate physical problems, - the or she can solve basic types of differential equations and can describe physical phenomena in terms of differential equations. 3. The student make use of variety of materials available in Polish as well as English resources to interpret, analyze and correctly infer on their base. 4. The student is able to present and confront his opinion and persuasion during discussion, analyzing and solving scientific problems in the classroom.	K1A_W02 K1A_W03 K1A_U01 K1A_U02 K1A_U07 K1A_K01 K1A_K02 K1A_K04	four tests, active participation in classes discussions and suitable preparation	class
1. After completing the course a student has acquired knowledge of the following issues: - the basics of mathematical logic and set theory, - the concept of a limit of a sequence, series and a function, - the concepts of derivative and differential of function, L'Hospital's rule, monotonicity, extreme values and concavity intervals of a function, sketching graph of a function, optimization problems arising in different branches of science, - the basic concepts and theorems of integral calculus, the method of integration by parts and by substitution, application of the definite integral to appropriate physical problems, - basics in differential equations. 2. The student selects appropriate methods of calculus to cope with a problem. 3. He or she is aware of his or her knowledge and skills and understands the need for continuous training and improvement of his or her skills.	K1A_W02 K1A_W03 K1A_U01 K1A_U02 K1A_K01	final exam, discussion	lecture

ASSESSMENT CRITERIA:

Class:

The grade consists of two criteria: the scores in four tests organized during classes (80%) and degree of active participation in classes and suitable preparation (20%). A student is required to obtain at least 50% of maximal score. The student with the lowest passing grade of 10% of maximal score may write a correction test before the exam class.

Lecture:

The final exam is composed of written part and conversation; to be admitted to the second part a student must receive at least 30% of maximal score of the first part. To be admitted to the exam a student must receive a credit for the class.

The course credit consists of the class grade (50%) and the exam grade (50%). The course credit is attained by positive passing both class and exam.

STUDENT WORKLOAD:

Contact hours:
lecture - 60 hours
Exercise - 60 hours
consultation - 30 hours (10 hours for lectures and 20 hours for exercises)
time: 150 hours
Working alone:
preparation for the lecture - 30 hours
preparation for exercise - 60 hours
preparation for the written tests - 15 hours
Exam preparation - 15 hours
time: 120 hours
Total time for all items: 270 hours (9 ECTS)
Effort associated with activities that require direct participation of teachers: 150 hours, 4 ECTS.

RECOMMENDED READING:

[1] R. Rudnicki, W*ykłady z analizy matematycznej*, PWN, Warszawa 2006.
[2] Sołtysiak, *Analiza matematyczna, Część I,* (Wykłady z matematyki dla studentów fizyki), Wydawnictwo Naukowe UAM, Poznań 1995.
[3] M. Gewert, Z. Skoczylas, *Analiza matematyczna 1, Definicje, twierdzenia, wzory*, Oficyna Wydawnicza GIS, Wrocław 2005.
[4] M. Gewert, Z. Skoczylas, *Analiza matematyczna 1, Przykłady i zadania*, Oficyna GIS, Wrocław 2005.
[5] Ron Larson, Bruce H. Edwards, *Calculus, 9th Edition,* Cengage Learning 2010.
[6] W. Krysicki, L. Włodarski, *Analiza matematyczna w zadaniach,* cz. 1 i 2, PWN, Warszawa 1992.

OPTIONAL READING:

[1] J. Banaś, S. Wędrychowicz, *Zbiór zadań z analizy matematycznej*, WNT, Warszawa 1994.
[2] G. M. Fichtenholz, *Rachunek różniczkowy i całkowy*, tom I i II, PWN, Warszawa 1995.
[3] F. Leja: Rachunek różniczkowy i całkowy, PWN, Warszawa 1972
[4] R. Adams, C. Essex, *Calculus - A Complete Course 7th ed* - (Pearson Canada, 2010) BBS.
[5] G. I. Zaporożec, *Metody rozwiązywania zadań z analizy matematycznej*, WNT, Warszawa 1976.
[6] Earl W. Swokowski, *Calculus with Analytic Geometry,* Alternate Edition –PWS Publisher 1983

[7] Other materials recommended by a lecturer.

PROGRAM PREPARATION:

Dr Bogdan Roszak

ALGEBRAIC AND GEOMETRICAL METHODS IN PHYSICS

Course code: **11.1-WF-FizP-MAiGF**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	I	Exam	
Class	45	3		Grade	

COURSE AIM:

The main aim of course is to give students mathematical knowledge necessary for their further studies and to be acquainted with English mathematical terminology.

ENTRY REQUIREMENTS:

Basic knowledge on the grammar school level.

COURSE CONTENTS:

Lecture:

- Sets, Collections, operations on sets, Cartesian product.
- Complex numbers – their properties, operations with use of complex numbers
- Complex plain – geometric interpretation of complex numbers and operations performed on them.
- Polynomials and partial fractions. Fundamental theorem of algebra. Horner scheme.
- Matrices and their types. Determinants and their properties and calculation of them. Finding of inverse matrices. Eigenvalues and eigenvectors.
- Cramer linear systems, Gaussian elimination method.
- Analytical geometry on the plane and in space. Points, lines and a plane. Conic sections, transformations of the plane. Vector calculus. Scalar, vector and mixed products of vectros.
- Space and linear subspace, linear independence of vectors, basis, coordinate transformations during change of the basis.
- Systems of linear equations. Kronecker-Capelli theorem, homogeneous and not homogenous systems.

Class:

Practical realization of the matter presented during lectures and enhancement of the calculus skills.

TEACHING METHODS:

Lecture: classical lecture

Class: solving of problems related to the subjects considered during lectures.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

Gaining the ability of performing calculations with use of complex numbers and presenting results in various forms. Application of the complex numbers formalism in various problems of algebra. Gaining skills in matrix calculus, application of matrix algebra in solving linear algebra problems. The ability to select the appropriate method of solving algebraic problems. Ability to analyze problems involving systems of linear equations and finding their solutions. Learning how to find zeros of polynomials in real and complex domains. As a result, the student have knowledge about the possibility of using above mathematical tools and methods in his further studies. He/she can use the tools of mathematical analysis and algebra to solve theoretical problems. He/she knows the matrix calculus, vector analysis **(K1A_W02)**.

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student gains the knowledge about the possibility of using mathematical tools and methods related to linear algebra and geometry. He/she can use algebraical tools to solve theoretical problems. He/she knows the matrix calculus, vector analysis.	K1A_W02	Partial exams (written)	lecture
The student gains the knowledge about the possibility of using mathematical tools and methods related to linear algebra and geometry. He/she can use algebraical tools to solve theoretical problems. He/she knows the matrix calculus, vector analysis.	K1A_W02	Partial tests (written)	class

ASSESSMENT CRITERIA:

Lecture: Positive passing of all partial exams (written).

Class: Positive passing of all tests (written).

Before taking the exam a student must gain positive grade during the class.

Total score: a weighted average rating of the exam (70%) and grade from the class (30%).

STUDENT WORKLOAD:

Lectures: 15 weeks x 2 hours = 30 hours

Class: 3 x 15 = 45 hours

Preparing for classes: 40 hours

Consultations: 3 hours

Preparing for exams: 20 hours

Exams: 2 hours

Total: 140 hours, 6 ECTS points

Workload related to the duties that require direct participation of teachers: 80 hours, **3 ECTS**

RECOMMENDED READING:

[1] T. Jurlewicz, Z. Skoczylas, *Algebra liniowa 1 i 2,* GIS Publishing House, Wrocław, (any edition).

[2] Materials prepared and supplied by lecturer (also in English).

OPTIONAL READING:

[1] I. N. Bronsztajn, K. A. Siemiendiajew, G. Musioł, H. Muhling, *Nowoczesne kompendium matematyki*, PWN, Warsaw, (any edition).

[2] T. Kaczorek, *Wektory i macierz w automatyce i elektrotechnice*, PWN, Warsaw, (any aedition).

PROGRAM PREPARATION:

Dr hab. Wiesław Leoński, prof. UZ

FUNDAMENTALS OF PHYSICS I – MECHANICS

Course code: **13.2-WF-FizP-PF1Me**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					8
Lecture	45	3	I	Exam	
Class	45	3		Grade	

COURSE AIM:

The first objective of this course is to acquaint students with the development of concepts and methods of physics. Executed in parallel, and most important goal is to get the student's ability for understanding and rigorous description of physical phenomena in the field of mechanics. Thanks to demonstrations accompanying lectures, verbal communication is illustrated by numerous examples.

ENTRY REQUIREMENTS:

Knowledge of mathematics and physics at the high school level

COURSE CONTENTS:

LECTURE:

- *History and methodology of science*: basic physical quantities and their measurement, the international SI system of units, coordinate systems, vectors and vector quantities in physics
- *Kinematics*: kinematics of uniform motion, linear motion, motion in two and three dimensions, velocity and acceleration
- *The dynamics of linear motio*n: the dynamics of material point, force and motion, mass and weight, the principles of Newtonian dynamics, friction
- *Frames of reference*: inertial and non-inertial, Galileo and Lorentz transformations
- *Circular motion dynamics*: uniform circular *motion*, the forces of inertia, the Coriolis force
- *Energy*: kinetic and potential energy, work and power, principle of the conservation of energy
- *Collisions*: momentum and the principle of conservation of momentum, elastic inelastic collisions
- *Gravitational interaction*: Kepler's laws, Newton's law of universal gravitation, the work force in a gravitational field, the first and second cosmic velocity
- *Rotary rigid body motion*: rigid body, center of mass, the principle of Steiner's, progressive and rotary motion, the principle of conservation of angular momentum
- *Statics*: a state of equilibrium, inclined plane, equilibrium of rigid bodies
- *Oscillatory motion and waves*: deformation of the bodies, harmonic vibrations, the elastic wave motion and the principle of superposition, interference and diffraction, standing waves, Doppler effect
- *Statics and dynamics of fluids*: Archimedes' principle, Pascal's law, the principle of continuity, Bernoulli's law

CLASS:

- *Vectors.* Adding vectors. Multiplication of vectors.
- *Motion in one dimension.* Average and instantaneous velocity. Accelerated motion. Freely falling bodies.
- *Motion in two and three dimensions.* Position, velocity, acceleration. Projectile motion. Relative motion. *Newton's laws.* Force, mass. Applications of Newton's laws. Frictional forces.
- *Work and energy.* Work done by a constant force and by a variable force. Kinetic energy and the work. Power.
- *Conservation of energy.* Conservative forces. Potential energy. One-dimensional conservative systems.
- *System of particles.* Two- and many-particle systems. Center of mass. Linear momentum of a particle and system of particles. Conservation of linear momentum.
- *Collisions.* Conservation of momentum during collisions. One- and two-dimensional collisions. *Rotational kinematics.* Rotational motion. The rotational variables. Rotation with constant angular acceleration. Relationship between linear and angular variables.

TEACHING METHODS:

Classes are in the form of lectures illustrated with demonstrations. During the lecture the student is encouraged to ask questions, while during the demonstration the students are also encouraged to actively participate. On the exercises, students analyze and solve problems with a teacher.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows the principle of superposition of forces and the principle of superposition of motions. Student knows and is able to apply Newton's principles, in the inertial and non-inertial reference frame. Student can describe wave motion and the superposition principle. Student understands the general method in physics: breaking problems down into idealized models, as the perfectly elastic collision.	K1A_W01 K1A_W02 K1A_W03 K1A_U01 K1A_U02	Assessment of problem solving Exam	Classes Lecture
Student understands the relationship between energy and work and can give various examples of potential energy . Student knows the conservation laws in mechanics and can use them to solve problems of mechanics. Student knows the law of universal gravitation and can apply to motion of the planets.	K1A_W01 K1A_W03 K1A_U01 K1A_U02	Assessment of problem solving Exam	Classes Lecture
Student understands the role of inertial mass and its distribution in the analysis of rigid body motion and is able to calculate the moment of inertia for the basic bodies, like a ring, rod or ball.	K1A_W02 K1A_W04 K1A_U01 K1A_U02	Assessment of problem solving Exam	Classes Lecture
Based on the concept of work and energy can explain Bernoulli's Pronciple and apply them to simple problems of fluid dynamics.	K1A_W02 K1A_W03 K1A_W04 K1A_U01 K1A_U02	Assessment of problem solving Exam	Classes Lecture

ASSESSMENT CRITERIA:

The exam is conducted in writing. Student receives four issues to consider requiring the knowledge of the issues and ability to combine different phenomena. For each task, one can get from 0 to 5 points. Received a positive rating requires at least 8 points (a sufficient for 8-10.5 points, a plus sufficient for 11-13.5 points, a good 14-16, a plus good 16.5-18.5 points, a very good 19-20 points).

The basis of assessment exercises is attendance and passing written tests.

The exercises must be completed before the exam begins.

The final grade is the weighted grade from two parts: exercises (40%) and final exam (60%).

STUDENT WORKLOAD:

- Participation in the excercises: 45 hours
- Preparation to the excercises: 45 hours
- Consultations: 5 hours
- Participation in the lectures and demonstrations: 45 hours
- Exam Preparation: 40 hours
- Exam: 2 hours

Total: 182 hours, 8 ECTS.

Effort associated with activities where the participation of teachers is required: 97 hours, 4 ECTS.

RECOMMENDED READING:

[1] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki*, tom 1 i 2, Wydawnictwo Naukowe PWN, Warszawa 2005.

[2] B. Jaworski, A. Dietłaf, L. Miłkowska, G. Siergiejew, *Kurs fizyki*, tom 1, PWN, Warszawa 1976.

[3] I. W. Sawieliew, *Kurs fizyki*, tom 1, Wydawnictwo Naukowe PWN, Warszawa 2002.

[4] L. D. Landau, J. M. Liftszyc, *Mechanika*, Wydawnictwo Naukowe PWN, Warszawa 2007.

OPTIONAL READING:

[1] A. K. Wróblewski, *Historia fizyki*, Wydawnictwo Naukowe PWN, Warszawa 2007.

PROGRAM PREPARATION:

Prof. dr hab. Andrzej Drzewiński

ASTRONOMY

Course code: **13.7-WF-FizP-Astro**
Type of course: **Compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Lecture	30	2	I	Grade	

COURSE AIM:

Presentation of basics ideas and problems of modern astronomy.

ENTRY REQUIREMENTS:

The knowledge of physics at the high-school level

COURSE CONTENTS:

Elementary phenomena on the celestial sphere. Astronomical coordinate systems, time in astronomy. The Solar system and the Kepler's laws. The sun as an example star. Stellar energy sources. Stars – physical parameters and classification. Evolution of stars. Binary and multiple star systems. Stellar clusters. Interstellar matter. The structure of the Milky Way Galaxy. Galaxies and the universe. The beginnings and the future of the Universe. Big Bang theory and the cosmic background radiation.

TEACHING METHODS:

Classic lecture

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to describe the elementary phenomena observed on the celestial sphere. He can name and describe the basic astronomical coordinate systems. He can name and characterize the basic constituents of the solar system – planets with their satellites, asteroids and comets, and the laws that govern their motions. He is able to describe the basic physical properties of the Sun, and the phenomena on its surface. He can	K1A_W01	Oral test	Lecture

explain the structure of the Sun and the sources of its energy. He can describe the basic parameters and the structure of stars of various spectral types. He can explain the evolution of the stars. Student is able to describe the basic interactions happening in binary stars. He can describe the Open and Globular Clusters, and explain their significance in our understanding of solar evolution. He can name and describe the basic components of the interstellar medium, and the structure of the Milky Way galaxy. He is able to identify and characterize various types of galaxies. He is able to explain the observational facts that led to the development of the big bang theory. He can name and describe the main stages of Universe's evolution.			

ASSESSMENT CRITERIA:

Grade – oral test; passing criteria – positive grade.

STUDENT WORKLOAD:

- Participation in lectures: 15 x 2 = 30 h
- Consultations: 2 h
- Test preparations: 12 h
- Test participation: 2 h

Total: 46 h, 2 ECTS.

Direct lecturer involvement: 34 h, 1 ECTS.

RECOMMENDED READING:

[1] J. M. Kreiner, *Astronomia z astrofizyką*, PWN, Warszawa 1988.
[2] F. Shu, *Galaktyki, gwiazdy, życie*, Prószyński i S-ka, 2003.
[3] D. Block, *Astronomia dla każdego*, Marba Crown 1994.
[4] E. Rybka, *Astronomia ogólna*, PWN, Warszawa 1983.

OPTIONAL READING:

[1] M. Kubiak, *Gwiazdy i materia międzygwiazdowa*, PWN, Warszawa 1994.
[2] M. Jaroszyński, *Galaktyki i budowa Wszechświata*, PWN, Warszawa 1993.

PROGRAM PREPARATION:

Dr Wojciech Lewandowski

METROLOGY

Course code: **13.2-WF-FizP-TePom**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the classes**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Class	15	1	I	Grade	

COURSE AIM:
The aim of the course is to familiarize students with the problems associated with the planning and execution of the experiments as well as the analysis of measurements data. A glossary of basic terms used in metrology (measurement, uncertainty of measurement, etc.), useful estimation method, the method of least squares will be introduced.

ENTRY REQUIREMENTS:
The knowledge of physics and mathematics according to the level of secondary school.

COURSE CONTENTS:
- International System of Units SI. Basic units, additional and blended. Suffixes. Classification, characterization and selection methods.
- The analysis and presentation of results. Smoothing and filtering data.
- Application of Lagrange and Newton interpolation. The method of least squares.
- Statistical analysis of the measurements. Probability distributions (uniform, normal, t-distribution, the Fisher-Snedecor, Chi-square, binomial, multinomial, Poisson) and the empirical estimation rules.
- Statistical hypotheses and their verification. Analysis of variance. Regression and correlation.
- Uncertainties and measurement errors
- Static properties of measuring devices. Methods and main measuring systems

TEACHING METHODS:
Explaining, demonstrating, collaborating.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of the methods of physical measurements that allows to understand the basic physical phenomena of the surrounding world, knows the cause-effect relationship	K1A_W01	Test	class

The student understands and can explain the course descriptions of physical phenomena and processes, can independently play the theorems and laws and selected calculations, can create a theoretical model of the phenomenon and tie it with the results of measurements	K1A_W03	Discussion, project	class
Students apply the methodology of physical measurements; is able to plan, perform simple physical measurements, analyze measurement data, interpret and present the results of measurement	K1A_U03	Project, test	class
Is aware of the importance of behavior in a professional, ethical values and respect for the diversity of views	K1A_K03	discussion	class
Understands the need to improve skills and personal use of different sources of information	K1A_K04	discussion	class

ASSESSMENT CRITERIA:

The final mark consists of:
- The quality of preparation for exercise (discussion, the activity during class time) - 35%
- The quality of prepared statements - 15%
- Final test - 50%

STUDENT WORKLOAD:

- The participation in classes: 15 hours
- The preparation to classes: 15 hours
- The preparation to the test: 10 hours
- Participation in consultation: 2 hours

Total: 42 hours, 2 ECTS points.

Effort associated with activities that require direct participation of teachers: 17 hours, 1 ECTS.

RECOMMENDED READING:

[1] H. Szydłowski, *Niepewności w pomiarach*. Wydawnictwo Naukowe UAM, 2001.

[2] H. Szydłowski, *Teoria pomiarów*, PWN, Warszawa 1974.

[3] J. R. Taylor, *Wstęp do analizy błędu pomiarowego*, PWN, Warszawa 2002.

[4] A. Strzałkowski, A. Śliżyński, *Matematyczne metody opracowywania wyników pomi*arów, PWN, Warszawa 1973.

[5] S. Brandy, *Analiza danych*, PWN, wyd. 2, Warszawa 1999.

OPTIONAL READING:

[1] E. M. Mikhail, G. F. Gracie, *Analysis and adjustment of survey measurements*, van Nostrand Reinhold Company 1981.

[2] E. M. Mikhail, F. Ackermann, *Observations and Least Squares*, IEP---Dun, 1976.

[3] R. Nowak, *Statystyka dla fizyków*, PWN, Warszawa 2002.

PROGRAM PREPARATION:

Dr inż. Artur Barasiński

ENGLISH AS A FOREIGN LANGUAGE

Course code: **09.0-WF-FizP-JAng2**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **mgr Grażyna Czarkowska**
Name of lecturer: **mgr Grażyna Czarkowska**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	II	Grade	

COURSE AIM:

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help the students to develop their ability to apply language functions to effective communication in everyday life. The course also aims to further develop ability to use grammar structures which describe present and past activities and are used to form questions.

The course will introduce elements of the language of mathematics and physics – basic vocabulary used in number theory, expressions used to describe basic operations in mathematics and basic vocabulary used to describe phenomena discussed in mechanics and dynamics.

ENTRY REQUIREMENTS:

A2 of the Common European Framework of Reference for Languages specified by the Council of Europe.

COURSE CONTENTS:

During the course students will learn how to:

- describe present and past activities using appropriate grammar tenses (8 hours)
- form basic questions in English - question words and auxiliary verbs (2 hours)
- exchange and get information in everyday life situations (3 hours)
- have a simple conversation in English (3 hours)
- read and understand texts describing present and past (4 hours)
- develop listening comprehension (2 hours)
- express opinions on social phenomena in a discussion in English (2 hours)
- read numbers – ordinal, cardinal, fractions (common, decimal) (2 hours)
- read dates and mathematical operations (2 hours)
- read with understanding simple specialist texts concerning basic notions of mechanics and dynamics (2 hours)

TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF LEARNING OUTCOMES	CODE	VERIFICATION METHODS	FORM OF INSTRUCTION
Upon successful completion of the course, the students: • are able to describe present and past activities using simple grammar structures-tenses • can form simple questions in English • give basic information concerning everyday life – personal data, habits, preferences • are able to get information concerning everyday life • are able to have simple conversations • understand non-specialist texts describing present and past activities • can read numbers – cardinal, ordinal, fractions • can read dates and basic mathematical operations • understand simple specialist texts concerning mechanics and dynamics • are able to work in a team	language skills and competence on level A2+ of the Common European Framework of Reference for Languages.	class tests presentation	classes (laboratory)

ASSESSMENT CRITERIA:

- Grade: a condition for receiving a credit are positive marks for tests, taking part in discussions and giving a short presentation in English.

STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 1 hour

Private study:

- preparing a presentation – 3 hours
- getting ready for classes – 20 hours
- revising for tests – 6 hours

Total: 60 hours, 2 ECTS.

RECOMMENDED READING:

[1] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007.

[2] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007.

OPTIONAL READING:

[1] *FCE Use of English* by V. Evans

[2] Internet articles

[3] L. Szkutnik, *Materiały do czytania – Mathematics, Physics, Chemistry,* Wydawnictwa Szkolne i Pedagogiczne

[4] J. Pasternak-Winiarska, *English in Mathematics*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006

PROGRAM PREPARATION:

Mgr Grażyna Czarkowska

PHYSICAL EDUCATION

Course code: **16.1-WF-FizP-WF**
Type of course: **optional**
Language of instruction: **Polish**
Director of studies: **mgr Tomasz Grzybowski**
Name of lecturer: **Teachers Physical Education and Sports Department**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					1
Class	30	2	II	Pass/Fail	

COURSE AIM:

Development of skills to meet the needs associated with the movement, physical fitness, and care for their own health.

ENTRY REQUIREMENTS:

-

COURSE CONTENTS:

General characteristics and basic rules of selected sport disciplines. Practical skills in selected sports. Health education through physical education and sport.

TEACHING METHODS:

Lectures, practical exercises, group activities

LEARNING OUTCOMES:

Knowledge: Student know the impact of physical activity on the proper functioning of the body; know the health risks resulting from unhygienic living; have a basic understanding of the rules and principles of playing different sports

Skills: Student is able to diagnose the state of his/her physical fitness; can use various forms of activities depending on the state of health, well-being, atmospheric conditions; carries out various forms of physical activity independently and is aware of its impact on the functioning of the body

Competence: Student is able to function in the group with the principles of social coexistence, responsibility for the safety of myself and others, helping less efficient is able to compete with the principles of "fair play", showing respect for the competitors and understanding for differences in the level of physical fitness; knows the health hazards due to the improper use of the sports equipment and appliances

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Exercise - credit on the basis of progress, commitment and student activities in classes and skills in the chosen sports.

Knowledge: observation of the student behaviour during the physical activity

Skills:

- Physical education (standard level) assessment of physical fitness and motor skills using standardized tests determining the level of motor development and technical skills

- Physical education (low level of physical fitness) evaluation of the student's knowledge of diagnostic methods for health and physical fitness and the ability to use exercise to improve movement dysfunction, physiological and morphological with the individual (depending on the type of disability) indicators of the body's functions

Competence: observation of the student behaviour in competitive Sports and in conditions that require the cooperation in the group

STUDENT WORKLOAD:

Contact hours: 30 hours, 1 ECTS

RECOMMENDED READING:

[1] M. Bondarowicz, *Zabawy i gry ruchowe w zajęciach sportowych*, Warszawa 2002.

[2] T. Huciński, E. Kisiel, *Szkolenie dzieci i młodzieży w koszykówce*, Warszawa 2008.

[3] R. Karpiński, M. Karpińska, *Pływanie sportowe korekcyjne rekreacyjne*, Katowice 2011.

[4] A. Kosmol, *Teoria i praktyka sportu niepełnosprawnych*, Warszawa 2008.

[5] T. Stefaniak, *Atlas uniwersalnych ćwiczeń siłowych*, Wrocław 2002.

[6] J. Talaga, *ABC Młodego piłkarza. Nauczanie techniki*, Warszawa 2006.

[7] J. Uzarowicz, Siatkówka. Co jest grane? Wrocław 2005

[8] B. Woynarowska, *Edukacja zdrowotna Podręcznik akademicki*, Warszawa 2010.

[9] J. Wołyniec, *Przepisy gier sportowych w zakresie podstawowym*, Wrocław 2006.

OPTIONAL READING: -

REMARKS: -

LANGUAGE CULTURE

Course code: **08.0-WF-FizP-KuJęz**
Type of course: **optional**
Language of instruction: **Polish/English**
Director of studies: **mgr Irmina Kotlarska**
Name of lecturer: **mgr Irmina Kotlarska**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					1
Lecture	30	2	II	Pass/Fail	

COURSE AIM:

The aim is to enhance efficiency in using Polish language and to increase cultural awareness, linguistic sensitivity.

ENTRY REQUIREMENTS:

None

COURSE CONTENTS:

Language as a means of communication, diversity of language and linguistic norm; fromal and informal register; linguistic and communicative competence, a standard communication situation, politeness, rudeness and aggression in public statements, the modern media communication and media dialect.

TEACHING METHODS:

Lecture, discussion, working with text.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student develops and improves skills of evaluation of language innovations, recognize their mistakes and make corrections.	K1A_U06 K1A_U07	Discussions with students.	lecture
Improves the ability to use dictionaries, and other sources of knowledge about the language	K1A_K01 K1A_K04	Discussions with students.	lecture
Is gaining in-depth knowledge of the wider culture of the language - the most important principles of linguistic norm; diversity of language. The course is also developing and improving the skills of error detection and correction. In addition, classes are designed to	K1A_U06 K1A_U07	Short speeches prepared by students concerning linguistic phenomena.	lecture

improve the skills of using dictionaries, and other sources of knowledge about language			
Student is able to evaluate the texts presented in mass communication	K1A_K03	Short speeches prepared by students concerning linguistic phenomena.	lecture

LEARNING OUTCOMES VERIFICATION AND ASSESSMENT CRITERIA:

Active participation in lecture. Preparing tasks for summative assessment in the field of modern linguistic phenomena.

STUDENT WORKLOAD:

Work time in hours	Types of workload	ECTS
30	Attending lectures	0,5
10	Attending tutorial	0,2
20	Preparation for classes	0,3
60	**Total**	**1**

RECOMMENDED READING:

[1] M. Bugajski, *Język w komunikowaniu*, Warszawa 2007.

[2] H. Jadacka, *Kultura języka polskiego, Fleksja, słowotwórstwo, składnia*, Warszawa 2005.

[3] G. Rickheit, H. Strohner, *Handbook of Communication Competence,* Berlin 2008.

OPTIONAL READING:

None

PROGRAM PREPARATION:

Mgr Irmina Kotlarska

MATHEMATICAL ANALYSIS II

Course code: **11.1-WF-FizP-AnMa2**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **dr Bogdan Roszak**
Name of lecturer: **dr Bogdan Roszak**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	II	Exam	
Class	45	3		Grade	

COURSE AIM:

Familiarize students with the advanced methods and potential abilities of differential and integral calculus of several variables and their applications that are essential in further education and professional work

ENTRY REQUIREMENTS:

Mathematical analysis I, Algebraic and geometrical methods in physics, Introduction to higher physics and mathematics

COURSE CONTENTS:

1. Partial Derivatives. Differentials in applications. Chain Rules for Functions of Several Variables. Directional Derivatives and Gradients. Tangent Planes and Normal Lines.
2. Extreme Values of Functions of Several Variables. Extreme Values of Functions Defined on Restricted Domains. Implicit Functions. Constrained Optimization Problems and the Method of Lagrange Multipliers. Applications in Geometry, Physics and Economy.
3. Double Integrals. Volume and Surface Area. Double Integrals in Polar Coordinates. Moments and Center of Mass.
4. Triple Integrals and Applications. Triple Integrals in Cylindrical and Spherical Coordinates. Change of Variables and the Jabionan of a Transformation.
5. Line Integrals and their Applications. Conservative Fields and Independence of Path. Geen's Theorem.
6. Surface Integrals and Their Applications. Gradients, Divergence, Curl as Differential Operators. Gauss' Divergence Theorem and Stokes' Theorem.
7. Introduction to Probability Theory. Relative Frequency and Axioms of Probability. Conditional Probability, Independent Events, Theorem of Total Probability, Bayes' Theorem.

TEACHING METHODS:

The problem-solving lecture, a seminar lecture, the use of multimedia, demonstrating method, textbook learning method. The discussion method classes, the problem-classical method, solving exercises illustrating the content of the lecture, individual classes.

LEARNING OUTCOMES. LEARNING OUTCOMES VERIFICATION:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
1. After completing the course a student is able to recognize, select and apply the classical theorems and methods of differential and integral calculus of severable variables - in finding extreme values of a function, in constrained optimization problems, - in geometrical problems such as measure properties of a solid, tangent plane and normal vector to a differentiable manifold, - and physical problems such as vector fields, work, conservative fields, interpretation of main differential operators 2. The student can apply the basics of probability theory in scientific investigation involving randomness 3. The student make use of variety of materials available in Polish as well as English resources 4. The student is able to present and confront his opinion and persuasion during discussion, analyzing and solving scientific problems in the classroom	K1A_W02 K1A_W03 K1A_U01 K1A_U02 K1A_U07 K1A_K01 K1A_K02 K1A_K04	four tests, active participation in classes discussions and suitable preparation	class
1. After completing the course a student is able to recognize, select and apply the classical theorems and methods of differential and integral calculus of severable variables - in finding extreme values of a function, in constrained optimization problems, - in geometrical problems such as measure properties of a solid, tangent plane and normal vector to a differentiable manifold, - and physical problems such as vector fields, work, conservative fields, interpretation of main differential operators 2. The student can apply the basics of probability theory in scientific investigation involving randomness	K1A_W02 K1A_W03 K1A_U01 K1A_U02	final exam, discussion	lecture

ASSESSMENT CRITERIA:

Class:

The grade consists of two criteria: the scores in four tests organized during classes (80%) and degree of active participation in classes and suitable preparation (20%). A student is required to obtain at least 50% of maximal score. The student with the lowest passing grade of 10% of maximal score may write a correction test before the exam class.

Lecture:

The final exam is composed of written part and conversation; to be admitted to the second part a student must receive at least 30% of maximal score of the first part. To be admitted to the exam a student must receive a credit for the class.

The course credit consists of the class grade (50%) and the exam grade (50%). The course credit is attained by positive passing both class and exam.

STUDENT WORKLOAD:

Contact hours:

Lecture – 60 hours

Class – 45 hours

Consultation – 5 hours

Time: 80 hours

Working alone:

Preparation to the lecture – 5 hours

Preparation to the classes – 10 hours
Preparation to the tests – 10 hours
Preparation to the exam: 15 hours
Time: 40 hours
Total time for all items: 120 hours (5 ECTS)
Effort associated with activities that require direct participation of the teacher: 80 hours (3 ECTS)

RECOMMENDED READING:

[1] M. Gewert, Z. Skoczylas, *Analiza matematyczna 2, Definicje, twierdzenia, wzory*, Oficyna Wydawnicza GIS, Wrocław 2005.

[2] M. Gewert, Z. Skoczylas, *Analiza matematyczna 2, Przykłady i zadania*, Oficyna GIS, Wrocław 2005.

[3] M. Gewert, Z. Skoczylas, *Elementy analizy wektorowej, Teoria, przykłady i zadania*, Oficyna GIS, Wrocław 1998.[4] Ron Larson, Bruce H. Edwards, *Calculus, 9th Edition,* Cengage Learning 2010.

[5] Earl W. Swokowski, *Calculus with Analytic Geometry Alternate Edition* – PWS Publisher 1983

OPTIONAL READING:

[1] R. Adams, C. Essex, *Calculus - A Complete Course 7th ed* - (Pearson Canada, 2010)

[2] R. Leitner, *Zarys matematyki wyższej dla studentów cz. II, wydanie ósme,* Wydawnictwa Naukowo-Techniczne 199

[3] Other materials recommended by a lecturer

PROGRAM PREPARATION:

Dr Bogdan Roszak

FUNDAMENTALS OF PHYSICS II – THERMODYNAMICS

Course code: **13.2-WF-FizP-PF2Te**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	II	Exam	
Class	30	2		Grade	

COURSE AIM:

The aim of the course is to rise the student's ability to understand and precisely describe physical phenomena in the language of thermodynamics and statistical physics. In addition, students learn about the development of concepts and methods in physics. Lecture is enriched with demonstrations illustrating the laws of physics and their applications.

ENTRY REQUIREMENTS:

Knowledge of mathematics and physics at the secondary school level, finished course "Fundamentals of physics I'

COURSE CONTENTS:

- Basis notions of thermodynamics: work, heat, internal energy
- The zeroth law of thermodynamics: measure of temperature, temperature's scales
- Specific heat and material properties: thermal expansions of fluids and solids, heat capacity, specific heat, latent (hidden) heat
- Heat and work: the first law of thermodynamics, thermodynamic processes
- Heat transfer modes: thermal conductivity, convection, radiation
- Model of ideal gas: assumptions of this model, equation of state for an ideal gas, thermodynamic processes for ideal gases
- Kinetic theory of gasses: relation of pressure and temperature to the average value of the square of the velocity of molecules, Maxwell distribution of velocities, mean free path
- The second law of thermodynamics: entropy, thermal engines, Carnot's engines, efficiency coefficient
- The third law of thermodynamics: reversible and irreversible processes; systems: open, closed and isolated; absolute zero temperature; cooling and obtaining very low temperatures
- Elements of statistical physics: probability, microstates and macrostates, statistical sum, entropy, microcanonical and canonical ensembles, statistical definition of temperature; open systems, grand canonical ensemble, bosons and fermions, the Fermi-Dirac and the Bose-Einstein statistics, photon gas in the cavity and Planck's radiation law, the blackbody spectrum

Random walks: Brown motions, diffusion, diffusion coefficient, abnormal diffusion

- Models of real gases: van der Waals state equation
- Elements of phase transitions physics: fluctuations, phase diagrams, phase transitions of first kind and continuous transitions

TEACHING METHODS:

Conventional lecture illustrated with demonstrations of physical experiments

During classes students analyse and solve exercises illustrating the content of the lecture.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student understands and can describe the phenomenological and statistical approach to the phenomena of thermodynamics	K1A_W01	Exam, grade	Lectures, classes
The student can give the parameters defining the thermodynamic state of the system and define the functions of the state. The student can provide and describe the different forms of energy and its transfer.	K1A_U01	Exam, grade	Lectures, classes
Students know, and can apply the principles of thermodynamics to the qualitative and quantitative analysis of simple problems. They can explain how a thermal engine and refrigerator work	K1A_W01 K1A_W03	Exam, grade, discussion	Lectures, classes
The student can extend the model of an ideal gas to the model of a real gas	K1A_W01 K1A_W03	Exam, grade	Lectures, classes
The student is able to describe the phase transitions of the first kind and continuous transitions using phase diagrams	K1A_U01 K1A_U05	Exam, grade	Lectures, classes
The student understands the concepts of microstates and macrostates and can determine the probabilities of their occurrence	K1A_W03	Exam, grade	Lectures, classes
The student can define entropy for an isolated system, and give a statistical definition of temperature	K1A_W01 K1A_K05	Exam, grade	Lectures, classes
The student knows the basic statistical grand canonical ensembles: microcanonical, canonical and grand canonical ensembles as well as knows applications of these ensembles	K1A_W01	Exam, grade	Lectures, classes

ASSESSMENT CRITERIA:

Lecture:

The course credit is obtained by passing a final written exam composed of tasks of varying degrees of difficulty.

Class:

A student is required to obtain at least the lowest passing grade from tests organized during class.

To be admitted to the exam a student must receive a credit for the class
Final grade: average of grades from the class and the exam.

STUDENT WORKLOAD:

- **Participation in lectures and demonstrations: 15 weeks x 2 hour = 30 hours**
- **Participation in exam: 2 hours**
- Preparation for exam: 20 hours
- **Participation in class: 15 weeks x2 hour = 30 hours**
- Preparation for class including preparation for tests: 15 hours
- **Attending lecturers' office hours: 3 hours**

Total: 100 hours, 4 ECTS points.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 65 hours. This corresponds to 2,5 ECTS points.

RECOMMENDED READING:

[1] A. K. Wróblewski, J. A. Zakrzewski, *Wstęp do fizyki*, (t. 2, cz. 2, roz. VI – Elementy termodynamiki, t. 1, roz. VII – Układy bardzo wielu cząstek), Wydawnictwo Naukowe PWN, 1991 i 1984.
[2] R. Hołyst, A. Poniewierski, A. Ciach, *Termodynamika dla chemików, fizyków i inżynierów*, Wydawnictwo Uniwersytetu Kardynała Stefana Wyszyńskiego, Warszawa 2005; English translation: R. Hołyst, A. Poniewierski, Thermodynamics for Chemists, Physicists and Engineers, Springer, Dordrecht, Heidelberg, 2012.
[3] K. Huang, *Podstawy fizyki statystycznej*, Wydawnictwo Naukowe PWN, Warszawa, 2006, English translation: K. Huang, Introduction to statistical physics, 2 ed, Taylor & Francis Group, Boca Raton, London, 2010.
[4] *Slajdy z wykładów*.

OPTIONAL READING:

[1] D. Halliday, R. Resnick, J. Walker, Podstawy fizyki, tom 2, Wydawnictwo Naukowe PWN, Warszawa 2005, English translation: D. Halliday, R. Resnick, J. Walker, Fundamentals of physics, 10 ed, Wiley, 2014.
[2] I. Anselm, *Podstawy fizyki statystycznej i termodynamiki,* Państwowe Wydawnictwo Naukowe, Warszawa 1990.

PROGRAM PREPARATION:

Dr hab. Maria Przybylska, prof. UZ

FUNDAMENTALS OF PROGRAMMING

Course code: **11.3-WF-FizP-PoPro**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					
Lecture	30	2	II (FK)	Exam	6
Laboratory	45	3		Grade	

COURSE AIM:

The aim of the course is learning the basics of programming and the ability to use knowledge to solve a variety of problems with special emphasis on the sciences. This approach to programming requires an understanding of not only the syntax of a programming language, but also the basics of algorithms, coding standards, the ability to work with documentation and analysis of a complex problem and reduce the number of elementary problems. Programming is the essential foundation for understanding the following subjects such as computer numerical methods and computer simulations.

ENTRY REQUIREMENTS:

It is assumed that students have a basic knowledge of working in a Linux environment. Prerequisites are a subset of the material carried out on the first computer lab.

COURSE CONTENTS:

1. Safety at work, rules of the computer lab.

2. Introduction to programming
- programming concept, cycle "analysis - code-execution", the types of errors
- the concept of the algorithm, the strategy of "divide and conquer"
- source code and machine code
- short note on programming languages

3. Introduction to programming in Python
- language, standards for naming and formatting of source code
- meaning of comments
- running the program
- NumPy: a package for scientific calculations

4. Data
- representation of numbers in a computer memory
- precision calculations, errors, excess and insufficiency
- data types, declarations and initialization of variables
- data appearance and downloading/reading data
- type conversion
- arithmetic operators, assignment operator
- strings

5. Conditinal statements and loops

6. Functions
- declaration and function definition
- the scope and validity of the variable life span, local and global variables
- recursion

7. Lists, dictionaries, tuples, arrays in NumPy.

8. Introduction to programming using classes
- basic concepts
- object creation
- inheritance

9. Visual Python

10. Overview of standard libraries

11. Examples of programming applications in physics
- steps to the program as an example of a typical problem in physics or related sciences

TEACHING METHODS:

Lecture:
Conventional lectures, discussion, workshops (currently testing the code fragments), brainstorming

Laboratory: exercises, project method, group work, exchange ideas, brainstorming, presentation, working with documents, self-knowledge acquisition

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows the safety rules in the computer lab.	K1A_W06	test	exercise
Student is able to define and explain the problem stated for elementary problems and provide methods (algorithms) of optimal solution of the problem.	K1A_W03 K1A_U05 K1A_U07	test exam	exercise lecture
Student knows the data types, control statements, functions, and can work arrays and IO streams. Can apply the acquired knowledge and available tools to provide solution to the problem (in particular in the field	K1A_W04 K1A_W09 K1A_U04 K1A_U05	test exam	exercise lecture

of physics and related fields) in source code form.			
Student can independently find and use the tools and information to solve a given problem.	K1A_W09 K1A_U07	test	exercise
Student can compile and run the program, and interpret the results of problems in physics (or similar), as well as to verify the correctness of the action on the basis of the acquired knowledge in a particular field.	K1A_W04 K1A_U04 K1A-U07	test	exercise
Students can work in a group, feels responsible for the tasks assigned to it, is open to new concepts and ideas.	K1A_K02 K1A_K03	discussion	exercise
Student is aware of Open Source software which is a professional alternative to commercial software. Student is aware of the rate of change in the IT industry and thus the need for continuing to improve own competence. Students can create and present a report on the project.	K1A_W09 K1A_K06 K1A_K01 K1A_K04 K1A_U08	discussion	exercise

ASSESSMENT CRITERIA:

Lecture:

The practical test consists in solving a given problem (the drawn from the list of problems). The final rating is the analysis of the problem, provide algorithms for solving the problem, the source code and the assessment and verification of the results.

Laboratories:

Score: average grades achieved during the laboratories of activity and short tests advances in science (50% of the final mark) and the assessment of the semester project (50% of the final mark). To pass the semester project is its preparation and commitment within the prescribed period of the project report and its presentation.

Before taking the exam the student must obtain a pass from the laboratory.
Score: weighted average rating of the exam (60%) and exercise (40%).

STUDENT WORKLOAD:

- Participation in lectures: 30 h
- Participation in excersises: 45 h
- Preparation for the laboratory: 35 h
- Project preparation: 20 h
- Preparation for the completion of the lecture: 15 h
- Consulting: 3 h
- Exam: 1h

Total: 149 h, 6 ECTS.

Contact hours: 79 h, 3 ECTS.

RECOMMENDED READING:

[1] Allen Downey, *Think Python. How to Think Like a Computer Scientist*, 2013, Green Tea Press Needham, Massachusetts.

[2] Mark Lutz, David Ascher, *Python. Wprowadzenie*, Helion 2002.

OPTIONAL READING:

[1] Internet

REMARKS:

Lectures should be in the room with internet access. Computer labs should be done in groups to allow individual work with each student's computer and not with more than 12 people.

PROGRAM PREPARATION:

Dr hab. Mirosław Dudek, prof. UZ

PHYSICS LABORATORY I - MECHANICS, THERMODYNAMICS

Course code: **13.2-WF-FizP-PF1MT**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					
Laboratory	45	3	II	Grade	4

COURSE AIM:

The skill of planning and analysis of physical measurements.

ENTRY REQUIREMENTS:

Foundations of mathematics and physics in the field of thermodynamics, the ability to analyze and visualize data, the ability to determine the measurement uncertainty

COURSE CONTENTS:

1.The determination of shear modulus. 2. The checking of equation of rigid body circular motion. 3. The determination of density of solids and liquids by way of pycnometer. 4. The determination of dynamic viscosity for liquids. 5. The determination of gravitational acceleration by way of Kater's pendulum. 6. The study of Lissajous curves. 7. The Quinke interferometer. 8. The determination of ratio c_p / c_v by way of Clement – Desormes. 9. The determination of specific heat for luquid by way of cooling.10. Determination of the speed of sound. 11. The investigation of the damped oscillations. 12. The investigation of the resonance phenomena in forced vibrations. 13. The investigation of the Joule's law.

TEACHING METHODS:

Laboratory method.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has a general knowledge of basic physics for classic and methodology of physical measurements	K1A_W01	Discussion	Laboratory
Student can use the tools of mathematical analysis, algebra for the development of	K1A_W02	Report	

measurement data			
Student understands and is able to explain the course of physical measurements performed using the language of mathematics, can rebuild itself theorems and laws of thermodynamics and classical mechanics	K1A_W03	Discussion	
Student analyzes measurement data, interprets and presents the results of measurements	K1A_U03	Report	
Student has a sense of responsibility for their own work and a willingness to comply with the principles of team work (work in pairs) and shared responsibility for the implementation of tasks	K1A_K02	Discussion	
Student performs tasks in a way that ensures their own safety and the environment in this respect safety rules and regulations of the physical laboratory	K1A_K06	Discussion	

ASSESSMENT CRITERIA:

Provided credit semester credit lab is 13 exercises. At the final evaluation exercise consists of:
- The degree of preparation for exercise (35%),
- Efficiency in the performance measurement (10%),
- The quality of the result (15%),
- Evaluate the accuracy (20%),
- Thoroughness and accuracy of applications (20%).

STUDENT WORKLOAD:

- Participation in class: 15 x 3 = 45 hours
- Preparing for the course: 20 hours
- Preparation of the report: 35 hours
- Consultation: 2 hours

TOTAL: 102 hours, 4 ECTS.
Effort involved in activities that require direct participation of the teacher is 47 hours. This corresponds to 2 ECTS.

RECOMMENDED READING:

[1] H. Szydłowski, *Wstęp do pracowni fizycznej*, Wydawnictwo Naukowe UAM, Poznań 1996.

[2] H. Szydłowski, *Pracownia fizyczna*, Wydawnictwo Naukowe PWN, Warszawa 1994.

[3] H. Szydłowski, *Pracownia fizyczna wspomagana komputerem*, Wydawnictwo Naukowe PWN, Warszawa 2003.

[4] T. Dryński, *Ćwiczenia laboratoryjne z fizyki*, Państwowe Wydawnictwa Naukowe, Warszawa 1978.

[5] R. Resnick, D. Halliday, *Fizyka*, tom 1, Wydawnictwo Naukowe PWN, Warszawa 2001.

[6] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki*, tom 2, Wydawnictwo Naukowe PWN, Warszawa 2003.

[7] R. Resnick, D. Halliday, K.S. Krane, *Physics*, John Wiley & Sons, Inc., New York 1992.

OPTIONAL READING:

[1] H. Szydłowski, Niepewności w pomiarach. Międzynarodowe standardy w praktyce, Wydawnictwo Naukowe UAM, Poznań 2001.

PROGRAM PREPARATION:

Dr Lidia Najder-Kozdrowska

COMPUTER LABORATORY II

Course code: **11.3-WF-FizP-PrKo2**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the laboratory exercises**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	II	Grade	

COURSE AIM:
To teach the students the use of computer based tools necessary for further study.

ENTRY REQUIREMENTS:
The knowledge of the Windows or Linux operating system, the knowledge of the basics of LaTex, the ability to program in any computer language.

COURSE CONTENTS:

- The Matplotlib graphical library, basic types of graphs, types of graphical objects and their usage.
- Basic graphical formats and electronic documents formats.
- Embedding graphics in dvi, ps and pdf documents.
- Using numerical libraries for basic scientific computing problems.
- Preparing reports on the results of calculations and scientific experiments.

TEACHING METHODS:
Computer laboratory

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student is able to make basic scientific graphics, is able to name the most important graphical formats and describe their properties as well as transforming between those formats.	K1A_W09 K1A_U04	Working with computer, oral answer, written answer, current control	laboratory
He or she is able to understand a report on scientific calculations and scientific experiments, including those prepared in English.	K1A_W10	Working with computer, oral answer, written answer, current control	laboratory
the student is also able to prepare a document containing the report on	K1A_W08 K1A_W10	Working with computer, oral answer, written	laboratory

scientific calculations and scientific experiments in Polish.	K1A_U07 K1A_U08 K1A_U09	answer, current control	
The student can conform to the rules of the computing laboratory.	K1A_K02	Working with computer, oral answer, written answer, current control	laboratory

ASSESSMENT CRITERIA:

Passing the final test.

STUDENT WORKLOAD:

- Participation in the laboratory – 30h
- Preparation for the laboratory – 20h
- Consultations – 2h

The burden of instructed activities is Together: 52 hours: 2 ECTS.

RECOMMENDED READING:

[1] Mark Lutz*, Python - Wprowadzenie*, Helion 2007.

[2] Antoni Diller**,** *LaTeX. Wiersz po wierszu*, Helion 2004.

OPTIONAL READING:

[1] Beginning Gimp, *From Novice to Professional*, Akkana Peck, Apress; 2 edition (December 17, 2008).

PROGRAM PREPARATION:

Dr Olaf Maron

COMPUTER GRAPHICS

Course code: **11.3-WF-FizP-GraKo**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	II (FK)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

The theoretical and practical knowledge of a wide range of issues of computer graphics.
Ability to independently create sophisticated graphic design in 2D and 3D.
Create a simple animation.

ENTRY REQUIREMENTS:

Basic programming, work on Linux / Windows, basic course in linear algebra and geometry.

COURSE CONTENTS:

LECTURE:

- History and overview of contemporary methods and applications of computer graphics
- Basic raster graphics algorithms
- Mathematics in computer graphics
- Transformation and projection
- Ray tracing

LABORATORY:

I PovRay
- The basic elements of the scene and geometric objects in the PovRay
- CSG
- Texture and surface facilities
- Lighting
- Scripting
- Animations

II. Managerial and presentation graphics
- Gimp - creating graphics for the web
- Create a slideshow and presentation

III. The graphics in scientific texts
- LaTeX and PSTricks

TEACHING METHODS:

Lectures and laboratory

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student knows the basic algorithms used in raster and vector graphics. The student has knowledge of the role of mathematics and physics in computer graphics .	K1A_W02 and K1A_W03	test	lecture
The student knows the modern graphical tools and their application and is able to expand knowledge about the capabilities of these tools .	K1A_W04 and K1A_W09 K1A_U07 and K1A_K04	Preparing a presentation with the help of of selected graphical tools	lab
The student has the ability to create managerial and presentation graphics and animations and advanced graphic both in 2D and 3D.	K1A_U04	PovRay animation Presentation on the designated topic	lab

ASSESSMENT CRITERIA:

The basis of the course is to pass a written test of theoretical knowledge.

Laboratory - credit rating based on individually completed graphic design, such as:

- PovRay animation
- Presentation on the designated topic
- Advanced graphic design in 2D vector technology.

Final rating is 60% of laboratory and 40% of the lecture.

STUDENT WORKLOAD:

Participation in lectures: 30 hours.

Laboratory classes: 30 hours.

Participation in the consultation: 3 hours.

Preparation for laboratory: 15 hours.

Preparation for the exam: 15 hours.

Preparation of graphic projects: 15 hours.

Total: 108 hours, 4 ECTS credits.

Effort involved in activities that require direct involvement of teachers is 63 hours. This corresponds to 2,5 ECTS.

RECOMMENDED READING:

[1] Foley James D., Dam Andries, Hughes John, Phillips Richard, *Introduction to Computer Graphics,* ddison-Wesley Professional 1993

[2] Eric Lengyel, *Mathematics for 3D game programming & computer graphics,* Charles River Media INC, Massachuset 2004.

[3]John Vince, Mathematics for Computer Graphics, Springer-Verlag, London 2006.

OPTIONAL READING:

[1] http://www.povray.org/documentation/

[2] http://www.povray.pl

[3] http://www.f-lohmueller.de/index.htm

[4] http://latex-beamer.sourceforge.net/

[5] http://www.gimp.org

PROGRAM PREPARATION:

dr Bartosz Brzostowski

FOUNDATIONS OF ASTROMETEOROLOGY

Course code: **13.2-WF-FizP-PoAst**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	15	1	II (FŚ)	Exam	
Class	30	2		Grade	

COURSE AIM:

Presentation and explanation of the astrophysical phenomena that influence the Earth's climate. Explanation of the significance of the „space weather" and its influence on the human technological civilization.

ENTRY REQUIREMENTS:

none

COURSE CONTENTS:

- *Celestial sphere phenomena* – astronomical coordinate systems, celestial objects motions, daily and annual motion of the Sun.
- *The Sun as the energy source* – structure and the evolution of the Sun. Solar energy sources – thermonuclear reactions. Solar activity and magnetism. Solar wind.
- *The Earth* – internal structure and magnetic field. Interactions between the solar wind and Earth's magnetosphere – radiation belts, aurorae. The influence of the solar wind on the life on Earth. "Space weather" versus the civilization.
- *Earth's atmosphere:* composition, and the escape of gases from the atmosphere. Structure of the atmosphere – layers from the troposphere to the exosphere. Special layers of the atmosphere: the inversion layer, the ozone layer, the ionosphere.
- *Relations between the solar activity and the climate.* The Sun as the main source of energy on the Earth. Solar cycle irregularities and the climate changes. The greenhouse effect and the global warming.
- *Astrophysical aspects of the climate* – Coriolis force – pasates, hurricanes and jet-streams.

TEACHING METHODS:

Classic lecture and calculational exercises during class

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to describe the motions of the astronomical objects on the celestial sphere. He is able to describe the structure of the Sun, and its energy sources. He is able to explain why and which thermonuclear reactions happen in the solar core. He is able to name and characterize the phenomena connected to the solar activity, and explain their connection to the solar magnetic field. Student is able to descrabe the internal structure of the Earth, and explain the origin of the Earth's magnetic field. He is able to explain why the existence of the Earth's magnetic field is crucial for the existence of life on the Earth's surface. He can describe the interaction of the solar wind with the Earth's magnetosphere and point out the civilizational implications. He is able to point out in which fields of modern technological civilizations, and in what way, we can protect ourselves from the devastating outcomes of the solar wind. Student can describe the structure of the Earth's atmosphere and can quote the physical laws that shape it. He can explain the origin and significance of the ozone layer. He is able to explain the significance of the greenhouse effect. He can relate the irregularities in the solar activity cycle to the Earth's climate changes.	K1A_W01	Multiple choice test	Lecture
He is capable of forming an independent opinion about the so called "global warming", based on the astrophysical, geophysical and historical data available. Student is able to solve simple arithmetical problems from the fields of spherical trigonometry, and astrometry. He is able to estimate the insolation of the earth's surface depending on the geographical coordinates and the date (K1A_U01, K1A_U05).	K1A_U01 K1A_U02 K1A_U05	Written test	Class

ASSESSMENT CRITERIA:

Lecture: written exam – multiple choice test, passing condition – more than 50% of the correct answers.

Class: written test, passing criteria: positive grade.

Before attempting the lecture test student has to pass the class.

Final grade: weighted average from the lecture test (60%) and the class test (40%).

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 1 h = 15 h
- Participation in the classes: 15 weeks x 2 h = 30 h
- Consultations: 5 h
- Class preparation: 15 weeks x 1 h = 15 h
- Homework: 15 weeks x 1 h = 15 h
- Exam preparations: 15 h
- Exam participation: 2 h

TOTAL: 97 hours, 4 ECTS.

Effort associated with activities where the participation of teachers is required: 52 hours, 2 ECTS.

RECOMMENDED READING:

[1] J. M. Kreiner, *Astronomia z astrofizyką*, PWN, Warszawa 1988.

[2] F. Shu, *Galaktyki, gwiazdy, życie*, Prószyński i S-ka, 2003.

[3] D. Block, *Astronomia dla każdego*, Marba Crown 1994.

[4] E. Rybka, *Astronomia ogólna*, PWN, Warszawa 1983.

[5] E. Boeker & R. Van Grondelle, *Fizyka środowiska*, PWN, Warszawa 2002.

OPTIONAL READING:

[1] J. D. Haigh, M. Lockwood, M.S. Giampapa, *The Sun, Solar Analogs and the Climate*, Springer Verlag – Saas-Fee Advanced Course 34, 2004.

PROGRAM PREPARATION:

Dr Wojciech Lewandowski

ASTRONOMICAL INSTRUMENTS

Course code: **11.3-WF-FIZP-InAst**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	II (AK)	Exam	
Class	30	2		Grade	

COURSE AIM:

The necessary concepts of optics and physics of electromagnetic wave needed to understand the principles of operation and construction of optical telescopes. Description of the construction of optical receivers used in astronomy. Construction and operation of the basic types of optical telescopes. Introduction of the concepts of electrodynamics and the physics of electromagnetic waves, that are necessary for understanding of the development of radio-astronomical telescopes and receivers. Description of basic receiver types used in radio astronomy. Description of basic radio-telescope types.

ENTRY REQUIREMENTS:

Knowledge of basic physical concepts of optics, electrodynamics and wave physics.

COURSE CONTENTS:

- Astronomical coordinate systems, siderial time, time-keeping, stellar brightness scale
- Optical telescopes, basic tesescope parameters
- Astronomical light detectors: photometers, CCD cameras, polarimeters, spectrographs, optical filter systems.
- The basic aplications of photometry, spectroscopy and polarymetry
- Radio-telescopes, radio wave detectors and receivers
- Interferometry in radioastronomy (VLA, VLBI, LOFAR, SKA)
- Microwave and infrared telescopes (ALMA)
- X-ray and gamma telescopes, including Cherenkov's telescopes (HESS)
- Cosmic rays: origin and detection
- Detection of astrophysical neutrinos
- Basics of the gravitational wve theory and gravitational wave detectors (VIRGO, LIGO).

TEACHING METHODS:

Classic lecture; computational exercises and research project preparation in the class

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student can name and describe basic types of optical telescopes, radio-telescopes, microwave and infrared telescopes. He can explain the idea and structure of Cherenkov telescopes, and the instruments used to detect cosmic rays, neutrinos and gravitational waves. He can describe and explain the astronomical receivers used to detect and measure electromagnetic radiation in all of its regimes: including photometers/radiometers and spectrometers. He knows their design and working principles, and he is able to calculate basic parameters of telescopes and receivers. Student understands the basic ideas of photometry, spectroscopy, polarimetry and their hybrids. He understands the concepts if the air mass, extinction, seeing and scintillation. He is able to use available astronomical databases and extract the information needed. Student has basic knowledge about astronomical sources of electromagnetic radiation, as well as cosmic ray particles, neutrinos and gravitational waves.	K1A_W01 K1A_W03 K1A_W05	Oral exam	Lecture
Student is able to solve simple problems concerning the basics of astrophysics and the designs of astronomical telescopes.	K1A_U02	Written test	Class
Student is able to prepare and perform a simple research project concerning astronomical observations	K1A_U03	Project grade	Class

ASSESSMENT CRITERIA:

Lecture: Oral exam, passing condition – positive grade.

Class: written test – solving computational exercises (50% of the grade) and the research project (50%) of the grade

Before taking the examination the student needs to obtain passing grade from the class

Final grade: average of the exam grade and the class grade.

STUDENT WORKLOAD:

- Participation in lectures: 15 x 2 h = 30 h
- Participation in classes: 15 x 2 h = 30 h
- Preparation for classes: 15 x 2 h = 30 h
- Consultations: 2 h
- Exam preparations: 6 h
- Participation in exam: 2 h

TOTAL: 100 h, 4 ECTS.

Effort associated with activities that require direct participation of teachers: 64 hours, 2,5 ECTS.

RECOMMENDED READING:

[1] F. Shu, *Galaktyki, gwiazdy, życie*, Proszyński i S_ka, 2003.

[2] M. Kubiak, *Gwiazdy i materia międzygwiazdowa*, PWN, 1994.

[3] J. M. Kreiner, *Astronomia z astrofizyką*, PWN, 1988.

[4] A. Branicki, *Obserwacje i pomiary astronomiczne*, WUW, 2006.

[5] R. Taylor, *Wstęp do analizy błędu pomiarowego*, PWN, 1999.

[6] K. Rohlfs, T. L. Wilson, *Tools of Radio Astronomy*, Springer, 2006.

OPTIONAL READING:

[1] B. D. Warner, *Lightcurve Photometry and Analysis*, Springer 2006.

[2] S. B. Howell, *Handbook of CCD astronomy,* Cambridge Uni. Press, 2006.

[3] E. Budding i O. Demircan, *Introduction to astronomical photometry*, Cambridge Uni. Press, 2007.

[4] J. D. Krauss, *Radio Astronomy,* Cygnus-Quasar Books, 1986.

[5] K. Grupen, I. Buvat (eds), *Handbook of particle detection and imaging*, Springer, 2012.

[6] I. S. Glass, *Handbook of infrared astronomy*, Cambridge Univ. Press, 1999.

[7] J. D. E. Creighton, W. G. Anderson, *Gravitational-Wave Physics and Astronomy: An Introduction to Theory, Experiment and Data Analysis*, Wiley, 2011.

PROGRAM PREPARATION:

Dr Wojciech Lewandowski

ENGLISH AS A FOREIGN LANGUAGE

Course code: **09.0-WF-FizP-JAng3**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **mgr Grażyna Czarkowska**
Name of lecturer: **mgr Grażyna Czarkowska**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	III	Grade	

COURSE AIM:

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help the students to develop their ability to apply language functions to effective communication in everyday life. The course also aims to further develop ability to use grammar structures which describe future and life experiences. It will help students to revise structures used to talk about present and past. The course provides an opportunity to learn the skill of writing informal letters.

The students will be able to deepen their knowledge of the specialist language used in the following branches of physics: mechanics, dynamics. They will get familiar with vocabulary concerning the Solar System.

ENTRY REQUIREMENTS:

A2+ of the Common European Framework of Reference for Languages specified by the Council of Europe

COURSE CONTENTS:

During the course students will learn to:

- describe present and past activities using more complex language structures -continuous tenses (2 hours)
- describe future activities – predictions, plans (4 hours)
- express offers, suggestions (2 hours)
- talk about life experiences using appropriate grammar tense (4 hours)
- exchange and get information concerning future in everyday life situations (3 hours)
- have longer conversations using familiar vocabulary and language structures (3 hours)
- understand non-specialist texts describing future (4 hours)
- participate in class discussions, express opinions with confidence (2 hours)
- write informal letters (2 hours)
- improve listening comprehension (2 hours)
- master and extend vocabulary used in mechanics, dynamics and be able to give a short description of the Solar System (2 hours)

TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF LEARNING OUTCOMES	CODE	VERIFICATION METHODS	FORM OF INSTRUCTION
Upon successful completion of the course, the students: • are able to describe present and past activities using complex grammar structures and recognize situational context for their application • are able to describe life experience using appropriate grammar tenses • are able to express offers and suggestions • are able to get detailed information concerning everyday life. • can have longer conversations using more complex structures and vocabulary • understand non-specialist texts describing future • have developed listening comprehension to understand longer dialogues • know expressions and rules used in informal letters • are able to give simple definitions of motion, force, and give a short description of the Solar Systems • are able to get information about topics from mechanics and dynamics • can deliver a short presenation in English • understand simple specislist texts concerning mechanics and dynamics • are able to work in a team	Language skills and competence on level A2+ of the Common European Framework of Reference for Languages.	Class tests presentation	Classes (laboratory)

ASSESSMENT CRITERIA:

– Grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information.

STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 1 hour

Private study:

- preparing a presentation – 3 hours
- getting ready for classes – 20 hours
- revising for tests – 6 hours

Total: 60 hours, 2 ECTS.

RECOMMENDED READING:

[1] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007.

[2] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007.

OPTIONAL READING:

[1] *FCE Use of English* by V. Evans.

[2] Internet articles.

[3] L. Szkutnik, *Materiały do czytania – Mathematics, Physics, Chemistry,* Wydawnictwa Szkolne i Pedagogiczne, 1974.

[4] J. Pasternak-Winiarska, *English in Mathematics*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006.

PROGRAM PREPARATION:

Mgr Grażyna Czarkowska

FUNDAMENTALS OF PHYSICS III – ELECTRICITY AND MAGNETISM

Course code: **13.2-WF-FizP-PF3EM**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
Physics – first degree studies					7
Lecture	30	2	III	Exam	
Class	45	3		Grade	

COURSE AIM:

To present the basic concepts of the classical theory of electromagnetism and the expansion of knowledge possessed by the student in the field. Transfer a knowledge in physics enabling for understanding at basic level the phenomena and processes in the classical electric and magnetic systems.

ENTRY REQUIREMENTS:

Skills in calculus and knowledge of the laws of physics at the high school level, and gained during completed courses.

COURSE CONTENTS:

- Basic historical background related to discoveries in the field of electromagnetism
- Basic concepts of electricity, discrete nature of the charge, the principle of charge conservation. The concept of an electric field and electric potential - relationships between them. Electric field lines. Potential energy in electric field. Point charge and electric dipoles - their behavior in the electric field. Coulomb's law, electric flux, Gauss's law, gradient of the field.
- Conductors in electric field, charge distributions in conductors, capacitors, capacity. Connecting of capacitors.
- Dielectrics in an electric field, Faraday's experiment, the polarization of dielectrics, electric susceptibility, polarization, electric displacement, isotropic and anisotropic dielectrics.
- Electricity, the concept of stationarity and homogenity of current, current and its density, resistance and resistivity, temperature dependence of resistance, Ohm law, superconductivity, the microscopic description of electric current, Kirchhoff law, electromotive force, energy and its conversion in electric circuits, combining of resistors, compensation circuit, measuring current and voltage, electrical RC circuit.
- Basic concepts related to magnetic field, definition of the vector of magnetic field induction, Lorentz force, magnetic dipole and its behavior in the magnetic field.
- Ampere's law, Biot-Savart law, forces acting on a current-carrying conductor in a magnetic field, ampere unit - its definition.

- Faraday's induction law, Lenz's law, inductance, LR circuit, energy of magnetic field.
- Gauss' law for magnetism, magnetic materials (para-, dia- and ferromagnetic) Curie law, magnetic field vector, magnetization, magnetic permeability.
- Displacement current, symmetry of equations of electromagnetism, the concept of divergence and curl and their relationship to macroscopic physical quantities, integral Maxwell equations and their differential counterparts.

TEACHING METHODS:

Classical lectures supported by physical demonstrations, classes.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

The student can describe the processes in the field of electricity and magnetism. He/she has a general knowledge of classical and modern physics, physical measurement methods, which allows for understanding of fundamental physical phenomena of the surrounding world and knows the cause-effect relationships (**K1A_W01**). The student understands and can explain physical phenomena and processes using the language of mathematics, can independently reproduce theorems and laws of physics, and selected calculations. He/she can create a theoretical model of the phenomenon and find its relationships with the results of measurements (**K1A_W03**). He/she can also analyze and solve physical problems on the basis of his acquired knowledge and information from the available literature sources, online resources (both in Polish and foreign language) **(K1A_U01)**. The student is able to analyze the theoretical and experimental results and formulate appropriate conclusions on their basis (**K1A_U02**). Moreover, the student is able to describe chosen physical problem and provide possible solutions **(K1A_U05).** He/she is able to acquire by oneself his/her knowledge and develop his skills using a variety of sources (in Polish and foreign language) and modern technology **(K1A_U07)**. After completing the course the student recognizes social role of the physics graduate. He especially understands the need for formulating and providing the information and opinions on the achievements of physics to the public. In consequence, he endeavors to provide such information and opinions in a widely understood way **(K1A_K05)**.

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of classical and modern physics, physical measurement methods, which allows for understanding of fundamental physical phenomena of the surrounding world and knows the cause-effect relationships	K1A_W01	Final exam (written)	lecture
The student understands and can explain physical phenomena and processes using the language of mathematics, can independently reproduce theorems and laws of physics, and selected calculations. Student can create a theoretical model of the phenomenon and find its relationships with the results of measurements	K1A_W03	Final exam (written)	lecture
The student is able to acquire by oneself his knowledge and develop his skills using a variety of sources (in Polish and foreign language) and modern technology	K1A_U07	Final exam (written)	lecture
The student recognizes social role of the physics graduate. He especially understands the need for formulating and providing the information and opinions on the achievements of physics to the public. In consequence, he endeavors to provide such information and opinions in a widely understood way	K1A_K05	Final exam (written)	lecture
The student has a general knowledge of classical and modern physics, physical	K1A_W01	Tests (partial)	class

measurement methods, which allows for understanding of fundamental physical phenomena of the surrounding world and knows the cause-effect relationships			
The student understands and can explain physical phenomena and processes using the language of mathematics, can independently reproduce theorems and laws of physics, and selected calculations. Student can create a theoretical model of the phenomenon and find its relationships with the results of measurements	K1A_W03	Tests (partial)	class
The student can analyze and solve physical problems on the basis of his acquired knowledge and information from the available literature sources, online resources (both in Polish and foreign language)	K1A_U01	Tests (partial)	class
The student is able to analyze the theoretical and experimental results and formulate appropriate conclusions on their basis	K1A_U02	Tests (partial)	class
The student is able to describe chosen physical problem and provide possible solutions	K1A_U05	Tests (partial)	class

ASSESSMENT CRITERIA:

Lecture - obtaining a positive assessment of the final exam (written). In addition, there is the opportunity to prepare and present a study on the given topic or practical task.

Classes - Positive pass all tests.

Before taking the exam a student must gain positive grade during the class.

Total score: a weighted average rating of the exam (70%) and grade from the class (30%).

STUDENT WORKLOAD:

- Participation in lectures: 30 hours
- Participation in classes: 45 hours
- Preparing for classes: 45 hours
- Preparing for the exam: 35 hours
- Consultations: 10 hours.
- Participation in the exam: 2 hours

Total: 167 hours, 7 ECTS.

Effort related to activities that require direct participation of teachers 87 hours, equivalent to 3,5 ECTS.

RECOMMENDED READING:

[1] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki, T. III, Elektryczność i magnetyzm*, Wydawnictwo Naukowe PWN, Warszawa (any edition).

[2] Materials prepared and supplied by lecturer (available in electronic form).

OPTIONAL READING:

[1] H. Rawa, *Elektryczność i magnetyzm w technice*, Wydawnictwo Naukowe PWN (any edition).

[2] D. J. Griffiths*, Podstawy elektrodynamiki,* Wydawnictwo Naukowe PWN, (any edition).

PROGRAM PREPARATION:

Dr hab. Wiesław Leoński, prof. UZ

PHYSICS LABORATORY I - ELECTRICITY AND MAGNETISM

Course code: **13.2-WF-FizP-PF1EM**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Laboratory	45	3	III	Grade	

COURSE AIM:

The aim of the course is to provide students with the phenomenon of the magnetism and with the chosen effects associated with the flow of an electric current. All experiences exercised during the classes are aimed to demonstrate a close relationships between branches of physics mentioned above. An additional purpose of this course is developing a logical thinking skills among students and their creativity.

ENTRY REQUIREMENTS:

Fundamentals of physics and mathematics, ability of analysis and presentation of data, ability of estimating measuring uncertainties.

COURSE CONTENTS:

In frame of the course the following laboratory exercises are being conducted:

- Determination of the charge and capacity of the capacitor,
- Study of Peltier module,
- Examination of Joule's law of heating,
- Measurement of the electrical resistance, checking Ohm's law,
- Study of circumferences of the direct current (examination of Kirchoff's laws),
- Study of transformer functioning,
- Measurement of the inductance and capacities with technical method,
- Resonance in the series and parallel circumference,
- Measuring the dielectric constant of solid materials,
- Study of relaxation oscillations,
- Measurement of the capacity of the capacitor with using Wheatstone's bridge,
- Experimental study of the electromagnetic resonances,
- Study of the vector of the magnetic induction along the axis of the solenoid with using the magnetron method,
- Study of hysteresis loops,
- Measurement of electrical power in alternating current circuits.

TEACHING METHODS:

Laboratory exercises preceded by the brief conventional or problem lecture are basing methods of teaching.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of basic physics (classical and modern), data acquisition and statistical processing of experimental data.	K1A_W01	discussion	short lecture
The student understands as well as is able to explain the course of phenomena and physical processes using language of mathematics; is able independently to reconstruct theorems and laws and chosen calculations.	K1A_W03	test	laboratory
The student understands the structure and the principles of operation of research apparatus applied in physics, is able to make the measurement of the physics quantity and to make his interpretation and visualisation.	K1A_W05 K1A_U02 K1A_U03	test / project / systematic checking during the classes	laboratory, homework
The student knows essentials of health and safety at work.	K1A_W06	systematic checking during the classes	laboratory
The student is able to speak intelligible, straight language about physical issues.	K1A_U06	discussion	short lecture
The student is able to think and to act in the enterprising way.	K1A_K06	systematic checking during the classes	laboratory

ASSESSMENT CRITERIA:

Form of receiving a credit for a course is a grade. Performing all exercises along with drawing them up in the form of written report is a condition for passing the course. The grade obtained from every exercise consists of:

- Grade from the preparation for classes 30%
- Grade from the laboratory work 20%
- Grade obtained from the report 50%

STUDENT WORKLOAD:

- Participation in classes: 45 hours
- Preparation for classes: 20 hours
- Preparing reports: 40 hours
- Consultation: 2 hours

TOTAL: 107 hours, 4 ECTS.

The workload requiring the teacher's direct participation: 47 hours. It is giving 2 ECTS.

RECOMMENDED READING:

[1] S. Szczeniowski, *Fizyka doświadczalna cz. II*, PWN, Warszawa 1972.

[2] H. Szydłowski, *Pracownia fizyczna*, PWN, Warszawa 1979.

[3] D. Halliday, R. Resnick, J. Walker, Podstawy fizyki - Elektryczność i magnetyzm t. 3, PWN, Warszawa 2006.

[4] T. Dryński, *Ćwiczenia laboratoryjne z fizyki*, PWN, Warszawa 1972.

[5] A. Zawadzki, H. Hofmokl, *Laboratorium fizyczne*, PWN, Warszawa 1961.

[6] J. Szatkowski, L. Lewowska (red.), *Ćwiczenia laboratoryjne z fizyki, część 3, Elektryczność i magnetyzm,* Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 1999.

OPTIONAL READING:

[1] E. M. Purcell, *Elektryczność i magnetyzm*, PWN, Warszawa 1968.

[2] J. Massalski, M. Massalska, *Fizyka dla inżynierów, t.1*, WNT, Warszawa 1975.

[3] H. Szydłowski*, Niepewności w pomiarach. Międzynarodowe standardy w praktyce*, Wydawnictwo Naukowe UAM, Poznań 2001.

[4] R. P. Feynman, R. B. Leighton, M. Sands, *Feynmana wykłady z fizyki*, t. 2 cz. 1, *Elektryczność i magnetyzm, elektrodynamika*, PWN, Warszawa 2009.

[5] R. P. Feynman, R. B. Leighton, M. Sands, *Feynmana wykłady z fizyki,* t. 2 cz. 2, *Elektrodynamika, fizyka ośrodków ciągłych*, PWN, Warszawa 2009.

PROGRAM PREPARATION:

Dr Piotr Jachimowicz

MATHEMATICAL METHODS IN PHYSICS

Course code: **11.1-WF-FizP-MeMaF**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	III	Exam	
Class	30	2		Grade	

COURSE AIM:

Acquainting the student with advanced mathematical methods necessary for understanding the contents of main study subjects.

ENTRY REQUIREMENTS:

Mathematical analysis I and II together with algebraic and geometric methods in physics.

COURSE CONTENTS:

- Elements of analytical geometry: planar and space curves, tangents and normals to planar curves, various parameterizations of of straight line, conics in Cartesian and polar coordinates, equations of plane in space, surfaces, quadrics and their classifications.
- Differential operators in curvilinear coordinates: planar and spatial Cartesian and curvilinear coordinates, curvilinear orthogonal coordinates, scalar and vector fields, differential operations on scalar and vector fields: gradient, divergence, rotation, Laplace operator in Cartesian coordinates; potential fields, divergence free fields and irrotational fields; gradient, divergence, rotation, Laplace operator in curvilinear orthogonal coordinates. Definition of tensor fields and algebraic operations on them.
- Elements of variational calculus: definition of functional and examples of them, weak and strong extrema, notion of variation of functional, necessary condition for existence of extremum of a functional, Eulera-Lagrange equations and their properties. Applications of variational calculus.
- Functions of complex variable: complex function of complex variable, limit of function, continuity of function, derivative of complex function, Cauchy-Riemanna conditions for the existence of the complex derivative, Cauchy integral formula, Taylor and Laurent series, singular points of a function, residue, calculation of integrals with the help of residue theory.
- Ordinary differential equations: first order differential equations: method of isoclines, finding solutions of various types of differential equations: separable, homogeneous, Bernoulli's and Riccati's equations, second order linear homogeneous and non-homogeneous differential equations with constant and variable coefficients, method of constant variations and method of undetermined coefficients.
- Partial differential equations of mathematical physics: vibrating string equation and d'Alembert method, membrane equation and Fouriera method of variables separation, Laplace equation.

In class students solve problems illustrating the lecture material.

TEACHING METHODS:

Conventional lecture. Computational problems illustrating the lecture material together with its physical applications.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows and understands selected problems from analytical geometry, vector analysis, variational calculus, functions of complex variable and practical aspects of ordinary and partial differential equations of selected types. Student knows elementary terminology employed in these areas of science	K1A_W02 K1A_K01	Exam, grade	Lectures, classes
Student knows and uses various parameterizations of planar and spatial curves, can write the straight line equation knowing various sets of given data, determines equations of tangents and normals to given planar curves, recognizes types of conics from their equations, rewrites conics equations from Cartesian to polar coordinates and vice versa, writes conics equations in coordinates frames with shifted origin	K1A_U02 K1A_W03	Exam, grade	Lectures, classes
Student knows various types of curvilinear coordinates, can check whether the coordinates are orthogonal, determines Lame coefficients, knows how to determine gradient, divergence, rotation and Laplace operator in given orthogonal coordinates.; applies the properties of the Kronecker delta and Levi-Civita's symbol for derivation of various vectorial identities. Student can check if vector fields are divergence free or irrotational, determines scalar and vectorial potential for given vector fields; can transform scalar functions and vectorial fields from one to another coordinates system.	K1A_U02 K1A_W03	Exam, grade	Lectures, classes
Student knows extremum condition for functionals and applies it for various problems of mathematics and physics	K1A_U02, K1A_W03	Exam, grade	Lectures, classes
Student knows how to check if a complex function is differentiable and calculates its derivatives, knows parametrisation of the most important curves on complex plane and calculates integrals of complex functions, applies Cauchy integral formula to determine integrals of complex functions. Student knows definition of Taylor series and expands given function into Taylor series, understands the notion of holomorphic function, knows the singular points classification. Student knows the definitions of Laurent series and residue, calculates residua using different methods, applies residues to calculate integrals	K1A_U02	Exam, grade	Lectures, classes
Student can solve basic classes of first and second order ordinary differential equations. Student knows fundamental partial differential equations: string, membrane and Laplace equations and knows simplest methods of solving them	K1A_W03 K1A_U02 K1A_U05	Exam, grade	Lectures, classes

ASSESSMENT CRITERIA:

Lecture: Exam. The course credit is obtained by passing a final written exam composed of tasks of varying degrees of difficulty.

Class: Written test. A student is required to obtain at least the lowest passing grade from the test organized during class.

To be admitted to the exam a student must receive a credit for the class.

Final grade: weighted average of grades from exam (60%) and class (40%).

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours

- Preparation for lectures: 15 hours

- Participation in class: 15 x 2 = 30 hours

- Preparation for class: 30 hours

- Preparation for test: 15 hours

- Attending lecturers' office hours: 5 hours

- Preparation for exam: 20 hours

- Participation in exam: 2 hours

TOTAL: 147 hours, 6 ECTS.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 67 hours, this corresponds to 3 ECTS.

RECOMMENDED READING:

[1] R. Leitner, *Zarys matematyki wyższej*, część I, II i III, WNT, Warszawa 1998.

[2] D. McQuarrie, *Matematyka dla przyrodników i inżynierów,* T. 1, 2 i 3, PWN, Warszawa 2006.

[3] T. Jurlewicz, Z. Skoczylas, *Algebra i geometria analityczna*, Oficyna Wydawnicza GiS, Wrocław 2011.

[4] E. Karaśkiewicz, *Zarys teorii wektorów i tensorów*, PWN, Warszawa 1974.

[5] I. M. Gelfand, S. W. Fomin, *Rachunek wariacyjny*, PWN, Warszawa 1970.

[6] J. Długosz, *Funkcje zespolone*, Oficyna Wydawnicza GiS, Wrocław 2005.

[7] M. Gewert, Z. Skoczylas, *Równania różniczkowe zwyczajne*, Oficyna Wydawnicza GiS, Wrocław 2006.

[8] G. I. Zaporożec, Metody rozwiązywania zadań z analizy matematycznej, WNT, Warszawa 1976.

OPTIONAL READING:

[1] F. W. Byron, R. W. Fuller, *Metody matematyczne w fizyce klasycznej i kwantowej*, t. 1-2, PWN, Warszawa 1974.

[2] J. Bird, *Higher engineering mathematics*, Elsevier, Amsterdam 2006.

[3] B. A. Dubrovin, S. P. Novikov, A.T. Fomenko *Modern Geometry. Methods and Applications,* Part 1, Springer-Verlag, 1984.

PROGRAM PREPARATION:

Prof. dr hab. Andrzej Maciejewski

NUMERICAL METHODS

Course code: **11.3-WF-FizP-MetNu**
Type of course: **compulsory**
Language of instruction: **polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Lecture	30	2	III (FK)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

Understanding the basics of Numerical Methods.

ENTRY REQUIREMENTS:

Knowledge of the linear algebra and calculus. Ability to program in *C* or another language.

COURSE CONTENTS:

Lecture:

The accuracy of the calculations and the types of errors.
Bisection method, secant and Newton's method - approximate root-finding algorithms.
Matrices. Gaussian elimination algorithm, LU decomposition. Inverse matrix. Determinants.
Eigenvalues and eigenvectors, QR method.
Polynomial interpolation, Lagrange's and Newton's method. Spline functions.
Numerical integration, the trapezoidal and Simpson's method. Gaussian quadrature.
Numerical differentiation.
Fast Fourier Transform.

Laboratory:

Searching for roots of the nonanalytical functions by bisection and Newton's method.
Finding the solution of linear equations.
Calculating the integrals using Simpson's method with a given accuracy.
The use of spline functions to the approximate calculation of definite integrals.
Calculations of nodes and weights for Gaussian quadrature.

TEACHING METHODS:

Conventional lecture; presentation of numerical methods by taking advantage of the practiced examples of programs.

Laboratory exercises in the computer lab. Working in groups. Together to solve more complex examples.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has sufficient knowledge of numerical methods to efficiently use it to solve simple physical problems using the computer, especially knows Gauss elimination method, methods of root-finding (bisection, Newton, secant), QR decomposition, Newton and Lagrange interpolation, spline functions, numerical differentiation, Gaussian quadrature, Fast Fourier Transform	K1A_W02	test, accomplishment of programming exercises	laboratory classes
Student has knowledge about the basic algorithms (eg quick sort) to write effective numerical program code in *C* (or *Fortran*), knows how to edit, archive and run programs on Linux	K1A_W04		
Student knows gcc compiler, the basic options and the basic functions of the program *gnuplot* for graphical presentation of the results of the numerical calculations, can indicate other free software (such as *grace*) and characterize areas of its applications in physics	K1A_W09		
Student can choose a suitable numerical method for solving the given physical problem, can read the computer code of programs written by other people and recognizes implemented numerical procedures therein	K1A_U01		
Student can write a program to help in the numerical analysis of theoretical results; can write a program that uses numerical procedures to analyse the experimental data, can formulate on this basis relevant proposals	K1A_U02		
Student is able to compile the program using *gcc* on Linux, can find the executable file and other output files generated during the running of the program; can generate a data file in a format suitable for later use *gnuplot* to visualize the results	K1A_U04		
Student can find in literature, the description of the numerical method of interest; can in simple programs take advantage of numeric code written by others, uses the instructions to the compiler *gcc* (eg The GNU C Reference Manual), uses both literature and internet (both in Polish and English as well)	K1A_U07		
Student consults with the lecturer in order to solve asked problems, is willing to, in collaboration with other students, to find an optimal method to solve the task	K1A_K04		

ASSESSMENT CRITERIA:

The condition of positive assessment of the lecture is taking the final test and obtain at least 51% of points.

The pass for the laboratory is to perform all programming exercises.

Before taking the exam a student must obtain a pass from the laboratory.

Final mark: a weighted average rating of the exam (60%) and laboratory (40%).

STUDENT WORKLOAD:

- Participation in lectures (1 hr. - Accuracy and errors, 4 hrs. - Root-finding, 9 hrs. - Matrices, 4 hrs. - Interpolation, 6 hrs. - Numerical integration, 2 hrs. - Spline functions, 2 hrs. - Numerical differentiation, 2 hrs. - Fast Fourier Transform): 30 hours.
- Participation in the labs: 30 hours.
- Preparation for labs: 30 hours.
- Preparation for the exam: 25 hours.
- Consultations: 5 hours.
- Participation in the exam: 2 hours.

TOTAL: 122 hours, 5 ECTS.

Workload directly involving teacher: 67 hours, 2,5 ECTS.

RECOMMENDED READING:

[1] Z. Fortuna, B. Macukow, J. Wąsoski, *Metody numeryczne*, WNT, Warszawa 1998.

[2] A. Bjorck, G. Dahlquist, *Metody numeryczne*, PWN, Warszawa 1987.

[3] A. Ralston, *Wstęp do analizy numerycznej*, WNT, Warszawa 1975.

[4] J. i M. Jankowscy, *Przegląd metod i algorytmów numerycznych*, WNT, Warszawa 1981.

[5] W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, *Numerical Reciepies in C*, CUP, 1992.

OPTIONAL READING: -

PROGRAM PREPARATION:

Dr Tomasz Masłowski

OBJECT ORIENTED PROGRAMMING

Course code: **11.3-WF-FizP-ProOb**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **dr Marcin Kośmider**
Name of lecturer: **dr Marcin Kośmider**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	III (FK)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

The aim of this course is to introduce the Object Oriented Programming techniques required to develope and create modern applications related to the „every day" and science problems. This is an active course where students solve realistic problems from beggining. Students learn how to analyse problem in the object oriented way and how to implement code according to the standards.

ENTRY REQUIREMENTS:

Linux

Procedural programming

COURSE CONTENTS:

1. Introduction

- object and procedural programming
- class, object and methods
- constructor and destructor
- encapsulation
- pointers
- operators overloading
- friend function

2. Using standard class

- IO operations
- short introduction to the STL containers and algorithms

3. Pointers

- objects and dynamic memory allocation
- copy constructor
- destructor

- „intelligent” pointers

4. Inheritance, polymorphism and code reuse

- inheritance
- virtual and abstract classes and methods
- interfaces
- polymorphism
- the idea of „code reuse”

5. Clean code

- name standards
- header files
- namespaces
- makefile
- code comment and documentation
- version control systems

6. Templates in C++

7. Exception

8. Object oriented modelling and programming

- defining and analysing problem and model creation
- UML diagrams
- coding UML diagrams in C++

9. Design patterns

- the idea
- creational patterns
- structural patterns
- behaviour patterns

10. Framewroks

- the idea
- Qt as as sample

TEACHING METHODS:

Lecture:

convencional lecture, work with problems, discusiion, workshop

Laboratory:

laboratory exercise, project, work in group, presentation, work with documentation, independed work, brain storm

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student know laboratory statute and BHP rules	K1A_W06	activity during laboratories	laboratory
Student can define problem,	K1A_W03	activity during laboratories,	laboratory,

describes and analyses it in the object oriented way	K1A_U05 K1A_U07	project, discussion, exam	lecture
Student can describe and presents how the scientific problem can be solved using object oriented programming techniques and can prepare source code	K1A_W04 K1A_W09 K1A_U04 K1A_U05	activity during laboratories, project, discussion, exam	laboratory, lecture
Student knows how to search, find and use modern tools and informations that can be used to solve given problem	K1A_W09 K1A_U07 K1A_K01 K1A_K04	activity during laboratories, project, discussion, exam	laboratory, lecture
Student can compile and run program. For a given physical problem student can analyse and interpret computational resuts and verify the correctness of a written application	K1A_W04 K1A_U04 K1A_U07	activity during laboratories, project, discussion, exam	laboratory, lecture
Student can work in group	K1A_K02 K1A_K01	activity during laboratories, project, discussion	laboratory
Student can create and present report from given problem	K1A_U08 K1A_K01 K1A_K04	activity during laboratories, project, discussion	laboratory

ASSESSMENT CRITERIA:

Lecture:

Student randomly choose one problem and has 2 hours to solve it and present results.

Laboratory:

50% - tests ad activity during laboratories

50% - final project

STUDENT WORKLOAD:

Lectures : 30 h.

Laboratories: 30 h.

Preparation for laboratory: 35 h.

Project preparation: 20 h.

Preparation for exam: 25 h.

Consultation: 5 h.

Exam: 2 h.

Sum: 147 h., 6 ECTS points

Lecturer direct participation: 67 h, 3 ECTS.

RECOMMENDED READING:

[1] Bruce Eckel, *Thinking in C++ Edycja Polska*, Helion Gliwice, 2002.

[2] Bruce Eckel, *Thinking in C++ Edycja Polska*, Tom 2, Helion Gliwice, 2004.

[3] Steve Holzner, *Design patterns for dummies*, Willey Publishing Ing. Indianapolis 2006.

OPTIONAL READING:

[1] Internet

PROGRAM PREPARATION:

Dr Marcin Kośmider

THERMODYNAMICS AND ELEMENTS OF HEAT ENGINEERING

Course code: **13.2-WF-FizP-TePTC**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Lecture	30	2	III (FŚ)	Exam	
Class	30	2		Grade	

COURSE AIM:

Acquaint students with the basic laws of thermodynamics in the context of their application in practice of thermal engineering.

ENTRY REQUIREMENTS:

Skills gained during previous courses of the studies.

COURSE CONTENTS:

- Basic concepts of thermodynamics
- Laws of thermodynamics
- Transformation of ideal gas and real gas.
- Thermodynamic cycles.
- Thermodynamic processes in heating and cooling systems.
- Transfer of heat.
- Alternative heat sources.

TEACHING METHODS:

Classical lectures, classes.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

The student knows how to describe the phenomena of thermodynamic processes occurring in the heating and cooling equipment. He/she understands the principles of operation of these devices.

The student has a general knowledge within the frames of classical and modern physics, physical measurement methodology that allows for the understanding of fundamental physical phenomena of the surrounding world. He/she knows the cause-effect relationships (K1A_W01). In addition, the student understands and can explain the nature of physical phenomena and processes using the language of mathematics and can reproduce the selected physical theorems and laws, and selected calculations (K1A_W03). The student can independently acquire knowledge and develop his skills, using a variety of sources (in Polish and foreign) and modern technologies. (K1A_U07). He/she has the ability to prepare oral presentations, in Polish and foreign language, using basic theoretical approaches and various sources (K1A_U08). He/she understands the need of improvement of his professional and personal skills, and broadening and deepening his knowledge with use of various sources of information (K1A_K04).

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge within the frames of classical and modern physics, physical measurement methodology that allows for the understanding of fundamental physical phenomena of the surrounding world. He knows the cause-effect relationships	K1A_W01	Final exam (written), preparing and presentation a study on the given topic or practical task.	Lecture, consultation
The student can independently acquire knowledge and develop his skills, using a variety of sources (in Polish and foreign) and modern technologies.	K1A_U07	Final exam (written), preparing and presentation a study on the given topic or practical task.	Lecture, consultation
The student has the ability to prepare oral presentations, in Polish and foreign language, using basic theoretical approaches and various sources.	K1A_U08	Preparing and presentation a study on the given topic or practical task.	Lecture, consultation
The student understands the need of improvement of his professional and personal skills, and broadening and deepening his knowledge with use of various sources of information	K1A_K04	Preparing and presentation a study on the given topic or practical task.	Lecture, consultation
Student understands and can explain the nature of physical phenomena and processes using the language of mathematics and can reproduce the selected physical theorems and laws, and selected calculations	K1A_W03	Tests (partial)	Class, consultation

ASSESSMENT CRITERIA:

Lecture - obtaining a positive assessment of the final exam (written). In addition, there is the opportunity to prepare and present a study on the given topic or practical task.

Classes - Positive pass of partial tests.

Before taking the exam a student must gain positive grade during the class.

Total score: a weighted average rating of the exam (60%) and grade from the class (40%).

STUDENT WORKLOAD:

- Participation in lectures: 30 hours.
- Participation in classes: 30 hours.
- Preparing for classes: 30 hours.
- Preparing for the exam: 25 hours.
- Consultations: 3 hours.
- Exam: 2 hours.

Total: 120 hours, 5 ECTS.

Effort related to activities that require direct participation of teachers 65 hours, which corresponds to 2,5 ECTS.

RECOMMENDED READING:

[1] J. Tomeczek, *Termodynamika*, Wyd. Politechniki Śląskiej, Gliwice 1999.

[2] S. Wiśniewski, *Termodynamika techniczna*, Wydawnictwo Naukowo-Techniczne, Warszawa 2005.

OPTIONAL READING:

[1] Materials from archive: Akademicka Telewizjia Naukowa, avaible at web page: *http://www.youtube.com/user/TVIATVN*

PROGRAM PREPARATION:

Dr hab. Wiesław Leoński, prof. UZ

ELEMENTS OF ACUSTICS, NOISE PROTECTION

Course code: **13.2-WF-FizP-PAOpH**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	III (FŚ)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

Introducing the basics of acoustics at a level sufficient for students to make an independent assessment of the degree of noise, to acquire noise measurement skills, and the knowledge of the active and passive noise protection.

ENTRY REQUIREMENTS:

Fundamentals of Physics, Mathematical Analysis.

COURSE CONTENTS:

- Basics of acoustics
- Wave equation, superposition of waves.
- Sound intensity
- Sound power
- Noise criteria
- Noise propagation control (noise isolation, double wall, acoustic coicidence, acoustic horizon)
- Sound sources (energy of the acoustic wave, acoustic monopoles, two monopoles, dipoles, quadrupoles)
- Acoustic profiles
- Measuring devices
- Legislation standards

LABORATORY:

- Fundamentals of acoustics (sound propagation in different media)
- Waves (superposition, acoustic impedance, sound power, intensity)
- Determining isophonic curves
- Methods of noise decreasing
- Technical conditions to be met by buildings and their location (legislation on protection against noise).

TEACHING METHODS:

Conventional lecture, theoretical exercises, laboratory exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Students have knowledge of the basics of acoustics, human perceptual abilities for noise detection, noise criteria, restrictions on the transfer of sound, active control of sound.	K1A_W01	test discussion exam	exercise exercise lecture
Students know the basic aspects of the design and operation of equipment for the measurement of sound, they can measure noise parameters and make its interpretation.	K1A_W05	test discussion	exercise exercise
Students analyze and solve acoustic problems based on acquired knowledge and information from the available literature sources, databases, online resources both in Polish and foreign.	K1A_U01	test discussion	exercise exercise
Students are able to perform the analysis of theoretical and experimental results and formulate on the basis of relevant proposals.	K1A_U02	test discussion	exercise exercise
Students use physical measurement methodology, they are able to plan and carry out simple acoustic measurements, analyze measurement data, interpret and present the results of measurement, the can provide solutions for the specific acoustic problems.	K1A_U03 K1A_U02	test discussion	exercise exercise
Students can develop their skills, using a variety of sources (Polish and foreign) and modern technology, - students have the ability to prepare written work from acoustics in Polish or English language, using basic theoretical issues, as well as various sources.	K1A_U07 K1A_U08	test discussion	exercise exercise
Students are aware of their knowledge and skills, understand the need and know the possibilities of continuous further training (second-and third-degree, postgraduate) - raising professional and personal competences, - they are aware of the responsibility for their own work and they have a will to comply with the rules work in a team and to take responsibility for common tasks performed.	K1A_K03 K1A_K02	test discussion	exercise exercise

ASSESSMENT CRITERIA:

Lecture: Exam grade (positive assessment)

Laboratory: Activity in classes, positive assessment of written works.

Overall rating: arithmetic mean score of the exam and lab pass.

STUDENT WORKLOAD:

- Participation in lectures: 30 hours

- Participation in excersises: 30 hours
- Preparation for the exercises: 30 hours
- Preparation of a study on noise protection: 25 hours.
- Consulting for the lecturees and excercises: 5 hours
- Preparation for the completion of the lecture: 25 hours
- Participation in exam: 2 hours

TOTAL: 147 hours, 6 ECTS.

Contact hours: 67 hours, 3 ECTS.

RECOMMENDED READING:

[1] E. Boeker, R. van Grondelle, *Fizyka środowiska*, Wydawnictwo Naukowe PWN, Warszawa 2002.

[2] R. Makarewicz, *Dźwięki i fale*, Wydawnictwo Naukowe UAM, Poznań 2009.

[3] F. S. Crawford Jr, Fale, PWN, Warszawa 1973.

[4] Rozporządzenie Ministra Infrastruktury z dnia 12 marca 2009 roku w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie, Tekst jednolity (Dz.U. nr 56 poz. 461, rok 2009).

OPTIONAL READING: -

REMARKS:

Laboratory - practical exercises with noise measurement, determination of the meeting noise standards for indoor and outdoor use.

Computer room - working with measurement data on noise measurements using the applicable standards, the use of ready-made programs, including online calculators.

PROGRAM PREPARATION:

Dr hab. Mirosław Dudek, prof. UZ

THE BASICS OF SPHERICAL ASTRONOMY AND ASTROMETRY

Course code: **11.3-WF-FizP-EASiA**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	III (AK)	Exam	
Class	30	2		Grade	

COURSE AIM:

Introduction to spherical triginometry, spherical astronomy and astrometry. Presentation of the Earth's atmosphere influence on the astronomical observations.

ENTRY REQUIREMENTS:

The knowledge of planar trigonometry. Basic knowledge about the solar system mechanics and the stellar physics

COURSE CONTENTS:

Astronomical metrods of describing the motions on the celestial sphere – teh Sun, the Moon, planets and asteroids, Astronomical coordinate systems. Time in astronomy. The influence of earth's atmosphere on astronomical observations. The aberration of light and heliocentric paralax. Proper motions of celestial objects. Motions of planets and asteroids on the celestial sphere.

TEACHING METHODS:

Classic lecture and computational exercises during class

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has basic knowledge about the spherical trigonometry. He is able to describe the motions of astronomical objects on the celestial sphere. He can define ad characterize the coordinate systems used in astronomy. He can name and describe the various time calculations used in astronomy. He can point and explain the phenomena in the	K1A_W01 K1A_W03 K1A_W05	Oral exam	lecture

earth;s atmosphere that can influence astronomical observations. He can define the proper motion of astronomical objects. He is able to explain the methods used to assess the orbital parameters of solar system bodies from the astrometric measurements			
Student can solve basic problems appearing in spherical trigonometry. He is able to transform astronomical coordinates between the various coordinate systems. He is able to solve basic problems concerning the celestial sphere motions: calculation of the celestial objects coordinates as seen from a given spot on earth at a given time	K1A_U01 K1A_U05 K1A_U08	Written test, homework	class

ASSESSMENT CRITERIA:

Lecture: Oral exam, passing condition – positive grade.

Class: written test – solving computational exercises; passing condition – positive grade.

Positive grade from class is needed to take part in the exam.

Final grade: average of the exam grade and the class grade (50/50).

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 h = 30 h
- Participation in the classes: 15 weeks x 2 h = 30 h
- Class preparation: 15 x 2 h = 30 h
- Homework: 15 x 1h = 15 h
- Consultations: 10 h
- Exam preparations: 30 h
- Participation in the exam: 2 h

TOTAL: 147 h, 6 ECTS.

Effort associated with activities that require direct participation of teachers: 72 hours, 3 ECTS.

RECOMMENDED READING:

[1] W. Opalski, L. Cichowicz, *Astronomia geodezyjna*, Państwowe Przedsiębiorstwo Wydawnictw Kartograficznych, 1980.

[2] J. Mietelski, *Astronomia w geografii*, PWN, 2009.

[3] A. Branicki, *Obserwacje i pomiary astronomiczne dla studentów, uczniów i miłośników astronomii*, Wydawnictwa Uniwersytetu Warszawskiego, 2006.

OPTIONAL READING:

[1] R. M. Green, *Spherical Astronomy*, Cambridge University Press 1999

[2] W. M. Smart, *Textbook on spherical astronomy*, Cambridge University Press 1999.

PROGRAM PREPARATION:

Dr Wojciech Lewandowski

INTRODUCTION TO CELESTIAL MECHANICS AND SOLAR SYSTEM

Course code: **11.3-WF-FizP-WMNUS**

Type of course: **compulsory**

Language of instruction: **English/Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Lecture	30	2	III (AK)	Exam	
Class	30	2		Grade	

COURSE AIM:

Introduction of basic problems of celestial mechanics. Presenting scientific information concerning astronomy of the Solar System and extrasolar planetary systems.

ENTRY REQUIREMENTS:

Knowledge of general astonomy and elementary physics.

COURSE CONTENTS:

- Motion in gravitational field and conservation laws.
- Kepler problem and motion in a central field.
- Two body problem.
- Determination of orbital elements from observations.
- Structure of the Solar System.
- Planetary and small bodies orbits.
- Extrasolar planetary systems.

TEACHING METHODS:

Conventional lecture, solving analytical and numerical problems.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to ennumerate basic laws of motion in simple gravitational fields. Students are able to describe and understand the Kepler problem. In particular, they can calculate Keplerian orbital elements and motions in them. They can also	K1A_W01	Exam, grade	Lectures, classes

calculate orbital elements from observations. Student knows, understands and is able to describe the basic laws governing the motion of planets and small bodies. Can describe in detail the structure of the Solar System, and characterize its components. The student has a basic understanding of the evolution of planetary systems. Knows the basic methods of observing extrasolar planetary systems and can provide their basic characteristics			
Student is able to perform, according to his knowledge of physical laws, calculations used to solve problems and issues related to the orbital motion of bodies	K1A_U01	Exam, grade	Lectures, classes

ASSESSMENT CRITERIA:

Lecture: The course credit is obtained by passing 2 written and oral final exams.

Class: Written test. A student is required to obtain at least the lowest passing grade from the test organized during class.

Before taking the examination the student needs to obtain passing grade in the computational exercises.

STUDENT WORKLOAD:

- Participation in lectures: 15 weeksi x 2 hours = 30 hours

- Participation in classes: 15 x 2 = 30 hours

- Preparation for classes: 15 x 1 = 15 hours

- Finishing computational tasks at home: 15 hours

- Attending lecturers' office hours: 5 hours

- Preparation for exam: 30 hours

- Taking the exam: 3 hours

TOTAL: 128 hours, 5 ECTS.

Effort associated with activities that require direct participation of teachers 68 hours, 2,5 ECTS.

RECOMMENDED READING:

[1] Alessandra Celletti and Ettore Perozzi, *Celestial Mechanics*, Springer, 2007.

[2] H. Pollard, *Mathematical Introduction to Celestial Mechanics*, Prentice Hall, 1966.

[3] Morbidelli, *Modern Celestal Mechanics*, Taylor & Francis, 2002.

OPTIONAL READING:

[1] G. Beutler, *Methods of Celestial Mechanics*, vol. I, Springer, 2005.

PROGRAM PREPARATION:

Prof. dr hab. A.J. Maciejewski

ENGLISH AS A FOREIGN LANGUAGE

Course code: **09.0-WF-FizP-JAng4**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **mgr Grażyna Czarkowska**
Name of lecturer: **mgr Grażyna Czarkowska**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	IV	Grade	

COURSE AIM:

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help the students to develop their ability to apply language functions to effective communication in everyday life. The course also aims to develop ability to compare objects, people, phenomena, to express necessity, prohibition and orders. The course provides an opportunity to learn the skill of writing formal letters, improve listening and reading comprehension. It helps students to further develop conversational skills, and gives basic knowledge of giving a presentation in English. It introduces vocabulary to describe atoms and expressions used in the following branches of physics: thermodynamics and optics.

ENTRY REQUIREMENTS:

B1 of the Common European Framework of Reference for Languages specified by the Council of Europe.

COURSE CONTENTS:

During the course students will learn to:

- compare people, objects (4 hours)
- use modal verbs to express prohibition and orders (3 hours)
- write formal letters (4 hours)
- use verb forms – gerund, infinitive (3 hours)
- make a longer dialogue using structures and vocabulary learned earlier in the course – comparison, modals to express prohibition, etc. (2 hours)
- prepare and deliver a short presentation in English (4 hours)
- understand longer and more difficult texts (2 hours)
- develop listening comprehension of long conversations (2 hours)
- master vocabulary of thermodynamics and optics (4 hours)
- understand simple specialist texts discussing problems of thermodynamics and optics (2 hours)

TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS :

DESCRIPTION OF LEARNING OUTCOMES	CODE	VERIFICATION METHODS	FORM OF INSTRUCTION
Upon successful completion of the course, the students: • can compare people, objects, and phenomena • can express prohibition, orders using modal verbs • are able to write formal letters • use verb forms (gerund, infinitive) according to the rules • can have long dialogues using complex language structures and vocabulary • are able to deliver a short presentation on a chosen topic in physics • are familiar with vocabulary used in thermodynamics and optics • understand specialist texts describing structure of an atom • know laws of thermodynamics and can give their short description in English • can cooperate with members of a group, exchange information, and discuss problems	Language skills and competence on level B1+ of the Common European Framework of Reference for Languages.	Class tests presentation	Classes (laboratory)

ASSESSMENT CRITERIA:

– grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information on different topics.

STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 1 hour

Private study:

- preparing a presentation – 3 hours
- getting ready for classes – 20 hours
- revising for tests – 6 hours

Total: 60 hours, 2 ECTS.

RECOMMENDED READING:

[1] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007.

[2] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University Press 2007.

OPTIONAL READING:

[1] *FCE Use of English* by V. Evans.

[2] L. Szkutnik, *Materiały do czytania – Mathematics, Physics, Chemistry,* Wydawnictwa Szkolne i Pedagogiczne.

[3] Internet articles.

[4] J. Pasternak-Winiarska, *English in Mathematics*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006.

[5] S. Hawking, *A Brief History of Time, The Universe In a Nutshell*, Bantam Books 2001.

PROGRAM PREPARATION:

Mgr Grażyna Czarkowska

FUNDAMENTALS OF PHYSICS IV – OPTICS, MODERN PHYSICS

Course code: **13.2-WF-FizP-PF4OF**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	IV	Exam	
Class	45	3		Grade	

COURSE AIM:

The aim of the course is acquainting students with basic laws of optics and elements of quantum physics necessary to understand and predict wave phenomena in optics and micro-world.

ENTRY REQUIREMENTS:

Mathematical methods in physics, Elements of physics I, II i III

COURSE CONTENTS:

LECTURE:

Electromagnetic waves in vacuum and material media.

Geometrical optics: reflection and refraction of light (Fermat's principle), mirrors, lenses, prisms; dispersion, aberrations and optical tools.

Wave optics: periodic wave motion, interference, diffraction and diffraction gratings, dispersion, absorption and dispersion of light, polarization of light.

Quantum nature of light: photoelectric and Compton effects, wave-particle duality.

Quantum nature of matter: atomic emission spectra, de Broglie's waves, diffraction of electrons, electron microscope. Quantum properties of matter: atom's models, energy quantization and Schrodinger equation, spin of electron and Pauli exclusion principle, multi-electron atoms, periodic table of elements, atom nuclei and elementary particles.

CLASS:

Solving chosen physical problems related to the lecture.

TEACHING METHODS:

Conventional lecture and demonstrations. Solving computational problems and discussing results.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF	VERIFICATION	FORM OF

	EFFECTS	METHODS	CLASSES
Student has knowledge of classical optics and contemporary physics	K1A_W01	Exam	Lectures
Student understands and can explain physical phenomena from optics and atom physics	K1A_W03	Exam	Lectures, classes
Student knows basic principles of construction and principles of operation of optical tools	K1A_W05	Exam, grade	Lectures, classes
Student can analyse theoretical problems from optics and draw reasonable conclusions	K1A_W02	Exam, grade	Lectures, classes
Student understands the necessity of inducing quantum notions to description of micro-world	K1A_K06	Exam	Lectures
Student can acquire on their own knowledge from optics and elements of contemporary physics	K1A_U07	Exam, grade	Lectures, classe

ASSESSMENT CRITERIA:

LECTURE: Exam. The course credit is obtained by passing a final written exam composed of tasks of varying degrees of difficulty.

CLASS: A student is required to obtain at least the lowest passing grade from the written tests organized during class.

To be admitted to the exam a student must receive a credit for the class.

Final grade: weighted average of grades from exam (60%) and class (40%).

STUDENT WORKLOAD:

- Participation in lectures: 15 x 2 = 30 hours

- Participation in class: 15 x 3 = 45 hours

- Preparation for class: 45 hours

- Preparation for exam: 25 hours

- Participation in exam: 2 hours

- Attending lecturers' office hours: 3 hours

TOTAL: 150 hours, 6 ECTS.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 80 hours. This corresponds to 3 ECTS.

RECOMMENDED READING:

[1] B. Jaworski, A. Dietlaf, *Kurs fizyki*, t. 3, *Procesy falowe. Optyka. Fizyka atomowa i jądrowa,* PWN, Warszawa 1984.

[2] I. W. Sawieliew, *Wykłady z fizyki,* t. 2, PWN, Warszawa 2002, (wyd. 3).

[3] J. R. Meyer-Arendt, *Wstęp do optyki,* PWN, Warszawa 1979.

[4] V. Acosta, C.L. Cowan, B.J. Graham, *Podstawy fizyki współczesnej,* PWN, Warszawa 1981.

[5] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki*, t. 4, t. 5, PWN, Warszawa 2003.

[6] J. Walker, *Podstawy fizyki. Zbiór zadań*, PWN, Warszawa 2005.

[7] David J. Griffiths, Podstawy elektrodynamiki, PWN, Warszawa 2005.

PROGRAM PREPARATION:

Prof. dr hab. Andrzej Maciejewski

PHYSICS LABORATORY I - OPTICS, MODERN PHYSICS

Course code: **13.2-WF-FizP-PF1OF**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Laboratory	45	3	IV	Grade	

COURSE AIM:

Teaching the basics of metrology and introduction into the basics of experimental physics.

ENTRY REQUIREMENTS:

- The knowledge of physics (optics, modern physics).
- The knowledge of metrology.

COURSE CONTENTS:

Terms and Physics Laboratory and safety and fire regulations.

List of exercises:

- The determination of the refractive index by measuring the apparent thickness.
- The determination of the refractive index of water by Abbe refractometer.
- The study of concentration of solution by saccharimeter SU-3.
- The determination of the constant of the diffraction grating using the laser.
- The determination of constant of the diffraction grating - method of the spectrometer.
- The determination of the refractive index by using a prism.
- The study of the photoelectric effect.
- The study of the triode. Determination of the characteristics of triode.
- The study of the diode.
- The determination of the electron work function.
- The study of the law of reflection and the law of refraction.
- The determination of the focal length of the lens.

TEACHING METHODS:

Laboratory exercise.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has a general knowledge of basic classical physics and methodology of physical measurement.	K1A_W01	control up to date in classroom, laboratory report	Laboratory
Student understands and explains physical phenomenon, knows statements and physical law's, can create a theoretical model and understands relation between experiment and theory.	K1A_W03	control up to date in classroom, laboratory report	
Student knows and can use equipment physics laboratory and knows and can refer work rules of medical equipment to physics equipment.	K1A_W05	control up to date in classroom, laboratory report	
Student knows the basic rules of safety and health at work, recognize the threat and knows how to prevent them.	K1A_W06	control up to date in classroom	
Student is able to perform the analysis of experimental results and formulate on the basis of relevant proposals, including proposals for the applicability of these results in medical physics, and evaluation of solution.	K1A_U02	control up to date in classroom, laboratory report	
Student knows the methodology of physical measurements, can plan and realize simples physical measurements, can analyse of experimental data and knows how to present results.	K1A_U03	control up to date in classroom, laboratory report	
Student is conscious how necessary is the development of professional and personal skills. Student using different information sources.	K1A_K04	control up to date in classroom, laboratory report	
Performs tasks in a way that ensures their own safety and the environment in this respect safety rules and regulations of the physical laboratory.	K1A_W06	control up to date in classroom	

ASSESSMENT CRITERIA:

The verification of background to the classes and the revision of the reports.

The grade obtained from every exercise consists of:

- Grade from the preparation for classes 30%
- Grade from the laboratory work 20%
- Grade obtained from the report 50%

STUDENT WORKLOAD:

- Participation in classes: 45 hours
- Preparation to classes: 20 hours
- Preparation of the reports: 30 hours
- Participation in consultation: 2 hours

Total: 97 hours, 4 ECTS points.

Effort associated with activities that require direct participation of teachers: 47 hours, 1,5 ECTS.

RECOMMENDED READING:

[1] R. Resnick, D. Halliday, *Fizyka*, tom 2, Wydanie piętnaste, Wydawnictwo Naukowe PWN, Warszawa 2001.

[2] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki*, Wydawnictwo Naukowe PWN, Warszawa 2003.

[3] H. Szydłowski, *Pracownia fizyczna wspomagana komputerem*, Wydawnictwo Naukowe PWN, Warszawa 2003.

[4] H. Szydłowski, *Pracownia fizyczna*, Wydawnictwo Naukowe PWN, Warszawa 1994.

OPTIONAL READING:

[1] H. Szydłowski, *Wstęp do pracowni fizycznej*, Wydawnictwo Naukowe UAM, Poznań 1996.

[2] H. Szydłowski, *Niepewności w pomiarach. Międzynarodowe standardy w praktyce*, Wydawnictwo Naukowe UAM, Poznań 2001.

PROGRAM PREPARATION:

Dr Joanna Kalaga

CLASSICAL AND RELATIVISTIC MECHANICS

Course code: **13.2-WF-FizP-MeKiR**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	IV	Exam	
Class	30	2		Grade	

COURSE AIM:

Familiarize students with formalism and the theory of classical mechanics and relativistic and manufacturing of physical problem-solving skills in this area.

ENTRY REQUIREMENTS:

Skills acquired during the previous course of study: basic physics, algebra and mathematical analysis.

COURSE CONTENTS:

- Kinematics and dynamic of point-mass systems and rygid bodies.
- Constraints, d'Alembert principle, Lagrange equations.
- Variational methods and conservation laws. Noether theorem.
- Phase space, Hamilton equations. Canonical invariants, integrals of motion.
- Galilean space-time. Minkowski space-time and special relativity theory.
- Elements of the relativistic dynamics.
- Elements of the continuous media mechanics.

TEACHING METHODS:

Conventional lecture and classes.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Skills acquisition process description with the use of the classical mechanics. The ability to correctly formulate the problem associated with the analysis of the physical model in order to apply appropriate methods of theoretical mechanics.	K1A_W01 K1A_W02 K1A_W03 K1A_U01 K1A_U02 K1A_U07	written exam	lecture
		test	clases

Student has a general knowledge of the physics of classical and modern physics, physical measurement methods and astronomy, which allows for the understanding of fundamental physical phenomena of the surrounding world, he knows the cause and effect relationship. The student is able to create a theoretical model of the phenomenon and associate it with the results of measurements. The student can use the formalism of classical mechanics to describe simple physical phenomena, is able to analyze and solve problems on the basis of physical knowledge and information from the available literature sources, databases and Internet resources. The student can independently acquire knowledge and develop their skills, using a variety of sources (in Polish and foreign) and new technologies. The student is aware of this knowledge and skills, and understands the need to know the possibilities of continuous further training in.	K1A_K01		

ASSESSMENT CRITERIA:

Lectures: passing a final written exam,

Classes: passing a final test.

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours
- Participation in classes: 15 weeks x 2 hours = 30 hours
- Preparation for classes: 45 hours
- Part in the consultation: 10 hours
- Preparation for an exam: 40 hours
- Participation in the exam: 2 hours

Total: 157 hours, 6 ETCS.

Effort associated with activities that require direct participation of teachers: 72 hours, 3 ECTS

RECOMMENDED READING:

[1] I. Olchowski, *Mechanika teoretyczna*, PWN, Warszawa 1978.

[2] W. Garczyński, *Mechanika teoretyczna*, Wrocław 1978.

OPTIONAL READING:

[1] W Rubinowicz, W. Królikowski, *Mechanika teoretyczna*, Wydawnictwo Naukowe PWN, Warszawa 1998.

[2] L. D. Landau, J. M. Lifszyc, *Mechanika*, Wydawnictwo Naukowe PWN, Warszawa 2007.

[3] J. R. Taylor, *Mechanika klasyczna*, Wydawnictwo Naukowe PWN, Warszawa 2006.

PROGRAM PREPARATION:

Dr hab. Krzysztof Urbanowski, prof. UZ

DATABASES

Course code: **11.3-WF-FizP-BazyD**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Laboratory	30	2	IV (FK)	Grade	

COURSE AIM:

Course aims to introduce students with the open source tools and techniques of data analysis and data storage

ENTRY REQUIREMENTS:

Basics in programming languages and programming

COURSE CONTENTS:

The course contents provides the basic knowledge on structure and workin schemes of SQL database systems. In praticular, the following problems will be discussed:

- data model construction,
- data relations: primary keys/foreign keys and the relations types (O2M, O2O, M2M),
- SQL introduction with the usage of open source SQL engines: PostgreSQL, MySQL,SQLite,
- programmers interfaces to SQL engines (C++, Python, PHP),
- object relational mapping (ORM),
- databases in web applications: CMS,
- databases engines scalability problem: replication and distributed dabases (Apache Cassandra),
- non-SQL databases types.

TEACHING METHODS:

Computer lab, discussions, individual students readings of technical documentation

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Students are able to install and administer popular and open-source DB engines available for Windows and Linux operating systems	K1A_W04 K1A_W09 K1A_U04	Activity during laboratories, Projects, Discussions	Laboratory
Students know the possible	K1A_W09	Activity during laboratories,	Laboratory

applications of DBs in scientific researchcontext		Projects, Discussions	
Students know how to use the DB engines with the interfaces of programing languages like C++, Python or PHP	K1A_U07	Activity during laboratories, Projects, Discussions	Laboratory
Students are able to use Internet and other available technical manuals to extend their knowledge regarding the data storage (especially scientific data)	K1A_K04	Activity during laboratories, Projects, Discussions	Laboratory

ASSESSMENT CRITERIA:

Reports from the two projects developed during the course are required to pass the lab.

STUDENT WORKLOAD:

- Lab: 30 h
- Lab preparations: 20 h
- Individual projects workload: 20 h
- Consultations: 5 h

Total 75 hours, 3 ECTS.

The workload requiring the participation of the teacher: 35 hours, 1,5 ECTS.

RECOMMENDED READING:

[1] Mark Whitehorn, Bill Marklyn, *Inside Relational Databases,* Springer 2001.

[2] A. Molinaro, *SQL Cookbook* , O'Reilly 2006.

OPTIONAL READING:

[1] PostgreSQL, MySQL, SQLite manuals and other technical docs.

PROGRAM PREPARATION:

Dr Sebastian Żurek

MEASUREMENT DATA ANALYSIS

Course code: **13.2-WF-FizP-FK-AnDPo**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	IV (FK)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

Teaching students how to analyze data measurements, their description, reduction and learning from them.

ENTRY REQUIREMENTS:

Experience from the first and second physics laboratory, knowledge of mathematical methods of physics, elements of the statistical analysis.

COURSE CONTENTS:

- *Measurement uncertainty*: significant digits and their rounding, the distribution of the population and the distribution of the sample, calculation of the mean, median, mode, standard deviation, range of variation and the average deviation.
- *Probability distributions*: calculation of the moments of a random variable with a known probability distribution, the cumulative distribution function and estimation of probabilities.
- *Error Analysis*: instrumental and statistical uncertainties, the equation of propagation of error, variance and covariance, the particular cases of error propagation, variance and covariance, computer implementations.
- *Estimation of averages and errors*: estimation of a mean, standard deviation and standard error, weighted estimates, relative estimates, testing of statistical hypothesis: Student's t-test and χ^2.
- *Monte Carlo Techniques*: random numbers generators, generation of random numbers from various probability distributions by the transformation of a homogeneous distribution, examples of simulations of simple measuring systems and experiments.
- *Fitting to a stright line with the least squares method*: linear regression exercises, solving normal equations and graphics science.
- *Least squares method for polynominal fitting:* solving of normal equations with determinant and matrix methods, fitting by using discrete orthogonal polynomials and Legendre polynomials.
- *Least squares method*: Marquardt'a-Levenberg method as the optimal method for linear and non-linear fit.
- *Fit testing*: χ^2 test, χ^2 distribution, correlation coefficient, multi-dimensional correlations, F-test, confidence intervals, the Monte Carlo test.

- *Grace* - the program for presentation and analysis of data: data loading, operations on data, the graphic presentation, linear regression, curves fitting.

TEACHING METHODS:

Conventional lecture, probabilistic experiment.

Tutorials, programming exercises, computer simulations (in the case of Monte Carlo method).

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has sufficient knowledge about: the uncertainty of measurement and measurement error analysis techniques, testing of statistical hypothesis, linear and nonlinear regression, direct and Monte Carlo techniques in error analysis, knows Marquard'a-Levenberg method	K1A_W02	tests	conventional lecture, programming exercises
Student knows the basic functions of the *grace* program and other free software to support the analysis of the measured data	K1A_W04 K1A_W09		
Student is able to analyze errors in a particular experiment, estimate the parameters of the sample, perform point and interval estimation, is able to use the basic tools for building statistical models, in particular linear and non-linear regression including Marquard'a-Levenberg method	K1A_U02 K1A_U03		
Student can test hypotheses and interpret their results	K1A_U02 K1A_U03		
Student can use the *grace* program to assist data analysis, in particular, load data, perform operations on them and present data graphically	K1A_U04		
Student is aware of the need to comply with the Rules of the computer lab	K1A_K02		

ASSESSMENT CRITERIA:

Lecture: final exam.

Classes: passing two tests, and performing the statistical project.

Final evaluation of laboratory exercises: arithmetic mean of the tests and the project.

Final evaluation of the course: arithmetic mean of the exam and laboratory exercises.

STUDENT WORKLOAD:

- Participation in the exercises: 30 hours
- Preparing for exercises: 30 hours
- Participation in lectures: 30 hours
- Participation in the exam: 2 hours
- Preparation for the exam: 25 hours
- Consultations: 5 hours.

TOTAL: 122 hours, 5 ECTS.

Workload directly involving teacher: 67 hours, 2,5 ECTS.

RECOMMENDED READING:

[1] H. Szydłowski (red), *Teoria pomiarów*, PWN, Warszawa 1981.

[2] S. Brandt, *Analiza danych*, PWN, Warszawa 1998.

OPTIONAL READING:

[1] R. Nowak, *Statystyka dla fizyków*, PWN, Warszawa 2002.

[2] P. R. Bevington, D. K. Robinson, *Data reduction and error analysis for the physical science,* McGraw-Hill., Inc., New York 1992.

PROGRAM PREPARATION:

Dr Tomasz Masłowski

DATA STRUCTURES AND ALGORITHMS

Course code: **11.3-WF-FizP-AiSDa**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	IV (FK)	Grade	
Laboratory	30	2		Grade	

COURSE AIM:

The aim of the course is to present algorithms and data structures as a powerfull tools that can be use to solve practical science problems in efficient manner.

ENTRY REQUIREMENTS:

Fundamentals of physics
Mathematical analysis
Algebraic and geometrical methods in physics

COURSE CONTENTS:

- Algorithm – idea, time complexity, examples
- Data structures and real life examples
- Data structures and algorithms – modern libraries and modules (C++ and Python)
- Geometric algorithms
- Image analysis and processign algorithms
- Genetic algorithms
- Text compression

TEACHING METHODS:

Conventional lecture, laboratories

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows how to use Linux operation system as a powerfull programming environment and	K1A_W04 K1A_U04	activity during laboratories, project, discussion, exam	laboratory, lecture

how test algorithms time and computational complexity using standard Open Source tools			
Student knows how to design or choose algorithm/data structure to solve given problem, how to interpret, analyse and prepare results for publication	K1A_U03	activity during laboratories, project, discussion, exam	laboratory, lecture
Student can use internet and scientific journals to look for informations related to the given problem and realize that permanent learning is a necessity of efficient problem solving in computational science, physics and data analysis	K1A_U07 K1A_K01 K1A_K04	activity during laboratories, project, discussion	laboratory

ASSESSMENT CRITERIA:

Lecture:

test - minumum 50%

Laboratory:

Students have to implement two choosen algorithms (image analysis and processing or/and genetic algorithms) and present results.

STUDENT WORKLOAD:

- Lectures: 30 h
- Laboratories: 30 h
- Preparation for laboratory: 20 h
- Project preparation: 10 h
- Preparation for exam: 20 h
- Consultation: 3 h

Sum: 113 h, 4 ECTS points.

Lecturer direct participation: 63 h, 2 ECTS.

RECOMMENDED READING:

[1] L. Banachowski, K. Diks, W. Rytter, *Algorytmy i struktury danych*, Wydawnictwa Naukowo-Techniczne, 2006.

[2] N. Wirth, *Algorithms and Data Structures*, Prentice Hall, 1985

OPTIONAL READING:

[1] W. H. Press, S. A. Teukolsky, W.T. Vetterling, B. P. Flannery, Numerical Recipes. The Art of Scientific Computing. Third Edition, Cambridge University Press, 2007.

PROGRAM PREPARATION:

Dr Marcin Kośmider

MEASURING DATA ANALYSIS

Course code: **13.2-WF-FizP-FŚ-AnDPo**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the laboratory exercises**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Laboratory	30	2	IV (FŚ)	Grade	

COURSE AIM:

The aim of the course is teaching the bases of measurement data analysis (i.e. data analysis and presentation as well as some elements of deductive and inductive ways of thinking).

ENTRY REQUIREMENTS:

Fundamentals of physics and mathematics, basic computer skills, basics of programming, ability of estimating measuring uncertainties

COURSE CONTENTS:

Elementary descriptive statistics, elements of probability theory, discrete random variables and their probability distributions, continuous random variables and their probability distributions, elements of sampling and statistical inference, hypotheses testing, analysis of variance, regression analysis, data presentation (with using open source software).

TEACHING METHODS:

Laboratory exercises (with using a computer) preceded by the brief conventional or problem lecture are basing methods of teaching.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student is able to select a suitable statistical method for the description and analysis of a given problem and interpret the results obtained with the use of the method selected	K1A_U02 K1A_U03	test / project / systematic checking during the classes	laboratory, homework
The student is able to work in Linux/Windows environment and to use chosen programming tools for solving physics problems	K1A_U04 K1A_W04	test / systematic checking during the classes	laboratory
The student is able to think and to act in	K1A_K06	systematic checking during	laboratory

the enterprising way		the classes	

ASSESSMENT CRITERIA:

Passing with a grade is a form of the course passing. Performing the statistical project is a condition for passing the course. The final course grade is a sum of: two grades from the tests (weight of every grade= 1,0) and grade obtained from the statistical project (weight of the grade = 1,5).

STUDENT WORKLOAD:

- Participation in classes: 30 hours
- Preparation for classes: 20 hours
- Consultation: 3 hours
- Project preparation: 20 hours

TOTAL: 73 hours, 3 ECTS.

The workload requiring the teacher's direct participation: 33 hours. It is giving 1,5 ECTS.

RECOMMENDED READING:

[1] H. Szydłowski (red.), *Teoria pomiarów*, PWN, Warszawa 1981.

[2] S. Brandt, *Analiza danych*, PWN, Warszawa 1998.

[3] H. Szydłowski, *Pracownia fizyczna*, PWN, Warszawa 1979.

OPTIONAL READING:

[1] J. R. Taylor, *Wstęp do analizy błędu pomiarowego*, Wydawnictwo Naukowe PWN, Warszawa 1995.

[2] R. Nowak, *Statystyka dla fizyków, ćwiczenia*, Wydawnictwo Naukowe PWN, Warszawa 2002.

[3] G. L. Squires, *Praktyczna fizyka*, Wydawnictwo Naukowe PWN, Warszawa 1992.

[4] P. R. Bevington, D. K. Robinson, *Data reduction and error analysis for the physical science*, McGraw-Hill., Inc., New York, 1992.

[5] H. Szydłowski, *Niepewności w pomiarach. Międzynarodowe standardy w praktyce*, Wydawnictwo Naukowe UAM, Poznań 2001.

PROGRAM PREPARATION:

Dr Piotr Jachimowicz

PHYSICS AND NUCLEAR ENERGY

Course code: **13.2-WF-FizP-FiEnJ**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Lecture	30	2	IV (FŚ)	Exam	
Class	30	2		Grade	

COURSE AIM:

Knowledge of the concepts of nuclear physics. Understanding the processes of nuclear spontaneous and forced, particularly fission and nuclear fusion. Understanding the principles of nuclear weapons and nuclear power plants. Getting to know the elementary interactions of nuclear radiation with matter.

ENTRY REQUIREMENTS:

Knowledge of mathematical analysis and physics presented at the first three semesters of study and degree.

COURSE CONTENTS:

LECTURE:
1) The structure of matter and the structure of the atomic nucleus:
- Quantum nature of the microworld, wave-particle duality (external photoelectric effect, Compton)
- Model of the atom: atom in the old quantum theory (Bohr) and the theory of Schrödinger
- Quantum numbers, the law of conservation of physical quantities of quantum numbers.
- Explanation Mendeleeva array structure.
- Standard Model. Hadrons in the framework of the theory of quarks, in particular protons and neutrons.
- Kernels as related systems of nucleons (protons and neutrons interacting with the quantum gluons of the strong force).
- Basic features of nucleons and nuclei in the theory of the nucleus.
- Chart binding energy per nucleon
- Models kernel: drip model, shell model, Fermi gas model.

2) Spontaneous processes:
- Exponential decay law.
- Decay constant and the width of the horizontal.
- Decays of alpha, beta and gamma.
- Spontaneous fission of heavy nuclei.

3) Forced processes, nuclear reactions:
- Reactions to the creation of complex nuclei.
- Reactions with alpha particles.
- Neutron reactions.
- Cosmic rays.

4) Nuclear fission of heavy nuclei:
- Fission of uranium nuclei.
- Outline of the theory of fission.
- Fission energy.
- Fission chain reaction of uranium and plutonium, a critical mass.

5) Controlled nuclear reactions - nuclear energrtyka.
6) Uncontrolled nuclear reactions - nuclear weapons.
7) The impacts of nuclear radiation with matter:
- Alpha particle interaction with matter.
- Beta particle interaction with matter.
- The impact of gamma and X photons with matter.

8) The use of nuclear medicine physics and dosimetry components (and of the absorbed dose, radiation weighting factor)
9) The effects of biological, chemical and nuclear radiation

EXERCISES:
- The calculation of basic hydrogen atom in the Bohr model. Appointment of permanent Ratheforda
- Simple nuclear reactions and methods of analysis: the exponential decay law, decay constant and the width of the level decays alpha, beta and gamma, spontaneous decay of heavy nuclei.
- Simple calculations for mandatory processes: reactions to the creation of complex nuclei, reactions with the use of alpha particles, neutron reactions, cosmic rays.
- The energy in the reactions of life: decay of uranium, a chain reaction in the case of uranium and plutonium, a critical mass.
- Energy produced nuclear weapons and thermonuclear.
- Obtained the energy and efficiency of nuclear reactors.
- Elements of dosimetry and related calculations: absorbed dose and individual weighting factor of radiation dose equivalent.

TEACHING METHODS:

Lecture - conventional lecture using multimedia tools.
Exercise - Exercise auditorium, group work.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of nuclear physics and nuclear energy, which allows us to understand the basic phenomena in nuclear power plants and their environment	K1A_W01	Grade from test exam	lecture
He knows the basic principles of nuclear safety and health, recognzes the threat and selects the appropriate measures for their prevention.	K1A_W06		
It has a basic knowledge of the legal and ethical issues with the use of nuclear physics.	K1A_W07		
Able to analyze and solve the problems of nuclear physics on the basis of acquired knowledge and information from the available literature sources, databases, Internet resources.	K1A_U01	Grade from classes	Classes
Able to perform the analysis of the results based on the known theoretical models of the atomic nucleus, and on this basis to formulate appropriate proposals.	K1A_U02		
He can talk about the issues of nuclear physics to understand, simple language.	K1A_U06		
Can independently acquire knowledge and develop their skills, using a variety of sources.	K1A_U07	Grade from test exam	Lecture
Are aware of their knowledge and skills, and understands the need to know the possibility of continuous training (second-and third-degree, postgraduate) - improving professional skills, personal and social.	K1A_K01		

It has a sense of responsibility for their own work and a willingness to comply with the principles of teamwork.	K1A_K02		
Is aware of the validity of the behavior in a professional manner at work related to the application of nuclear physics, ethics and respect for the diversity of views.	K1A_K03		

ASSESSMENT CRITERIA:

Lecture: Exam test (before taking the exam a student must obtain a pass from exercise)
Exercise: The arithmetic average of the evaluation tests including the activity in class.
Total score: arithmetic mean fitness exam and pass.

STUDENT WORKLOAD:

- Participation in lectures: 30 hours.
- Participation in the exercises: 30 hours.
- Preparing for practice: 30 hours.
- Preparation for the exam: 30 hours.
- Consultation: 3 hours.
- Participation in the exam: 2 hours.

Total: 125 hours, 5 ECTS.

Effort associated with activities that require direct participation of teachers: 65 hours, 2,5 ECTS.

RECOMMENDED READING:

[1] A. Strzałkowski, *Wstęp do fizyki jądra atomowego*, PWN, Warszawa 1983.
[2] Z. Wilhelmi, *Fizyka reakcji jądrowych*, PWN, Warszawa 1976.
[3] T. Mayer-Kuckuk, *Fizyka jądrowa*, PWN Warszawa 1983.
[4] B. Dziunikowski, *O fizyce i energii jądrowej*, Wydawnictwo AGH, Kraków 2001.

OPTIONAL READING:

[1] W. N. Cottingham, D. A. Greenwood, *An Introduction to Nuclear Physics*, Cambridge University Press 2001.
[2] H. A. Enge, *Introduction to Nuclear Physics*, Addison-Wesley Publishing Company 1972.
[3] J. Kubowski, *Broń jądrowa*, Wydawnictwo Naukowo-Techniczne, Warszawa 2008.
[4] K. N. Muchin, Doświadczalna fizyka jądrowa, PWN Warszawa 1978.

PROGRAM MADE BY: CAO LONG VAN

ELECTROMAGNETIC RADIATION AND HEALTH

Course code: **13.2-WF-FizP-PrEaZ**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Lecture	15	1	IV (FŚ)	Grade	
Class	30	2		Grade	

COURSE AIM:

To teach students the physical description of influence of electromagnetic fields on living beings in the framework of electrodynamics and quantum physics. To familiarise students with norms concerning non-ionizing and ionizing radiations.

ENTRY REQUIREMENTS:

Fundamentals of Physics and in particular Fundamentals of Physics III - Electricity and magnetism, and Mathematical Analysis I and II.

COURSE CONTENTS:

- Constant electric field in a material medium. Electric polarization, the field of a polarized object, electric displacement field, linear dielectrics.
- Constant magnetic field in a material medium. magnetization, the field of a magnetized object, magnetic field **H,** linear and non-linear media (diamagnets, paramagnetic and ferromagnetic), magnetic susceptibility and permeability.
- DC current in the conductors of the first and second kind. Ohm's law for the conductors of the first kind, Joule's law. Ion-conductors of the second kind, electrolysis, electrolytic polarization, Ohm's law for conductors of the second kind. Electrokinetic phenomena in colloidal solutions (electroosmosis and electrophoresis)
- Electromagnetic waves in the material media. Absorption and dispersion.
- Influence of electric and magnetic fields on living beings. The electrical properties of cells and tissues: structure of the cell and its electrical properties, dispersion of permittivity and conductivity, electrical impedance of cells and tissues, thermal effects of electromagnetic fields on living organisms, non-thermal effects. Classification of effect of EM fields in living organisms taking into account lenghts of electromagnetic waves, norms for electromagnetic radiation taking into account lenghts of electromagnetic waves.
- Influence of ionizing radiation on living organisms. Visible light and problems concecrning lightning of workplace, norms of lighting. Use of certain optical methods in medicine.
- Influence of ionizing radiation on living beings. Sources of ionizing radiation. Ionization and excitation of matter under the influence of ionizing radiation. Dosimetry of ionizing radiation. The biological effects of ionizing radiation. The values of permissible doses of ionizing radiation.

TEACHING METHODS:

Conventional lecture with applications of electromagnetic fields and radiation in medicine.
During class students solve exercises illustrating the content of the lecture. Students receive also lists of exercises to solve on their own. Students work with source materials: analyse legal regulations concerning electromagnetic radiation. Students also prepare a 45-minute presentations on a given subject, present them, answer questions, listen to presentations of colleagues and ask them questions.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of classical electrodynamics of material media that allows for understanding physical phenomena related to influence of electromagnetic radiation on living beings. The student knows and understands the mechanisms of interaction of electromagnetic radiation with organic matter for the whole range of the electromagnetic spectrum	K1A_W01 K1A_W03	Exam, grade	Lectures, classes
The student can describe physical phenomena in organisms under influence of electromagnetic field using the language of mathematics. The student cancreate theoretical models of theses phenomena using laws of electrodynamics	K1A_W03	Exam, grade, discussion	Lectures, classes
Students can determine the electric and magnetic fields for simple distributions of charges, and currents using various laws of electrodynamics (Gauss's law, the principle of superposition of potentials, the Poisson equation, Ampere's law, the law of Biot-Savart). Student determines induced current using Faraday's law	K1A_W01 K1A_W02	Exam, grade	Lectures, classes
Student knows the permissive values of electromagnetic fields and permissible doses for ionizing radiation, knows the applicable standards and legal regulations, and knows where to look for their novelizations	K1A_U07	Exam, grade	Lectures, classes
Students use various teaching materials in Polish and English, provided by the teacher as well as found on their own. The student learns a critical approach to materials found on the internet	K1A_U07	Exam, grade	Lectures, classes
The student can prepare a presentation on a given topic and present it to using simple language	K1A_U09 K1A_U06	Presentation	Classes
Student is aware of his knowledge and skills. Student recognises the necessity and knows possibilities of permanent training at higher level studies at university. Student understands necessity of permanent improvement of professional qualifications using various materials and opportunities and can keep track of changes in legal regulations concerning permissible values of electromagnetic radiation and permissible doses of ionizing radiations	K1A_K01 K1A_K04	Discussion	Lectures, classes

ASSESSMENT CRITERIA:

Lecture:

The course credit is obtained by passing a final written test composed of tasks of varying degrees of difficulty.

Class:

A student is required to obtain at least the lowest passing grade from the test organized during class. Also the presentation and participation in discussions during presentations of other students is evaluated.

To be admitted to the test from the content of lecture a student must receive a credit for the class.

Final grade: average of grades from the class and the exam.

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 1 h = 15 hours
- Preparation for obtaining a credit for the lecture: 15 hours
- Participation in class: 15 weeks x 2 h = 30 hours
- Preparation for class including preparation for tests and preparation of presentation: 28 hours
- Attending lecturers' office hours: 2 hours

Total: 90 hours, 3 ECTS points.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 47 hours. This corresponds to 1,5 ECTS points.

RECOMMENDED READING:

[1] M. Przybylska, Materiały do wykładu *Promieniowanie elektromagnetyczne a zdrowie*, skrypt, dostępny u wykładowcy.

[2] M. Zeńczak, *Oddziaływanie pól elektromagnetycznych na środowisko naturalne i środowisko pracy*, Wydział Elektryczny Politechniki Szczecińskiej, Szczecin 2000.

[3] A. S. Presma, *Pole elektromagnetyczne a żywa przyroda*, PWN, Warszawa 1971.

[4] D. J. Griffiths*, Podstawy elektrodynamiki*, PWN, Warszawa 2005.

[5] H. Aniołczyk, *Pole elektromagnetyczne, Źródła, oddziaływanie, ochrona*, Instytut Medycyny Pracy im. Prof. J. Nofera, Łódź 2000.

[6] F. Jaroszyk, *Biofizyka*, PZWL, Warszawa 2001.

[7] A. Z. Hrynkiewicz, ed., *Człowiek i promieniowanie jonizujące*, Wydawnictwo Naukowe PWN, Warszawa 2001.

[8] L. Latanowicz and J. Latosińska, *Promieniowanie UV a środowisko*, Wydawnictwo Naukowe PWN, Warszawa 2012.

OPTIONAL READING:

[1] J. D. Jackson*, Elektrodynamika klasyczna*, PWN, Warszawa 1987.

[2] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki 3*, PWN, Warszawa 2006.

[3] A. H. Piekara, *Elektryczność, materia i promieniowanie*,PWN, Warszawa 1986.

[4] R. Kubacki, *Anteny mikrofalowe. Technika i środowisko* (ostatni rozdział), WKŁ, Warszawa 2009.

[5] M. Young, S. Venn, *Essential physics for manual medicine*, Elsevier, Edinburgh 2010.

[6] P. Jaracz, *Promieniowanie jonizujące w środowisku człowieka*, Wyd. Uniwersytetu Warszawskiego, Warszawa 2001.

PROGRAM PREPARATION:

Dr hab. Maria Przybylska, prof. UZ

ENVIRONMENTAL PROTECTION LAW

Course code: **10.0-WF-FizP-PPdOŚ**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					1
Lecture	15	1	IV (FŚ)	Grade	

COURSE AIM:

The aim of the course is to familiarize students with current legislation related to environmental protection.

ENTRY REQUIREMENTS:

No requirements.

COURSE CONTENTS:

Lecture:
1. General principles of environmental law
2. Environmental Management
- Tasks of public administration in environmental protection,
- Social and environmental authorities,
- The financing of environmental protection,
- Access to environmental information,
3. Social organizations and the environment.
4. Legal aspects of the OS from threats
- Waste management,
- Emission permits (including the trading of emission rights),
- Accidents, environmental disasters
- Protection against noise and other harmful factors,
- Protection of the environment in the process of investment and planning.
5. Environmental Resources
- Protection of the air,
- The protection of groundwater,
- Protection of soil and minerals,
- Preserving the biosphere.
6. Legal and economic instruments of environmental protection.
7. Responsibility in law to protect the environment.

TEACHING METHODS:

A seminar lecture.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Students know the state institutions and regulations relating to the protection of the environment to a degree sufficient to refer to them in practice, for example by advising leading waste management companies, consulting companies which are dealing with the issue of toxic agents in different states. Students know the standard excess noise and other nuisances.	K1A_W06 K1A_W07	Discussion, develop written listed issues	lecture

ASSESSMENT CRITERIA:

The pass is to get good ratings from the development of written:
- Analysis of legal standards for the protection of the environment.
- Examples of companies' activities to protect the environment.

STUDENT WORKLOAD:

Participation in lectures: 15 hours.
- Preparing to pass the course, study: Analysis of legal standards for the protection of the environment. Examples of companies Lubuskie environmental protection 15 hours.
Total: 30 hrs., 1 ECTS.
Issue associated with activities that require direct participation of teachers: 15 hrs., 0.5 ECTS.

RECOMMENDED READING:

[1] Podstawowe aktualne akty prawne.

[2] M. Górski (red.*), Prawo ochrony środowiska*, Wolters Kluwer Polska, Warszawa 2009.

[3] B. Wierzbowski, B. Rakoczy, *Podstawy prawo ochrony środowiska. Zagadnienia podstawowe*, LexisNexis, Warszawa 2005.

OPTIONAL READING:

[1] M. Górski, *Odpowiedzialność administracyjnoprawna, w ochronie środowiska*, Wolters Kluwer Polska, Warszawa 2008.

PROGRAM PREPARATION:

Dr Stefan Jerzyniak

THE PHYSICS OF STARS AND THE SCATTERED MATTER

Course code: **11.3-WF-FizP-FGiMR**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	IV (AK)	Exam	
Class	30	2		Grade	

COURSE AIM:

Consolidation and extension of the basic astrophysical ideas. Presentation of physical theories that are aplicable to astronomical problems, at the level required for basic understanding of the processes governing the structure and evolution of starts, and the properties of the interstellar medium.

ENTRY REQUIREMENTS:

Basic knowledge of physics and astronomy.

COURSE CONTENTS:

- Basic physical laws and their application to astrophysical problems: gravitation, electrodynamics, thermodynamics, statistical physics, properties of the electromagnetic waves, special relativity.
- The basics of quantum mechanics. The structure of an atom. Nuclear physics, strong and weak interactions. Thermonuclear reactions.
- The structure of stars. Stellar energy sources. Radiation transfer. The basics of stellar atmosphere physics: origin of spectral lines.
- Basic problems of stellar evolution and its final stages: white dwarves, neutron stars, black holes.
- The basics of the interstellar medium physics: gaseous and dust clouds, radiative processes (thermal and non-thermal) in the interstellar medium.

TEACHING METHODS:

Classic lecture and computational exercises during class

LEARNING OUTCOMES. LEARNING OUTCOMES VERIFICATION:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to name and describe the	K1A_W01	Oral exam	lecture

basic laws of gravity, electrodynamics, thermodynamics, statistical physics, electromagnetic radiation physics and special relativity. Student knows the basics of quantum mechanics at the level required to describe the structure of atoms and molecules, and atomic nuclei. Student can describe the qualitative properties on weak and strong interactions. He can name and describe the basic thermonuclear reactions happening in stars(the proton-proton cycle, the CNO cycle, 3-alpha reaction). Student knows, understands and is able to describe the basic physical laws governing the structure of stars. He can characterize the structures of stars of various masses, and explain what observational parameters will result from such structure. He can explain the origin of spectral lines, and describe how they can be used to ascertain the basic physical parameters of stars. Student has knowledge about the stellar evolution, and is able to explain how and why stars of different masses will evolve. He can name and describe the final stages of stellar evolution: white dwarves, neutron stars and black holes. He can name and explain the radiative processes applicable to the interstellar medium. He can name the types of various portions of the interstellar medium and point which physical processes are responsible for their observational parameters.			
Based on the acquired knowledge student can perform simple calculations to solve basic astrophysics problems. He is able to interpret the results of simple astronomical observations, and on their basis infer the basic parameters of stars: mass, brightness, size and temperature. He is able to use his knowledge of astronomy to develop a simple observing project.	K1A_U01 K1A_U03 K1A_U05 K1A_U08	Written test, homework	class

ASSESSMENT CRITERIA:

Lecture: Oral exam, passing condition – positive grade.

Class: written test – solving computational exercises; passing condition – positive grade.

Before taking the examination the student needs to obtain passing grade in the computational exercises.

Final grade: and average of the exam grade and the class grade

STUDENT WORKLOAD:

- Participation in lectures: 15 x 2 h = 30 h
- Participation in classes: 15 x 2 h = 30 h
- Preparation for classes: 15 x 2 h = 30 h
- Homework: 15 x 1 h = 15 h
- Consultations: 5 h
- Exam preparations: 30 h
- Participation in exam: 3 h

TOTAL: 143 h, 6 ECTS.

Effort associated with activities that require direct participation of teachers 68 hours, 3 ECTS.

RECOMMENDED READING:

[1] F. Shu, *Galaktyki, gwiazdy, życie*, Prószyński i S_ka, 2003.

[2] M. Kubiak, *Gwiazdy i materia międzygwiazdowa*, PWN, 1994.

[3] J.M. Kreiner, *Astronomia z astrofizyką*, PWN, 1988.

OPTIONAL READING:

[1] E. Rybka, *Astronomia ogólna*, PWN, 1983.

PROGRAM PREPARATION:

Dr Wojciech Lewandowski

OBSERVATIONAL METHODS AND DATA ANALYSIS IN ASTROPHYSICS

Course code: **11.3-WF-FizP-MOADA**

Type of course: **compulsory**

Language of instruction: **Polish / English**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	IV (AK)	Grade	
Class	30	2		Grade	

COURSE AIM:

Basic knowledge on the methods of observation and measurement of in radio astronomy. Learning the methods of data analysis, in particular radio wave.

ENTRY REQUIREMENTS:

Zaliczenie przedmiotów: Technologia informacyjna, Podstawy programowania, Podstawy elektrodynamiki i instrumenty radioastronomii.

COURSE CONTENTS:

Methods of observations for different astronomical objects. Multi-frequency flux measurement - spectrum, spectroscopy, interferometry, pulsars. Measurement error analysis, the normal distribution (Gaussian), fitting the data to a linear function. Chi-square test, correlation and autocorrelation function. Introduction to Fourier analysis. Types of optical telescopes, the basic parameters of telescopes. Optical radiation receivers used in astronomy: photometers, CCD camera, polarimeters, spectroscopes. Filter systems. Construction and operation of optical receivers and their basic parameters.
Astronomical sources of optical radiation, and particularly interesting astronomical objects visible in the optical range of the electromagnetic spectrum: asteroids, variable stars, eclipsing systems, cataclysmic stars, pulsating stars, long-term variables, planetary nebulae, supernova remnants, stars and supernovae new, galaxies, micro-and makro-lenses, extrasolar planets.

TEACHING METHODS:

Lecture and class.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES

1. Student has a basic knowledge of astronomical sources of radiation.	K1A_W01	Test	Lecture
2. Students can describe the methods in radio astronomy observations and explain the operation of modern astronomical instruments.	K1A_W03 K1A_W05	Discussion	Lecture
3. The student is able to solve some astronomical problems and issues. He can interpret astronomical observations. Students can construct a simple research project and use statistical methods to analyze data	K1A_W04 K1A_K03	Test	Lecture
4. Can use source literature, including astronomical databases and directories.	K1A_W03 K1A_U01 K1A_U05 K1A_K01 K1A_K02	Exercise/task	Class
5. Able to interpret simple astronomical observations and based on them estimate the most important physical parameters of astronomical objects	K1A_U05 K1A_U08 K1A_U06	Exercise/task	Class
6. Students can construct a simple research project and use statistical methods to analyze data.	K1A_U03 K1A_U04 K1A_U07	Project	Class

ASSESSMENT CRITERIA:

Lecture: Positive passing of final test (80%) and discussion (20%).

Class: positive completion of homework (50%), solving problems in the class (50%)

Final grade: 50% lecture, 50% class.

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours

- Participation in class: 15 weeks x 2 hours = 30 hours

- Preparation for discussions during lecture: 15 x 1 = 15 hours

- Preparation for classes: 15 x 2 = 30 hours

- Solving problems and home: 15 x 1 = 15 hours

- **Participation in the consultations: 10 hours**

- Preparation for the test: 15 hours

TOTAL: 145 hours, 6 ECTS.

Effort associated with activities that require direct participation of teachers: 70 hours, 3 ECTS.

RECOMMENDED READING:

[1] L. Oster, *Astronomia współczesna*, PWN, Warszawa 1986.

[2] F. H. Shu, The Physical *Universe*, *An Introduction to Astronomy*, University Science Books, 1982 - 584 , wyd. Polskie; Fizyka Wszechświata, Galaktyki, gwiazdy, życie, Prószyński i S_ka, 2003.

[3] M. Jaroszyński, *Galaktyki i budowa Wszechświata*, PWN, 1993.

[4] M. Kubiak, Gwiazdy i materia międzygwiazdowa, PWN, 1994.

[5] M. Demiański, *Astrofizyka relatywistyczna*, PWN, Warszawa 1991.

OPTIONAL READING:

[1] G. L. Verschuur, *Interstellar Matters*, Springer-Verlag, 1989.

PROGRAM PREPARATION:

Dr hab. Jarosław Kijak, prof. UZ, dr Wojciech Lewandowski

ENGLISH AS A FOREIGN LANGUAGE

Course code: **09.0-WF-FizP-JAng5**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **mgr Grażyna Czarkowska**
Name of lecturer: **mgr Grażyna Czarkowska**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	V	Grade	

COURSE AIM:

The course aims to enable students to improve speaking, reading and writing skills, as well as listening comprehension in English. It will help the students to develop their ability to apply language functions to effective communication in everyday life. The course also aims to develop ability to describe hypothetical situations, express probability, give advice and use Passive Voice properly. The course provides an opportunity to learn the skill of writing formal letters, improve listening and reading comprehension. It helps students to further develop conversational skills, and ability to deliver a presentation in English.

The course helps students to develop vocabulary from the following branches of physics – electricity and magnetism.

ENTRY REQUIREMENTS:

B1+ of the Common European Framework of Reference for Languages specified by the Council of Europe.

COURSE CONTENTS:

During the course students will learn to:

- describe hypothetical situations, use conditional sentences referring to present, future and past (6 hours)
- use clauses of time introduced by *when, as soon as, till, before, after* (2 hours)
- use modal verbs to express probability (2 hours)
- understand and form correct sentences in Passive Voice (4 hours)
- understand long and difficult non-specialist texts describing hypothetical situations, as well as discussing social issues (4 hours)
- prepare and deliver a presentation in English using language structures studied during the course (6 hours)
- develop listening skills (2 hours)
- understand and use specialist vocabulary – electricity and magnetism, as well as quantum mechanics (2 hours)
- analyse and understand specialist texts (2 hours)

TEACHING METHODS:

The course focuses on communication activities in functional and situational context. It encourages students to speak with fluency and develop the four skills of reading, writing, listening and speaking by means of group and pair work, discussion, presentation, oral and written exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS :

DESCRIPTION OF LEARNING OUTCOMES	CODE	VERIFICATION METHODS	FORM OF INSTRUCTION
Upon successful completion of the course, the students: • can describe hypothetical situations with the use of adequate language structures • use modal verbs to express probability and give advice • use with understanding Passive Voice • can prepare and deliver a presentation on a topic concerning a branch of physics • are familiar with and can use specialist vocabulary from the following branches of physics: electricity and magnetism, as well as quantum mechanics • understand specialist texts • can cooperate with members of a group, exchange information, and discuss problems	Language skills and competence on level B2 of the Common European Framework of Reference for Languages	Class tests presentation	Classes (laboratory)

ASSESSMENT CRITERIA:

– Grade: a condition for receiving a credit are positive marks for tests, participating in class discussions, dialogues, delivering a presentation in English, getting information on different topics.

STUDENT WORKLOAD:

Contact time:

- classes – 30 hours
- consultation – 1 hour

Private study:

- preparing a presentation – 2 hours
- getting ready for classes – 20 hours
- revising for tests – 6 hours

Total: 60 hours, 2 ECTS.

RECOMMENDED READING:

[1] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Student's Book,* Oxford University Press 2007.

[2] C. Oxenden, V. Latham-Koenig, P. Seligson, *New English File Workbook,* Oxford University

Press 2007.

OPTIONAL READING:

[1] V. Evans, *FCE Use of English* , Express Publishing 1998.

[2] L. Szkutnik, *Materiały do czytania – Mathematics, Physics, Chemistry,* Wydawnictwa Szkolne i Pedagogiczne.

[3] Internet articles.

[4] J. Pasternak-Winiarska, *English in Mathematics*, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2006.

[5] S. Hawking, *A Brief History of Time, The Universe In a Nutshell*, Bantam Books 2001.

PROGRAM PREPARATION:

Mgr Grażyna Czarkowska

INTELLECTUAL PROPERTY PROTECTION, OCCUPATIONAL SAFETY, ERGONOMICS

Course code: **16.0-WF-FizP-OWIBP**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **prof. dr hab. inż. Edward Kowal**

Name of lecturer: **prof. dr hab. inż. Edward Kowal**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					1
Lecture	15	1	V	Pass/Fail	

COURSE AIM:

The practical application of the legal principles of intellectual property. Knowledge of the basic factors influencing the ergonomic, safe and healthy working conditions - the impact of their influence.

PREREQUISITES: -

SUBJECT AREA OF THE COURSE:

The practical application of the legal principles of intellectual property. Knowledge of the basic factors influencing the ergonomic, safe and healthy working conditions - the impact of their influence. The importance of the rights and standards in the art. The basic instrument for the protection of intellectual property rights: patents, copyrights, trademarks. Legal regulations on intellectual property rights. The provisions on the protection of inventions, industrial designs and trademarks, applied art objects and other works of authorship (studies, publications, culture). Legal basis for conservation work. Management systems working conditions and occupational hazards. The science behind ergonomics including anthropometric requirements, industrial hazard and its effects, work organization, human system - a technical object.

TEACHING METHODS:

Informative lecture, lecture and a seminar problem, activating methods - method of cases.

EDUCATION OUTCOMES:

- The student has a basic knowledge of the man, especially as a social entity, engineered structures and principles of their functioning and operating in these structures, in the field of health promotion.
- The student knows the basic rules of safety and health at work, recognize the threat and selects the appropriate measures to prevent them (K1A_W06).

- The student has a basic knowledge regarding the legal and ethical issues in research and teaching especially in the field of intellectual achievements (K1A_W07).
- Student correctly identifies and resolves dilemmas associated with the pursuit of health and safety inspector's work.
- The student has a basic knowledge of copyright, intellectual property protection, the use of appropriate licenses and rights to scientific, personal and commercial (K1A_W08, K1A_W07).
- The student can independently acquire knowledge and develop skills using a variety of sources (polish language and foreign language) and modern technology (K1A_U07, K1A_U10).
- The student is aware of the importance of behavior in a professional, ethical values and respect for diversity of opinion (K1A_K03).

ASSESSMENT CRITERIA:

The presence and activity in the classes, the ability to use relevant legislation.

STUDENT WORKLOAD:

Hours	Student work	ECTS
15	Participation in classes	0,5
5	Participate in consultations	0,2
10	Individual work and preparations for classes	0,3
30		**1**

RECOMMENDED READING:

[1] Dyrektywa ramowa 89/391/EWG.

[2] E. Kowal, *Ekonomiczno społeczne aspekty ergonomii*, PWN, Warszawa 2004.

[3] Kodeks Pracy.

[4] Rozporządzenie MIPS z 26 września 1997 W sprawie ogólnych przepisów bhp wraz ze zmianami.

[5] J. Lozański, *Własność przemysłowa* i *intelektualna w Unii Europejskie*j, Warszawa- Poznań 2005.

OPTIONAL READING: -

PROGRAM PREPARATION:

Prof. dr hab. inż. Edward Kowal

FOUNDATIONS OF QUANTUM PHYSICS

Course code: **13.2-WF-FizP-PoFKw**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					
Lecture	30	2	V	Exam	6
Class	30	2		Grade	

COURSE AIM:

To acquaint students with the basics of quantum mechanics and the formalism

ENTRY REQUIREMENTS:

Knowledge of basic physics, mathematical methods of physics, elements of algebra and mathematical analysis

COURSE CONTENTS:

Lecture: Experimental foundations of quantum physics. Corpuscular properties of the electromagnetic radiation. Wave properties of particles. Atoms structure. Mathematical methods in Quantum Mechanics – vectors spaces, Hilbert spaces, operators, discrete and continuous and discrete basis representation. Quantum postulates and their consequences – the state of the quantum system, a correspondence of observables with operators, an eigenvalue problem, probabilistic interpretation of results of measurements, the time evolution of the quantum system. Uncertainty relation. Symmetries: space translations and time translations. Quantum Mechanics of a particle in one dimension: a free particle, harmonic oscillator. Quantum Mechanics of a particle in three dimensions: angular momentum, a hydrogen-like atom.

Theoretical class: Problems and exercises for the lecture: elements of a theory of the linear operators in the Hilbert space, uncertainty principle, the square potential barrier, potential well, symmetries, conservation laws.

TEACHING METHODS:

Conventional lecture, classes.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student understands the essence of quantum effects and processes, understands and can	K1A_W02 K1A_W03 K1A_U01	Written exam	Conventional lecture
		Final test	Conventional

explain descriptions of physical phenomena and processes using mathematical language, can independently reproduce the claims and the rights and selected calculations. The student is able to create a theoretical model of the phenomenon and associate it with the results of measurements. The student can use the formalism of quantum mechanics to describe simple physical phenomena on the quantum level, is able to analyze and solve problems on the basis of physical knowledge and information from the available literature sources, databases and Internet resources. The student can independently acquire knowledge and develop their skills, using a variety of sources (in Polish and foreign) and new technologies. The student is aware of this knowledge and skills, and understands the need to know the possibilities of continuous further training in.	K1A_U02 K1A_U07 K1A_K01		classes

ASSESSMENT CRITERIA:

Lectures: passing a final written exam,

Classes: passing a final test.

Before taking the examination the student needs to obtain passing grade in the computational exercises.

The final grade: the arithmetic average of the examination grade and computational exercises grade

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours
- Participation in classes: 15 weeks x 2 hours = 30 hours
- Preparation for classes: 35 hours
- Part in the consultation: 10 hours
- Preparation for an exam: 40 hours
- Participation in the exam: 2 hours

Total: 147 hours, 6 ETCS.

Effort associated with activities that require direct participation of teachers: 72 hours, 3 ECTS

RECOMMENDED READING:

[1] R. L. Liboff, *Wstęp do mechaniki kwantowej*, PWN, 1987 (*Introductory Quantum Mechanics*, Holden–Day, San Francisco).

[2] L. D. Landau, E. M. Lifszic, *Mechanika kwantowa*, PWN (L. D. Landau, E. M. Lifshitz, *Quantum mechanics: Nonrelativistic theory*, Pergamon Press).

[3] L. I. Schiff, *Mechanika kwantowa*, PWN, 1977 (*Quantum Mechanics*, McGraw–Hill, New York).

[4] Nouredine Zettili, *Quantum Mechanics: Concepts and Applications*, 2^{nd} ed., Willey 2009.

[5] Michel Le Bellac, *Quantum Physics*, Cambridge 2006.

OPTIONAL READING:

[1] J. Brojan, J. Mostowski, K. Wódkiewicz, *Zbiór zadań z mechaniki kwantowej*, PWN 1978.

PROGRAM PREPARATION:

Dr hab. Krzysztof Urbanowski, prof. UZ

PHYSICS OF PHASE TRANSITIONS

Course code: **13.2-WF-FizP-FiPFa**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	V	Exam	
Class	30	2		Grade	

COURSE AIM:

The aim of the course is to provide students knowledge of the issues, concepts, and methods relevant to phase transitions and critical phenomena, to acquaint them with the phenomenological and microscopic descriptions of critical phenomena, present and discuss various experimental results with regard to phase transitions

ENTRY REQUIREMENTS:

Passed lectures: "Fundamentals of Physics I, II"

COURSE CONTENTS:

LECTURE:

- *Elements of thermodynamics*: the four laws of thermodynamics, thermodynamic potentials, the equation of state for an ideal gas and for real gas (the van der Waals equation)
- *Phases and phase transitions*: the concept of thermodynamic phase, a typical phase diagram, a classification of phase transitions, the thermodynamic description of phase transitions, the role of the correlation
- *Ising model*: a microscopic approach to the modelling of phase transitions, the canonical ensemble of statistical mechanics, exact and approximate solutions of the Ising model
- *Mean field theory*: phenomenological Landau theory, symmetry, an order parameter
- *Scaling*: dimensional analysis and dimensionless parameters, the nature of the critical singularities, relationships between the critical indices, the scaling hypothesis
- *Renormalization group*: determination of the critical indices, the critical temperature assignment, the parameter space of the Hamiltonian, the fixed points of the renormalization group transformation, the block-spin renormalization-group transformation
- *Phase transitions in quantum systems*: symmetry of the wave function in quantum mechanics, statistical description of quantum systems, a Bose–Einstein condensate, superfluidity, superconductivity
- *Universality*: Universality hypothesis and its consequences, universality classes
- *Finite-size scaling*: the evaluation of critical indexes and critical temperature based on a finite-size scaling analysis, the Binder cumulants
- *Critical phenomena in confined liquid systems*: binary liquid mixtures, simple fluids, the role of confinement in liquids, capillary condensation, critical adsorption, wetting
- *Percolations*: the phase transition in random structures, percolation clusters, the percolation threshold for various lattices, the order parameter for percolation

CLASS:

- *Thermodynamics*: thermodynamic processes, the Carnot cycle, entropy, specific heat
- Mean Field Theory, the Bragg-Williams approximation
- *Ising Model:* the exact solution for the one-dimensional Ising model, the Bethe lattice, the two-dimensional Ising model
- *The Landau theory of phase transitions*
- *Critical phenomena:* the critical indices, the critical temperature
- *Percolation*

TEACHING METHODS:

Classes are in the form of lectures when the student is encouraged to ask questions. On the exercises, students analyze and solve problems with a teacher.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows and can apply the principles of thermodynamics for qualitative and quantitative analysis of simple physical problems	K1A_W01 K1A_W03 K1A_W05 K1A_U01 K1A_U07 K1A_K01 K1A_K05	Assessment of problem solving Exam	Classes Lecture
Student should have a working knowledge in modern theory of phase transitions based on phenomenological and microscopic approaches. By means of a phase diagram a student is able to describe a first-order phase transition and continuous one.	K1A_W01 K1A_U01 K1A_U05 K1A_U06 K1A_U07 K1A_K05	Assessment of problem solving Exam	Classes Lecture
Student can demonstrate an understanding of the scaling hypothesis and universality hypothesis including their implications for critical phenomena in nature. Based on the finite-size scaling hypothesis a student can describe and evaluate bulk properties of the system using data obtained from finite systems	K1A_W01 K1A_W03 K1A_K01 K1A_K05 K1A_U01	Assessment of problem solving Exam	Classes Lecture
Student is able to provide and describe the most important phase transitions and critical phenomena occurring in real physical systems	K1A_W01 K1A_U02 K1A_K05	Assessment of problem solving Exam	Classes Lecture

ASSESSMENT CRITERIA:

The exam is conducted in writing. Student receives four issues to consider requiring the knowledge of the issues and ability to combine different phenomena. For each task, one can get from 0 to 5 points. Received a positive rating requires at least 8 points (a sufficient for 8-10.5 points, a plus sufficient for 11-13.5 points, a good 14-16, a plus good 16.5-18.5 points, a very good 19-20 points).

The basis of assessment exercises is attendance and passing written tests.

The final grade will be based on the following factors:

- activity at classes *(40%),*
- *the result of the final test (60%) that will be based on problems similar, but not identical, to the problems studied during the classes.*

The classes must be completed prior to the exam.

The lecture grade will comprise 60% of the final grade while the class grade will comprise 40% of the final grade.

STUDENT WORKLOAD:

Participation in the excercises: 30 hours

Preparation to the excercises: 30 hours

Consultations: 15 hours

Participation in the lectures: 30 hours

Exam Preparation: 45 hours

Exam: 2 hours

Total: 152 hours, 6 ECTS.

Effort associated with activities where the participation of teachers is required: 77 hours, 3 ECTS.

RECOMMENDED READING:

[1] M. Gitterman, V. Halpern, *Phase transitions. A Brief Account with Modern Applications*, World Scientific 2004.

[2] R. Hołyst, A. Poniewierski, A. Ciach, *Termodynamika dla chemików, fizyków i inżynierów*, Wydawnictwo Uniwersytetu Kardynała Stefana Wyszyńskiego, Warszawa 2005.

[3] K. Huang, *Podstawy fizyki statystycznej*, Wydawnictwo Naukowe PWN, Warszawa 2006.

[4] M. Plischke, B. Bergersen, *Equilibrium Phase Transitions*, World Scientific 2005.

OPTIONAL READING:

[1] R. Gonczarek, *Teoria przejść fazowych. Wybrane zagadnienia*, Oficyna Wydawnicza Politechniki Wrocławskiej 2004.

[2] K. Huang, *Mechanika statystyczna*, PWN, Warszawa 1978.

[3] J. Klamut, K. Durczewski, J. Sznajd, *Wstęp do fizyki przejść fazowych*, Ossolineum, Wrocław 1979.

PROGRAM PREPARATION:

Prof. dr hab. Andrzej Drzewiński

ENVIRONMENTAL PHYSICS I – NATURAL ENVIRONMENT POLLUTION

Course code: **13.2-WF-FizP-FŚ1Za**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	V (FŚ)	Exam	
Class	30	2		Grade	

COURSE AIM:

To give the students' the ability to understand the mechanisms of contamination's propagation in the environment, to familiarize the students with methods of the descriptions for these processes

ENTRY REQUIREMENTS:

Finished course "Fundamentals of physics I", "Mathematical analysis I" and "Mathematical analysis II"

COURSE CONTENTS:

A. Basic concepts of environmental fluid mechanics the control volume, the flow of physical quantity, the rate of accumulation of physical quantity. Fluid properties: density, equation of state, thermal expansion, specific heat.

B. Balance equation for the the physical quantity and examples of applications:
- Mass preservation and examples of this balance: the balance of water in the lake, gravity current
- Conservation of momentum and example of applications:the momentum balance for horizontal jet and the balance of momentum in the river,
- The application of the principle of conservation of mass and momentum: Determination of strength of the wind flowing over the building, Bernoulli's equation and its applications,
- Conservation of energy

C. The law of conservation the physical quantity for an infinitesimal control volume and its applications:
- The evolution of pollutants that react chemically,
- The mass continuity equation,
- The equation of conservation of momentum with the various forces (pressure force, gravity, friction, Coriolis), Boussinesq approximation, the Venturi effect).

D. Dimensional analysis, similarity criteria (Buckingham theorem (Pi theorem)), criteria of similarity, numbers: Strouhal, Froude, Richardson, Reynolds, Rossby'ego, Peclet, Euler.

E. Vortex flow: vorticity vector, the surface vortex, vorticity (circulation) Γ, Kelvin theorem, theorem Bjerknsa, the use of Theorem Bjerknes to explain the phenomenon of sea breeze.

F. Wave phenomena: surface gravity waves: limiting cases: waves in deep water, waves in shallow water, seiches ; internal gravity waves, the propagation of wave energy in motion.

G. Kelvin-Helmholtz instability: the equation for the case of two layers of immiscible liquids of different velocities, horizontal oscillation frequency - the ratio of dispersion, the condition of instability, the formation of instabilities in the fluid of variable density, the number of Richardson criterion of instability.

H. Mixing the two liquid layers: the energy balance, the number of Richardson criterion for mixing liquids.

I. Rayleigh-Benard convection and penetration convection.

J. Turbulence: cascade energy, scales of turbulence's size, the spectrum of turbulence, mixing length.

K. Plumes (rising currents) in a homogeneous and stratified.

L. Dynamics of lakes and rivers and propagation of the contaminants.

Ł. Dynamics of closed lakes and reservoirs, and the propagation of contaminants in them.

TEACHING METHODS:

Conventional lecture.

During class students solve exercises illustrating the content of the lecture e.g. kinetic equations in the Lagrange and Euler variables, equation of continuity, circulation velocity, hydrostatic pressure, the coordinates of the pressure's centre, flows under pressure. Students also prepare a 45-minute presentations on particular problems of natural environment pollution, present them, answer questions, listen to presentations of colleagues and ask them questions.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows and understands the selected topics of classical and contemporary physics that allows to understand the physical phenomena of the surrounding world. In particular student is familiar with physics of fluid, which allows to understand the propagation of contaminants in liquids (water and air)	K1A_W01	Exam, grade	Lectures, classes
Student can develop a specific problem related to the propagation of contaminants based on the known mechanism. Student applies taught knowledge, in particular the conservation laws to explain the phenomena of fluid dynamics in the environment	K1A_W03 K1A_U05	Exam, grade, discussion	Lectures, classes
Student can explain the propagation of pollutants as a result of processes: the emergence of instability, mixing, turbulence	K1A_W03	Exam, grade	Lectures, classes
Student can find on their own various teaching materials in Polish and English and develop their skills on the physics of environmental pollutants	K1A_U07	Exam, grade	Lectures, classes
The student can prepare a presentation on a given topic related to particular problems of natural environment pollution, and present it to using simple language	K1A_U09 K1A_U06	Presentation	Classes
Student is aware of his knowledge and skills as well as knows opportunities for further training of environmental physics	K1A_K01	Discussion	Lectures, classes
Student recognises the necessity of permanent training and improvement of his knowledge on environmental physics using various sources	K1A_K04	Discussion	Lectures, classes

ASSESSMENT CRITERIA:

Lecture:

The course credit is obtained by passing a final written exam composed of tasks of varying degrees of difficulty.

Classes:

A student is required to obtain at least the lowest passing grade from tests organized during classes and give the oral presentation on a given topic related to particular problems of natural environment pollution.

To be admitted to the exam a student must receive a credit for the classes.

Final grade: weighted average of grades from the classes (40 %) and the exam (60 %).

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x2 hour = 30 hours

- Preparation for exam: 33 hours

- Participation in classes: 15 weeks x 2 hour = 30 hours

- Preparation for classes (including preparation of presentation, search for materials): 40 hours

- Attending lecturers' office hours: 5 hours

- Participation in exam: 2 hours

Total: 140 hours, 6 ECTS points.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 67 hours. This corresponds to 2.8 ECTS points.

RECOMMENDED READING:

[1] B. Cushman-Roisin, Environmetal Fluid Mechanics, available on the author's web page: http://engineering.dartmouth.edu/~cushman/books/EFM.html

[2] M. Przybylska, Fizyka środowiska I – Zanieczyszczenie środowiska naturalnego, Lecture notes available in electronic form.

[3] K. Bajer, slides for the lecture „Environmental physics" available on the web page: http://www.igf.fuw.edu.pl/fs/FIZYKA_SRODOWISKA/

[4] E. Boeker, R. van Grondelle, *Fizyka środowiska*, PWN 2002.

[5] K. Rup, *Procesy przenoszenia zanieczyszczeń w środowisku naturalnym*, WNT, Warszawa 2006.

[6] E. Kubrak, J. Kubrak, *Podstawy obliczeń z mechaniki płynów w inżynierii i ochronie środowis*ka, Wydawnictwo SGGW, Warszawa 2010.

[7] Z. Orzechowski, J. Prywer, R. Zakrzewski, *Zadania z mechaniki płynów w inżynierii środowiska*, WNT, Warszawa 2001.

[8] W. Roszczynialski, K. Filek, *Zbior zadań z mechaniki płynów i termodynamiki*, AGH 1991.

OPTIONAL READING:

[1] R. Puzyrewski, J. Sawicki, *Podstawy mechaniki płynów i hydrauliki*, Wydawnictwo Naukowe PWN, Warszawa 2000.

[2] S. A. Socofolsky, G. H. Jirka, *Special topics in mixing and transport processes in the environment*, Coastal and Oceanic Engineering Division, Texas A&M University, 2005, available on the web page http://www.ifh.uni-karlsruhe.de/lehre/envflu_i/Lecture_notes/lecture_notes.htm

PROGRAM PREPARATION:

Dr hab. Maria Przybylska, prof. UZ

ENVIRONMENTAL PHYSICS LABORATORY

Course code: **13.2-WF-FizP-PraFŚ**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Laboratory	30	2	V (FŚ)	Grade	

COURSE AIM:

Application by the student according to known laws of physics and the physics of the environment and in laboratory practice.

ENTRY REQUIREMENTS:

Theory of measurements, Fundamentals of Physics I – IV.

COURSE CONTENTS:

- *The study of the photoelectric effect.*
- *The test photovoltaic cells.*
- *The study of electromagnetic resonance and determination of the resonance curve.*
- *The study of electromagnetic wave propagation in the air.*
- *The study Peltier module.*
- *Determination of the electron work function of metal.*
- *Determination of work function in the photoelectric effect.*
- *Determination of cut-off frequency and Planck's constant in the photoelectric effect.*
- *The study of ultrasonic wave propagation in materials.*
- *The study of ultrasound attenuation in metals using the flaw.*
- *The study of absorption of ultrasound in air.*
- *Application and operation of the electromagnetic spectrum analyzer HAMEG HMS.*
- *The test signal source electromagnetic spectrum.*
- *The study of electrical characteristics of the selected filters.*
- *The study of radiation characteristics of antennas.*

TEACHING METHODS:

Laboratory exercises, group work.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student general understanding of physics and environmental physics and physical measurement methodology that allows for the understanding of basic physical phenomena of the surrounding world, knows the cause-effect relationship knows the basic aspects of the design and operation of equipment and test equipment used in physics and the physics of the environment , can measure a physical quantity and interpret the knows the basic rules of safety and health at work, recognize the threat and selects the appropriate measures to prevent them.	K1A_W01 K1A_W05 K1A_W06	Check in writing student theoretical knowledge on topics of exercise, practical execution of exercises in the laboratory, to prepare a report of the exercises in the form of a written report containing a detailed analysis of the measurement results, a description of the measurements and draw conclusions. To pass the lab to perform all provided practical exercises, and the development and submission of reports.	laboratory classes

ASSESSMENT CRITERIA:

Check in writing student theoretical knowledge on topics of exercise, practical execution of exercises in the laboratory, to prepare a report of the exercises in the form of a written report containing a detailed analysis of the measurement results, a description of the measurements and draw conclusions.
To pass the lab to perform all provided practical exercises, and the development and submission of reports.

STUDENT WORKLOAD:

- Participation in laboratory exercises: 30 hours.
- Prepare for Training, preparation of reports: 20 hours. + 50 hours.
- Consultations: 3 hours.

TOTAL: 103 hours., 4 ECTS.
Effort involved in activities that require direct involvement of teachers is 33 hours. This is equivalent to 1,5 ECTS.

RECOMMENDED READING:

[1] R. Resnick, D. Halliday, J. Walker, *Podstawy fizyki*, t. III, IV, V, PWN, Warszawa 2003.

[2] E. Boeker, R. Van Grondelle, *Fizyka środowiska*, PWN, Warszawa 2002.

OPTIONAL READING:

[1] J. W. Kane, M. M. Sternhaim, *Fizyka dla przyrodników,* t. 1 - 3, PWN, Warszawa 1988.

[2] A. Śliwiński, *Ultradźwięki i ich zastosowania*, WNT, Warszawa 1993.

PROGRAM PREPARATION:

Dr Stefan Jerzyniak

PYTHON LANGUAGE IN NUMERICAL CALCULATIONS

Course code: **11.3-WF-FizP-JPyON**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					7
Lecture	30	2	V (FK)	Exam	
Laboratory	30	2		Grade	

COURSE AIM:

The course aim is to introduce the Python as the scientific programming tool. Python is a general purpose, high-level and modern programming language and the capabilities of its standard library as well as the external modules to handle the numerical analysis in physics and related fields will be presented.

ENTRY REQUIREMENTS:

Basic knowledge in programming and object oriented programming.

COURSE CONTENTS:

1) General Python introduction
- language syntex and data types
- flow-control and exceptions
- Interactive shell
- scripts
- functions
- modules

2) File I/O operations
- writing to and saving files
- data serialization
- typical I/O operations errors

3) Object Oriented Programming
- classes and objects
- inheritance and polymorphism
- abstractions

4) Introduction to software engineering

- version control systems
- Linux as IDE
- Introduction to unit-tests
- software efficiency and profiling

5) Numerical analysis and computer simulations introduction
   - the math module
   - NuPy's arrays
   - random numbers
   - basic linear algebra operations in NumPy
   - differential equations solvers in NumPy
   - data visualisations in the matplotlib module
   - Introduction to parallel computing with mpi4py

6) Visualization, animations and image processing
   - the canvas and graphical primitives
   - plots
   - animations
   - Image processing with openCV (computer vision) module

TEACHING METHODS:

Lecture and computer lab, discussions, individual students readings of technical documentation

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to use Python and its standard library to implement a simple software that numerically solves a classical physics problem	K1A_W04 K1A_W09 K1A_U01 K1A_U02 K1A_U07	activity during laboratories, project, discussion, exam	laboratory, lecture
Student is able to find out, learn and use the external Python libraries that will help him with the numerical analysis of physical problems	K1A_W04 K1A_W08 K1A_W09 K1A_U01 K1A_U02 K1A_U07 K1A_K04	activity during laboratories, project, discussion, exam	laboratory, lecture
Student is able to perform graphical data analysis and data visualization using Python and its modules	K1A_W04 K1A_W09 K1A_U01 K1A_U02	activity during laboratories, project, discussion, exam	laboratory, lecture
Student is able to solve and present (in spoken and printed form) the outcomes of assigned project	K1A_U01 K1A_U02 K1A_U05 K1A_U07 K1A_U08 K1A_U09 K1A_K04	activity during laboratories, project, discussion	laboratory

ASSESSMENT CRITERIA:

Lecture:

To pass the exam the student will be asked to numerically solve a certain problem of the classical physics or data analysis. The examined knowledge fields and the final exam grade will be evaluated using the following aspects: the problem analysis, presentation of the algorithms used in the problem solution, the presentation of the source code and the validity of the results.

Laboratory:

30% - tests ad activity during laboratories

70% - final project

Before taking the exam the student must obtain a pass from the laboratory.

Score: weighted average rating of the exam (60%) and exercise (40%).

STUDENT WORKLOAD:

- Lectures: 30 h
- Laboratories: 30 h
- Preparation for laboratory: 40 h
- Project preparation: 35 h
- Preparation for exam: 25 h
- Consultation: 5 h
- Exam: 2 h

Sum: 167 hours, 7 ECTS points.

Lecturer direct participation: 67 hours, 3 ECTS.

RECOMMENDED READING:

[1] Mark Lutz, Learning Python, Fifth Edition, O'Reilly, June 2013.

[2] http://python.org

[3]http://python-ebook.blogspot.com/

[4] http://numpy.scipy.org

OPTIONAL READING:

[1] Internet

PROGRAM PREPARATION:

Dr Marcin Kośmider

ADVANCED PROGRAMMING METHODS

Course code: **11.3-WF-FizP-ZaMeP**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the laboratory exercises**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Laboratory	30	2	V (FK)	Grade	

COURSE AIM:

The aim of the course is to present modern external libraries and frameworks. Student learn how to look for and how to use usefull tools to solve scientific problems.

ENTRY REQUIREMENTS:

Object oriented programming

Minimum one programming language – Python, C++, Java

COURSE CONTENTS:

- Data structures
- Scientific libraries
- Multithreading
- Introduction to Image analysis and processing
- Data sources – web services API
- GUI programming

TEACHING METHODS:

Laboratory:

laboratory exercise, project, work in group, presentation, work with documentation, independed work, brain storm

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student can use numerical library to write program to solve given problem from physics or related	K1A_W02 K1A_W04 K1A_W09	activity during laboratories, project, discussion	laboratory

science subject.	K1A_U01 K1A_U04 K1A_U07		
For a given problem student can find propper libarary, install it and use it according to the licence to solve problem.	K1A_W04 K1A_W09 K1A_U01 K1A_U07 K1A_K04	activity during laboratories, project, discussion	laboratory
Student can work in a group.	K1A_K02	activity during laboratories, project, discussion	laboratory
Student can create and present a report from a given problem.	K1A_U01 K1A_U07 K1A_U08 K1A_K01 K1A_K04	activity during laboratories, project, discussion	laboratory

ASSESSMENT CRITERIA:

Laboratory:

30% - tests ad activity during laboratories

70% - final project

STUDENT WORKLOAD:

- Laboratories: 30 h
- Preparation for laboratory: 20 h
- Project preparation: 20 h
- Consultation: 5 h

Sum: 75 h, 3 ECTS points.

Lecturer direct participation: 35 h, 1,5 ECTS.

RECOMMENDED READING:

[1] http://boost.org

[2] http://pil.org

[3] http://scipy.org

OPTIONAL READING:

[1] Interet

PROGRAM PREPARATION:

Dr Marcin Kośmider

INTRODUCTION TO ANALYSIS OF ASTROPHYSICAL TIME SERIES

Course code: **11.3-WF-FizP-WAACC**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Lecture	15	1	V (AK)	Exam	
Class	15	1		Grade	

COURSE AIM:

Ability to analysing time series based on pulsar observations. Use of Fourier transform and interpretation of results from carrying out time series analysis.

ENTRY REQUIREMENTS:

Finished courses: Basic programming.I ntroduction to higher physics and mathematics. Mathematical analysis.

COURSE CONTENTS:

LECTURE:

- Pulsar emission as a numerical time series.
- Spectral analysis of pulsar emission.
- Fourier series.
- Finding of amplitude and power spectrum of periodic series.
- Application of Fourier transform to calculation of amplitude and power spectrum of chosen periodic series.
- Spectral analysis of non-periodic pulsar emission.
- Spectral analysis of random signal from pulsars.
- Numerical methods of spectral analysis of pulsars:
    a) rules of analogue-digital signal processing; digital filtering
    b) discrete Fourier transform – DFT
    c) fast Fourier transform – FFT
    d) numerical calculation of spectral density
    e) numerical calculation of the cross-spectral density
- Special methods of the spectral analysis of signal from pulsars.

CLASS:

- Working and usage of Fourier transform and fast.
- Time series simulations.
- Searching for periodicities in a sample of real and simulated data using computer programme.
- Spectral analysis of pulsar emission.
  a) Fourier transform
  b) calculation of amplitude and power spectrum of periodic series
  c) application of Fourier transform to calculation of amplitude and power spectrum of chosen periodic series
- Spectral analysis of non-periodic pulsar emission.
- Spectral analysis of random signal from pulsars.

TEACHING METHODS:

Lecture, calculus exercises, writing computer programmes.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student should be able to use techniques used in astronomy according to time series analysis e.g. Fourier transform or expansion of the time series into Fourier series. Student knows limitations coming out from used methods or computer programmes	K1A_W04	C: ongoing monitoring of the progress in the classroom, test L: test, exam	C/L
Student is able to: define amplitude spectrum and find a periodicities in a time series, power spectrum, spectral density, cross-spectral density	K1A_U04 K1A_U07 K1A_U04	C: ongoing monitoring of the progress in the classroom L: test, exam	C/L

ASSESSMENT CRITERIA:

Class: pass all tests and all programming tasks (project).

Lecture: Exam allowed only with a positive class grade. Oral exam. Pass condition – satisfactory grade.

Final grade: 50% class grade+ 50% exam grade.

STUDENT WORKLOAD:

- Lectures: 15 weeks x 1 h = 15 h
- Classes: 15 x 1 = 15 h
- Homework: 15 x 2 = 30 h
- Consultations: 2 h
- Preparation for exam: 15 h
- Exam: 1 h

TOTAL: 78 h, 3 ECTS.

Effort associated with activities that require direct participation of teachers: 33 hours, 1,5 ECTS.

RECOMMENDED READING:

[1] E.Ozimek, *Podstawy teoretyczne analizy widmowej sygnałów*, PWN, Warszawa-Poznań, 1985

[2] L. H. Koopmans, *The spectral analysis of time series*, Academic Press, New York, 1974.

OPTIONAL READING:

[1] С. Я. Адзерихо, *Введение в линейную алгебру, теорию поля и ряады фурье*, Издательство "Вышейшая школа", Минск, 1968.

PROGRAM PREPARATION:

Dr Krzysztof Maciesiak

SCIENTIFIC CALCULATIONS AND NUMERICAL METHODS

Course code: **11.1-WF-FizP-ONiMN**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher directing the laboratory exercises**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Laboratory	45	3	V (AK)	Grade	

COURSE AIM:

Learning basic both theoretical and practical skills in numerical methods. Moreover, writing computer codes and using already existing procedures to analysing research results, especially statistics. Computer simulations e.g. Monte Carlo or simple genetic algorithm.

ENTRY REQUIREMENTS:

Finished course: *Programming basics, Programming languages and paradigms.*

COURSE CONTENTS:

- Interpolation – equations (Lagrange, Newton), selection of interpolation nodes and converging of interpolation processes.
- Approximation – least squares, polynomial, trigonometrical, fast Fourier transform.
- Numerical integration.
- Obtaining pseudorandom numbers with a set distribution.
- Approximate solving non-linear equations.
- Methods of solving boundary conditions for ordinary differential equations.
- Monte Carlo simulations in astronomy.
- Basics of genetic algorithms.

TEACHING METHODS:

Programming exercises

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows programming basics and numerical methods use in	K1A_W04	ongoing monitoring of the progress in the classroom	Laboratory

astronomy			
Uses numerical methods as a tool to solve physical and astronomical tasks	K1A_U04 K1A_U07	ongoing monitoring of the progress in the classroom	Laboratory
Student can write and analyse an algorithm of astronomical problem and is able to write it in a form of computer code in a chosen programming language, also using already existing procedures	K1A_U07 K1A_U04	ongoing monitoring of the progress in the classroom	Laboratory

ASSESSMENT CRITERIA:

Get a pass from minimum 75% programming tasks.

STUDENT WORKLOAD:

- Classes: 15 x 3 = 45 h
- Homework: 55 h
- Consultations: 2 h

TOTAL: 102 h, 4 ECTS.

Effort associated with activities that require direct participation of teachers 47 hours, 2 ECTS.

RECOMMENDED READING:

[1] Z. Fortuna, B. Macukow, J. Wąsowski, *Metody numeryczne*, WNT Warszawa 1982.

[2] S. Brandt, *Analiza danych*, Wydawnictwo Naukowe PWN 1999.

[3] D. Chrobak, *Fortran, praktyka programowania*, Mikom 2003.

OPTIONAL READING:

[1] T. Pang, *Metody obliczeniowe w fizyce*, Wydawnictwo Naukowe PWN, 2001.

[2] J. V. Wall, C. R. Jenkins, Practical Statistics for Astronomers, Cambridge University Press 2003.

PREPARED BY dr Krzysztof Maciesiak

PLASMA ASTROPHYSICS

Course code: **11.3-WF-FizP-AsPla**
Type of course: **compulsory**
Language of instruction: **English/Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					3
Lecture	15	1	V (AK)	Exam	
Class	15	1		Grade	

COURSE AIM:

The expansion of the knowledge of the basic concepts of plasma astrophysics. To transfer messages from plasma physics allowing the students to understand on a basic level some phenomena and physical processes in the magnetospheres of Earth and pulsars, and in the accretion disks of black holes and neutron stars.

ENTRY REQUIREMENTS:

Knowledge of general astronomy, mathematical analysis and the basis of theoretical physics.

COURSE CONTENTS:

- Plasma in the laboratory and space.
- The basic properties of plasma.
- The kinetic equation for plasma.
- Wlasow theory of plasma waves and plasma stability.
- Plasma as a magnetic fluid.
- Generation of radiation in the plasma.
- The space plasma.
    - Magnetosphere of the Earth
    - Pulsar magnetosphere
    - Accretion disks of black holes and neutron stars

TEACHING METHODS:

The conventional lectures, the conventional classes

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Students can describe and discuss the fundamental laws of physics plasma. The student knows, understands and is able to describe the basic physical laws that govern the	K2A_W01 K2A_U01	Oral examination	Lecture

magnetospheres of the Earth and pulsars, and accretion disks.			
The student has a basic knowledge of plasma waves and plasma stability. He can name and describe the processes occurring in the space plasma.	K2A_W01 K2A_W03 K2A_U01	Oral examination	Lecture
Taking into account their knowledge of the laws of physics, the students can solve some problems and issues of the plasma astrophysics.	K2A_W01 K2A_U03	Written test	Classes
They can use their knowledge and understanding of astrophysics to distinguish some of the physical characteristics of space objects.	K2A_U04	Written test	Classes

ASSESSMENT CRITERIA:

Lecture: Oral examination; Condition assessment - a positive mark of the exam.

Classes: Written test - positive mark of the test.

STUDENT WORKLOAD:

- Attendance of the lectures: 15 weeks x 1 hours = 15 hours
- Attendance of the classes: 15 x 1 = 15 hours
- Preparation for the classes: 15 x 1 = 15 hours
- Homework: 15 x 1 = 15 hours
- Participation in the consultations: 1 hours
- Preparation for the exam: 15 hours
- Participation in the exam: 1 hours

TOTAL: 77 hours, 3 ECTS.

Effort associated with activities that require direct participation of teachers 32 hours, 1.5 ECTS.

RECOMMENDED READING:

[1] The lecture notes.

[2] D. Melrose, *Plasma Astrophysics*, Vol. 1 i 2, Gordon and Breach, 1980.

[3] M. A. Krall, A. W. Trivelpiece, *Fizyka plazmy*, Państwowe Wydaw. Naukowe, 1979.

[4] V. L. Ginzburg, *Theoretical Physics and Astrophysics*, Pergamon Press, 1979.

OPTIONAL READING:

[1] Astrophysical formulae, a compedium for the physicist and astrophysicist (K.R. Lang), Springer-Verlag 1980.

[2] *Theoretical Physics and Astrophysics* (V.L.Ginzburg) Pergamon Press PRES.

PROGRAM PREPARATION:

Prof. dr hab. Giorgi Melikidze

PPROFESSIONAL PRACTICE

Course code: **13.2-WF-FizP-PraZa**
Type of course: **optimal**
Language of instruction: **Polish**
Director of studies: **Academic teacher from the Faculty of Physics and Astronomy**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Practice	60	20	V	Pass/Fail	

COURSE AIM:

The basic aim of the practice is to make possible to use of the theoretical knowledge gained during lessons covered by the plan of study and confront its with actual requirements by employers.

ENTRY REQUIREMENTS:

The knowledge and skills obtained during the first and second year of studies.

COURSE CONTENTS:

While serving the practice student:

- familiarises with the activities of the employing establishment and the conditions and the nature of the activity pursued,
- familiarizes with the work regulations, the provisions on health and safety at work, the provisions for the safety and fire protection of state secrecy and duty,
- gets to know the structure and mechanisms of functioning of the workplace,
- has a possibility of the confrontation of possessed abilities with requirements of the employer,
- prepares in the practical way for the future career.

TEACHING METHODS:

Practical session, laboratory exercises, design in the workplace

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student expands his knowledge and abilities obtained during classes and is using it in practice	K1A_W01	Work during the practice	Practice
He is aware of his knowledge and the ability, understands the need and knows	K1A_K01	Work during the practice	Practice

possibilities of of continuous training			
The student is able to lead dossiers relating to the practice correctly, acquires the skills needed in the future professional work	K1A_K03	Work during the practice	Practice
The student knows fundamentals of the health and safety at work	K1A_W6	Work during the practice	Practice
The student has an appreciation of responsibility for the own work and the readiness of the chain of command to the principles of the work of the team and to take responsibility for common tasks carried out	K1A_K03	Work during the practice	Practice
The student is able to think and to act in the enterprising way	K1A_K06	Work during the practice	Practice

ASSESSMENT CRITERIA:

Condition of completing student practice is the presentation by its journal practices and positive opinion delivered by work place.

STUDENT WORKLOAD:

- Training period at the workplace: 60 hours
- Preparing documentation before starting the practice: 10 hours
- Preparing for practice: 50 hours
- Preparing documentation necessary to settle the practice: 10 hours

With time: 130 hours (5 ECTS)

NATURAL SCIENCES METHODOLOGY

Course code: **08.9-WF-FizP-MeNaP**

Type of course: **optional**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Lecture	30	2	VI	Pass/Fail	

COURSE AIM:

The aim of the subject is to familiarize the student with the methodology of physics, its historical development and the influence of the development of science and technology.

ENTRY REQUIREMENTS:

Basic knowledge of physics and astronomy. Elements of philosophical education: history of philosophy, logic and ethics.

COURSE CONTENTS:

Introduction: the knowledge and the learning, classification of sciences. The coming into existence of the civilization and the development of the scientific knowledge: Ancient Egypt, Mesopotamia, the calculation of the time in the antiquity- calendar; basics of mathematics.

Learning in ancient Greece: basics of the Greek learning, the Ionic school of philosophers of the nature, Pythagoras and his work, the idealism of the Plato, Greek concept of atoms -Democritus, Aristoteles physics, development metematyki and mechanics in the alexandrine period, optics and acoustics, Rome and dusk of classical science.

Natural sciences in the period of the Middle Ages: learning in the period of the Middle Ages, the contribution of philosophers and Arabic scholars, the coming into existence of universities, the Jagiellonian University, the Paris school, the Oxford school, the development of optics in the Middle Ages.

Natural sciences in the Renaissance period: beginning of the modern era-Leonardo da Vinci, the development to astronomy-Kopernik, Kepler, optics, the magnetism and hydrostatyka in the Renaissance period.

Physics before Newton: Galileo, Descartes, the revival of atom concept.

Contribution of Newton to the science: Newton's optics, the fundamentals of mechanics - the differential calculus, his basic book „Mathematical principles of philosophy of the nature", other works of Newton.

Methodology of natural sciences on the example of physics: physical phenomena and models, physics theories: classical mechanics, the kinetic-molecular theory of the structure of matter. Integration and the specialization in natural sciences.

Basic model of the learning: the method of the idealization, the theory of paradigms, examples: the special theory of relativity, the quantum theory, basic particles and quarks, the theory of everything.

TEACHING METHODS:

Teaching takes the form of lectures combined with discussion

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student knows and understands basic concepts of methodology of physics and their historical development	K1A_W01	Writing notes	Lecture
Uses various sources of information in order to extend his knowledge	K1A_K04	Writing notes	Lecture

ASSESSMENT CRITERIA:

Positive result of a test work.

STUDENT WORKLOAD:

- Participation in the lecture: 15 x 2 = 30 hours
- Preparation of test work: 15 x 1 = 15 hours

TOTAL: 45 hours, 2 ECTS.

Effort associated with activities that require direct participation of teachers: 30 hours, 1 ECTS.

RECOMMENDED READING:

[1] L. N. Cooper, *Istota i struktura fizyki,* PWN, Warszawa 1975.
[2] Z. Galasiewicz, *Poznanie świata. Z dziejów filozofii i fizyki.,* Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2005.
[3] L. Nowak, *Wstęp do idealizacyjnej teorii nauki,* PWN, Warszawa 1977.
[4] A. K. Wróblewski, *Historia fizyki*, PWN, Warszawa 2007.

OPTIONAL READING: -

PROGRAM PREPARATION:

Dr hab. Anatol Nowicki, prof. UZ

ELECTRODYNAMICS

Course code: **13.2-WF-FizP-Elekt**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					6
Lecture	30	2	VI	Exam	
Class	30	2		Grade	

COURSE AIM:

Electromagnetism is the most important interaction that most physicists need to understand well to pursue their careers because electromagnetism is responsible for the structure of atoms, molecules, plasmas, gases, liquids and solids, and because electromagnetism is responsible for most of the phenomena we encounter in daily life. The goal of the course is to develop among students a deeper understanding of the electromagnetism, and to deepen their understanding of analytic tools useful for solving problems in electromagnetism.

ENTRY REQUIREMENTS:

Courses of Mathematical analysis and Fundamentals of physics

COURSE CONTENTS:

LECTURE:

Elements of the tensor calculus.

Maxwell's equations as a result of generalization of experimental facts.

Stationary fields.

Variable electromagnetic field.

Scalar light theory.

Kinematics in special relativity and electrodynamics.

Moving Charge in the electromagnetic field.

Energy and momentum in elektrodynamics and relativistic mechanics.

CLASS:

Applications of the Maxwell equations to solving the problems in classical electrodynamics.

TEACHING METHODS:

Conventional lectures, calculate class.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student applies theoretical methods to interpretation of experimental facts	K1A_W01 K1A_W03	Test, exam	class
Student understands and forecasts mechanisms of physical phenomena	K1A_U01	Test, exam	class

ASSESSMENT CRITERIA:

Lecture: The exam.

Class: Credits of exercises.

STUDENT WORKLOAD:

- Participation in the lectures: 30 hours
- Participation in the exercises: 30 hours
- Participation in the examination: 3 hours
- Participation in consultation: 5 hours
- Preparation for exam: 25 hours
- Preparation for exercises: 50 hours

Total: 143 hours, 6 ECTS points

Effort associated with activities that require direct participation of teachers: 68 hours, 3 ECTS.

RECOMMENDED READING:

[1] L. D. Landau, E. M. Lifszic, *Teoria pola*, PWN, Warszawa 2009.

[2] J. D. Jackson, *Elektrodynamika klasyczna*, PWN, Warszawa 1982.

[3] M. Suffczyński, *Elektrodynamika*, PWN, Warszawa 1978.

[4] R. S. Ingarden, A. Jamiołkowski*, Elektrodynamika klasyczna*, PWN, Warszawa 1980.

OPTIONAL READING:

[1] D. J. Griffiths, *Podstawy elektrodynamiki*, PWN, Warszawa 2006.

PROGRAM PREPARATION:

Dr hab. Anatol Nowicki, prof. UZ

SPECTROSCOPY

Course code: **13.2-WF-FizP-Spekt**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the laboratory exercises**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	30	2	VI (FŚ)	Grade	

COURSE AIM:

Knowledge of the theoretical foundations, experimental equipment and techniques of modern spectroscopy, in particular nuclear magnetic resonance (NMR), electron paramagnetic resonance (EPR), ferromagnetic resonance (FMR), and optical spectroscopy as well as their possible applications in physics of environment.

ENTRY REQUIREMENTS:

Basic knowledge of modern physics, including the basics of thermodynamics, electrodynamics, atomic and nuclear physics, and quantum mechanics in the framework of university courses.

COURSE CONTENTS:

Classification and short characteristic of the spectroscopy methods, in particular magnetic resonances and optical spectroscopy.

Nuclear magnetic resonance (NMR). Theoretical foundations, experimental techniques and applications of the NMR spectroscopy – specific examples including environmental physics.

Theoretical foundations, experimental methods, and equipment of the EPR and FMR spectroscopy. Presentation of applications of the EPR and FMR spectroscopy – specific examples including environment al physics.

Optical absorption and luminescence (photoluminescence, thermoluminescence *etc.*). Optical spectroscopy and its applications in the environmental physics.

The EPR and optical spectroscopy of the radiation-induced centres in different substances. Radiation protection dosimetry.

TEACHING METHODS:

Conventional laboratory. Work with a book in the preparation of laboratory works, treatment, presentation, and interpretation of the obtained experimental results.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES

It has a general knowledge of classical physics and modern physics, physical measurement methods and astronomy, which allows you to understand the basic physical phenomena of the surrounding world, he knows the cause-effect relationship.	K1A_W01	Grade	Laboratory
He knows the basic aspects of the design and operation of equipment and test equipment used in physics, can measure a physical quantity and interpret its.	K1A_W05	Grade	Laboratory
Knows the basic rules of safety and health at work, recognize the threat and selects the appropriate measures to prevent them.	K1A_W06	Grade	Laboratory
Able to analyze and solve problems based on physical acquired knowledge and information of the available literature sources, databases, online resources, both in Polish and foreign.	K1A_U01	Grade	Laboratory
Able to perform analysis of theoretical and experimental results and formulate on the basis of relevant proposals.	K1A_U02	Grade	Laboratory
Methodology used physical measurements, can plan and perform simple physical measurements, analyze measurement data, interpret, and present the results of measurement.	K1A_U03	Grade	Laboratory
He is aware of their knowledge and skills, understands the need and knows the possibilities of continuous further training (second-and third-degree, postgraduate courses) – increasing professional and personal competences.	K1A_K01	Grade	Laboratory

ASSESSMENT CRITERIA:

Presence and active participation in the laboratory works. Grading positive laboratory works reports within the prescribed period.

STUDENT WORKLOAD:

Participation in the lab works: 30 h.
Prepare for lab works: 15 h.
Preparation for grade: 15 h.
Consultation and credit: 5 h.
Total: 65 h, 3 ECTS.
Efforts related to activities that require direct participation of teachers: 35 h, 1.5 ECTS.

RECOMMENDED READING:

[1] J. Stankowski, W. Hilczer, *Wstęp do spektroskopii rezonansów magnetycznych*, PWN, Wydawnictwo Naukowe, Warszawa 2005.
[2] J. A. Weil, J. A. Bolton. J. E. Wertz, *Electron Spin Resonance. Elementary Theory and Practical Applications*, John Wiley & Sons, New York 1994.
[3] B. Padlyak, *Foundations of the Electron Paramagnetic Resonance Spectroscopy of Ions of the Transition Groups*, Lviv National University, Lviv 1996 (in Ukrainian).
[4] A. Stasiewicz, *Budujemy spektrometr optyczny*, MIKOM, Warszawa 2003.
[5] A. Stasiewicz, *Filmujemy i analizujemy zjawiska optyczne*, MIKOM, Warszawa 2003.

OPTIONAL READING:

[1] Monographs and original articles on spectroscopy of magnetic resonance and optical spectroscopy in solids, published in the special scientific journals.

PROGRAM PREPARATION:

Dr hab. Bohdan Padlyak, prof. UZ

FOUNDATIONS OF INORGANIC CHEMISTRY

Course code: **13.3-WF-FizP-PoChN**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **mgr Bartłomiej Zapotoczny**
Name of lecturer: **mgr Bartłomiej Zapotoczny**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Laboratory	Laboratory	30	VI (FŚ)	Grade	

COURSE AIM:

Acquisition of basic knowledge and skills in the use of chemical laboratory.

ENTRY REQUIREMENTS:

None

COURSE CONTENTS:

Basic laboratory operations, methods of substances purification, colloids and solutions, types of inorganic compounds, electrolytes and nonelectrolytes, fundamentals of electrochemistry, the calibration curve - colorimetric determination (UV-VIS spectroscopy).

TEACHING METHODS:

Laboratory classes

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student has a general knowledge of general, inorganic and analytical chemistry. The gained knowledge will help him to better identify, understand, and interpret changes in the environment . The student knows and explains the relation of cause and effect, understands and explain the basics of chemical reactions and physical processes	K1A_W01	Verify in written form the student's theoretical knowledge on topics of exercises. The practical implementation of exercises in the laboratory, preparing a report of the exercises in the form of a written report	Laboratory

Student is able to independently formulate a chemical reaction equations, perform calculations based on stechiometry and to evaluate the reactivity of inorganic compounds. Student is able to interpret the results of an experiment and associate them with the results of theoretical.	K1A_W03	Containing an analysis of the experimental results, a description of the calculations and experiment results and formulate conclusions. To pass the laboratory classes the implementation of all provided practical exercises, preparation of reports is obligatory.	
The student independently performs synthesis of inorganic compounds, has the ability to sampling and preparing samples for analysis; is able to perform qualitative and quantitative analysis of basic inorganic chemicals, refer them to the theoretical results and formulate relevant conclusions, plan simple experiments, interpret and present experimental results.	K1A_U03 K1A_U02		
The student is aware of responsibility for own work; shows willingness to comply with the principles of teamwork and share responsibility for the implementation of tasks.	K1A_K02		
The student understands the need for continuous training and improving professional competence, is aware of the responsibility for the performed tasks .	K1A_K03		

ASSESSMENT CRITERIA:

Grade:

- Preparation for exercises 60%
- Preparation of reports 40%

STUDENT WORKLOAD:

- Participation in laboratory classes - 30h
- Prepare for classes / preparation of reports - 25h
- Consultation - 3h

Total: 58 h, 2 ECTS.

Effort associated with activities that require direct participation of teachers: 33 h, 1 ECTS.

RECOMMENDED READING:

[1] Adam Bielański, *Podstawy chemii nieorganicznej*, Tom I - III, PWN, Warszawa 1994.

[2] F. Albert Cotton, Geoffrey Wilkinson, Paul L. Gaus, *Chemia nieorganiczna. Podstawy*, PWN, Warszawa 2002.

OPTIONAL READING:

[1] L. Pauling, P. Pauling, *Chemia*, PWN, Warszawa 1998.

PROGRAM PREPARATION:

Mgr Bartłomiej Zapotoczny

ENVIRONMENTAL PHYSICS II – ENERGY RESOURCES MANAGEMENT

Course code: **13.2-WF-FizP-FŚ2Go**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	VI (FŚ)	Exam	
Class	15	1		Grade	

COURSE AIM:

Acquaint students with physical foundations concerning the description and production of all kinds of energy resources. Moreover he should know that every method of energy production leads to some troubles and has to pay some prices, however the risk and strategy are inseparable features of any choice made by the society.

ENTRY REQUIREMENTS:

Knoeledge of physics, especially from thermodynamics and nuclear physics found from the previous period of study.

COURSE CONTENTS:

Lecture

+ General knowledge from phenomenological thermodynamics:
  - General concepts: system-environment; parameters (thermodynamical variables) related to the system and environment; thermodynamical processes; temperature; state functions
  - Three laws of thermodynamics
+ Heat exchange: Types of heat; thermal conductivity; thermal resistance; analogy with electricity; equation of heat conduction; some simple examples
+ Fossil fuels – main energy sources
  - Application of the first law of thermodynamics. Change of heat to mechanical energy and on the contrary
  - Second law of thermodynamics. Entropy and absolute temperature. Enthalpy. Free energy. Free enthalpy (Gibbs enthalpy)
  - Heat and combustion engines. Possible work to be obtained. Engine efficiency. Carnot cycle
  - Electricity produced by the heat obtained from fossil fuels anf nuclear power plants
  - Impurities. Lidar
+ Renewable energy resources
  - Sun energy

- Wind energy
- Water energy
- Biological energy

+ Nuclear energy
  - Nuclear fission. Chain reaction. Nuclear reactors
  - Nuclear fusion
  - Radiation and safety, nuclear waste

+ Energy transport and storing
  - Examples of energy storing
  - Energy transport

Classes:

Classes having theoretical character recommended by lecturer.

TEACHING METHODS:

- Conventional lectures with the application of multimedia devices.
- Audience classes, work in group.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Knowledge: Student possesses a general knowledge concerning environmental physics, the methods od measurement related to considered phenomena in this domain. He understands and can explain the course of these phenomena and related physical processes using proper mathematical tools. Student also possesses the knowledge of safety rules, identifies the threats (in particular the radiation threat) resulted from production and exploitation of all kind of energy, then takes proper tools for their prevention.	K1A_W01 K1A_W03 K1A_W06	Exam	Lecture
Ability: Student can analyze and solve physical problems existing in environment, based on the knowledge from lecture and information obtained from the literature, data bases, internet resources in both Polish and English. He can perform the analysis of both theoretical and experimental results and then takes proper conclusions. He can present the related physical problems by a simple comprehensible language.	K1A_U01 K1A_U02 K1A_U06	Control tests in classes	Classes
Social competences: Student has an awareness about his role in passing on to the society information and opinions concerning different aspects of environmental protection, for example the new achievements in prevention against the nuclear danger.	K1A_K05	Exam	Lecture

ASSESSMENT CRITERIA:

Lecture: The condition for credit is a positive grade of the writing exam.

Classes: The condition for credit is obtaining all positive grades from control tests.

Final grade: Weighting average from the exam grade (60%) and class grade (40%).

STUDENT WORKLOAD:

- Participation on the lecture: 30 hours
- Participation on the class: 15 hours
- Preparation to the class: 15 hours
- Preparation to the lecture: 20 hours
- Consultations: 3 hours
- Participation in the exam: 2 hours

In sum: 85 hours, 3 ECTS (50 hours with the presence of the teacher, 2 ECTS).

RECOMMENDED READING:

[1] E. Boeker, R. van Grondelle, *Fizyka środowiska*, Wydawnictwo Naukowe PWN, Warszawa 2002.

OPTIONAL READING: -

PROGRAM MADE BY: CAO LONG VAN

INTRODUCTION TO COMPUTER SIMULATIONS

Course code: **13.2-WF-FizP-WdSyK**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					7
Lecture	30	2	VI (FK)	Grade	
Laboratory	45	3		Grade	

COURSE AIM:

The aim of the course is to gain basic knowledge of computer simulations of selected methods for problems of deterministic and Monte Carlo-type issues. Students should acquire skills of implementation of this knowledge by designing an algorithm and a computer program and then interpreting the results of computer simulations. Specific examples will include e.g. problems of molecular dynamics of a single particle, molecular dynamics with constraints, modeling Brownian motion and other random events for different distributions of random variables.

ENTRY REQUIREMENTS:

Programming skills in C / C + +, Python or Java and knowledge of numerical methods.

COURSE CONTENTS:

- Representation of numbers, excess and underflow errors, truncation error (finite difference method), the stability of numerical algorithms.

- Algorithms for solving the equation of motion: Euler, Verlet, prędkościowy Verlet, leap-frog predictor-corrector algorithm, the choice of the time step, the stability and accuracy of the algorithms, numerical solution of the harmonic oscillator 1D and 2D. the band izobaryczno isothermal, thermostats).

- Monte Carlo algorithms (random number generators, random variables with different probability distributions, Metropolis algorithm, stochastic equations).

- Cellular automata.

- Genetic algorithms.

TEACHING METHODS:

Lectures and laboratory exercises, discussions, independent work with a specialized scientific literature in Polish and English, and work with the technical documentation, search for information on the Internet.
Before taking the exam the student must be credited with the exercises.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Students expand their ability to acquire knowledge in different ways using a variety of sources	K1A_U10	Activity during laboratories, Projects, Discussions	Lecture, Laboratory
Students have an extended knowledge of classical physics of interacting systems with particular emphasis on the impact parameters potential impact on the stability and behavior of the studied systems	K1A_W01	Activity during laboratories, Projects, Discussions	Lecture, Laboratory
Students have has expertise in the following areas: numerical error analysis, numerical solution of differential equations, implementation, and application design to simulate the physical processes of the molecular dynamics of interacting particles, integration methods of Monte Carlo, Metropolis algorithm, the results of numerical analysis, random number generators	K1A_W04	Activity during laboratories, Projects, Discussions	Lecture, Laboratory
They have skills in data analysis, they have knowledge which is acquired during the studies of scientific literature	K1A_U01 K1A_U02 K1A_U07	Activity during laboratories, Projects, Discussions	Lecture, Laboratory
Students have expanding awareness of the need to update the technical knowledge on the available techniques and simulation results as well as awareness of the impact of research on the development of computer technology, including in particular nanotechnology.	K1A_K04 K1A_K05	Activity during laboratories, Projects, Discussions	Lecture, Laboratory

ASSESSMENT CRITERIA:

Lecture: positive evaluation of the test.
Laboratory: positive evaluation of the tests, the execution of the project.
The final evaluation of the laboratory: evaluation of tests of 60%, the assessment of the project 40%.
Final grade: arithmetic mean of the completion of the lecture and in classes.

STUDENT WORKLOAD:

- Participation in lectures: 30 hours
- Participation in lab excersises: 45 hours
- Preparation for the lab exercises: 45 hours
- Project preparation: 20 hours
- Consulting for the lecturees and excercises: 10 hours
- Preparation for the completion of the lecture: 20 hours

TOTAL: 170 hours, 7 ECTS.

Contact hours: 85 hours, 3.5 ECTS

RECOMMENDED READING:

[1] J. C. Berendsen and W. F. Van Gunsteren, *Practical Algorithms for Dynamic Simulations in Molecular dynamics simulations of statistical mechanical systems*, Proceedings of the Enrico Fermi Summer School, p.43-45, Soc. Italinana de Fisica, Bologna 1985.

[2] Stephen Wolfram, *Statistical mechanics of cellular automata*, Rev. Mod. Phys. 55, 601-644 (1983).

[3] Tao Pang, *An Introduction to Computational Physics*, Cambridge University Press (2006).

OPTIONAL READING:

[1] William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, *Numerical recipes, The art of scientific computing*, third edition 2007.

PROGRAM PREPARATION:

Dr Sebastian Żurek

SYSTEMS OF STARS, THE STRUCTURE OF THE UNIVERSE AND COSMOLOGY

Course code: **11.3-WF-FizP-SGSWK**
Type of course: **compulsory**
Language of instruction: **English/Polish**
Director of studies: **The academic teacher giving the lecture**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Lecture	30	2	VI (AK)	Exam	
Class	30	2		Grade	

COURSE AIM:

Consolidation and expansion of basic knowledge about the systems of stars, globular clusters and open, building galaxies, clusters of galaxies (including the Local Group) and the large-scale structure of the Universe. Increasing knowledge of cosmology: the origins and future of the universe, the big bang, relic radiation, the cosmological constant. Methods for determining distances in the universe.

ENTRY REQUIREMENTS:

General knowledge of astronomy and fundamental physics.

COURSE CONTENTS:

- Star systems: open and globular clusters.
- Basic information about the Milky Way.
- The structure of the Galaxy.
- Classification and evolution of galaxies.
- Extragalactic astronomy.
- Determination of distances in the Universe.
- Elements of cosmology.

TEACHING METHODS:

Conventional lectures, tutorials.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student is able to identify and describe the differences between open and globular clusters. Able to characterize	K1A_W01	Exam, tutorials	Lecture/Class

both types of star clusters and their distribution in the galaxy. Understand the principle of setting a distance from the color-luminosity diagram for clusters. The student is able to characterize the various elements of the construction of the Galaxy and explain the differences between them. Student is able to explain the method of determining the rotation curve of the galaxy shape and interpret it in the context of the existence and distribution of dark matter. The student knows and understands the method of estimating the age of the Galaxy. The student knows the classification and evolution of galaxies, the Hubble tuning fork is able to characterize and groups of galaxies in the Local Group of Galaxies particular. The student knows the theory of the Big Bang, the Universe thermal history and basic cosmological models. Understand the expansion of the universe, Hubble's law, the importance of the cosmological constant and the microwave background radiation.			
Student is able to perform, including its knowledge of the rights of astrophysical, simple accounts used to solve basic problems and astrophysical issues. Able to interpret simple astronomical observations and based on them estimate the most important physical parameters of systems of stars.	K1A_U06	Exam, tutorials	Lecture/Class
Student is able to use their knowledge to construct a simple astrophysical research projects.	K1A_K01 K1A_K05	Exam, tutorials	Lecture/Class

ASSESSMENT CRITERIA:

Lecture: Oral examination, Condition Assessment - a positive evaluation of the test Exercise: the correct and timely execution of homework

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours
- Participation in exercises: 15 x 2 = 30 hours
- Preparation for exercise: 15 x 2 = 30 hours
- Completion of accounting tasks in the house: 15 x 1 = 15 hours
- Participation in the consultations: 2 hours
- To prepare for the exam: 15 hours
- Participation in the exam: 2 hours

TOTAL: 124 hours, 5 ECTS.

Effort associated with activities that require direct participation of teachers: 64 hours, 2.5 ECTS.

RECOMMENDED READING:

[1] F. Shu, *Galaktyki, gwiazdy, życie*, Prószyński i S-ka, 2000.

[2] M. Kubiak, Gwiazdy i materia międzygwiazdowa, PWN, 1994.

[3] A. Liddle, *Wprowadzenie do kosmologii współczesnej*, Prószyński i S-ka, 2000.

OPTIONAL READING:

[1] P. Schneider, *Extragalactic astronomy and Cos*mology, Springer, 2006.

PROGRAM PREPARATION:

Dr Agnieszka Słowikowska

INTRODUCTION TO THE COMPACT OBJECTS ASTROPHYSICS

Course code: **11.3-WF-FizP-WdAOZ**

Type of course: **compulsory**

Language of instruction: **Polish**

Director of studies: **The academic teacher giving the lecture**

Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					2
Lecture	30	2	VI (AK)	Exam	

COURSE AIM:

Presentation of the basic problems of astrophysics of compact objects. Transfer news from physics to enable a basic level of understanding of most of the phenomena and processes of compact objects.

ENTRY REQUIREMENTS:

General knowledge of astronomy and fundamental physics.

COURSE CONTENTS:

- Compact objects as the last stages of stellar evolution
- Observations of neutron stars and white dwarfs
- Observational evidence of existence of black holes
- Properties of degenerate matter
- Construction of white dwarfs and neutron stars
- Models of neutron stars
- The stability of neutron stars and white dwarfs
- Black holes
- Accretion in systems with compact objects

TEACHING METHODS:

Conventional lecture

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
The student is able to characterize the class of compact objects and describe the differences between stars and compact objects. He has knowledge of the theory and observations of white dwarfs, neutron stars and black holes. Can describe the properties of matter	K1A_W01 K1A_W02 K1A_W10 K1A_KU1 K1A_U07	Exam	Lecture

and the structure of degenerate compact stars, depending on the density inside them. Student explains the mass-radius relation for white dwarfs nierotujących and neutron stars, and gives the reason for the existence of upper limits on the gravitational mass. Explains the phenomenon of accretion on compact objects.			
Student can introduce gained popular science news in a way.	K1A_U06 K1A_K05	Exam	Lecture
Student can use the English-language literature.	K1A_K01	Exam	Lecture

ASSESSMENT CRITERIA:

Lecture: Oral examination, Condition Assessment - a positive evaluation of the test.

STUDENT WORKLOAD:

- Participation in lectures: 15 weeks x 2 hours = 30 hours
- Participation in the consultations: 2 hours
- To prepare for the exam: 26 hours
- Participation in the exam: 2 hours

TOTAL: 60 hours, 2 ECTS.

Effort associated with activities that require direct participation of teachers: 34 hours, 1 ECTS.

RECOMMENDED READING:

[1] F. Shu, *Galaktyki, gwiazdy, życie*, Prószyński i S_ka, 2003.

[2] S. Shapiro, S. Teukolsky, Black Holes, *White Dwarfs and Neutron Stars*, Wiley-VCH 2004.

OPTIONAL READING:

[1] W. H. G. Lewin, M. van der Klis, *Compact Stellar X-ray Sources*, Cambridge Uni. Press, 2006

PROGRAM PREPARATION:

Dr Agnieszka Słowikowska

UNDERGRADUATE SEMINAR

Course code: **13.2-WF-FizP-SemLi**
Type of course: **compulsory**
Language of instruction: **Polish**
Director of studies: **The academic teacher directing the seminar**
Name of lecturer: **Academic teacher from the Faculty of Physics and Astronomy**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					5
Seminar	30	2	VI	Grade	

COURSE AIM:

Getting the student acquainted with legal and ethical conditions during of the undergraduate thesis preparation and putting in order the knowledge from different areas of physics having in mind the undergraduate exam

ENTRY REQUIREMENTS:

Chosen subject of undergraduate thesis.

COURSE CONTENTS:

- Explaining the rules of undergraduate thesis writing: creating plan and different variants of its composition, how to put forward scientific problems and solve them.
- Presenting methods of searching for, gathering and preparing material.
- Presenting legal and ethical conditions, elementary knowledge of copyright regulations in regard to the thesis, warning against plagiarism, rules of citation and making references.
- Presenting by students the subjects of their undergraduate thesis in the form of a seminar.
- Formulating aims and composition of the thesis.
- Overview and consolidation of physics course contents before the undergraduate exam.
- Final presentation of undergraduate thesis using Beamer or PowerPoint slides.

TEACHING METHODS:

Elements of conventional lecture, students' presentations concerning their thesis (introduction to the subject and final presentation) as well as main subjects of the final exam.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Student has basic knowledge regarding copyrights and intelectual property.	K1A_W07 K1A_W08	Presentation of seminar, discussion	seminar

Knows rules of using scientific resources			
Student is able to investigate a specific physical problem	K1A_U05	Presentation of seminar, discussion	seminar
Understands the need for, and sees opportunities for further training	K1A_K01	discussion	seminar

ASSESSMENT CRITERIA:

The credit for the seminar will be given on the basis of the presentations and activities (asking questions, providing comments) during the presentation of others.

STUDENT WORKLOAD:

- Participation in seminar: 30 hours
- Preparing two presentations of undergraduate thesis (preliminary and final): 55 hours
- Preparing presentation of chosen topics from the list of undergraduate exam topics: 35 hours
- Attending the lecturer's office hours: 5 hours

TOTAL: 125 hours, 5 ECTS.

Workload connected with lectures and classes requiring direct participation of the teacher amounts to 35 hours, this corresponds to 1,5 ECTS.

RECOMMENDED READING:

[1] T. T Kaczmarek, *Poradnik dla studentów piszących pracę licencjacką lub magisterską*, dostępne na stronie bg.szczecin.pl/pliki/poradnik_dla_studentow.pdf .

[2] strona www.praca-dyplomowa.com.pl/praca-licencjacka/

[3] J. Orear, *Fizyka*, tom 1 i 2, WNT, Warszawa 2004.

[4] D. Halliday, R. Resnick, J. Walker, *Podstawy fizyki*, tomy 1 – 5, PWN, Warszawa 2006.

OPTIONAL READING: -

PROGRAM PREPARATION:

Dr hab. Anatol Nowicki, prof. UZ

MONOGRAPHIC LECTURE-NUCLEAR PHYSICS AND NUCLEAR ENERGY

Course code: **13.2-WF-FizP-WyMon**
Type of course: **compulsory**
Language of instruction: **Polish or English (chosen)**
Director of studies: **dr hab. Van Cao Long, prof. UZ**
Name of lecturer: **dr hab. Van Cao Long, prof. UZ**

Form of instruction	Number of teaching hours per semester	Number of teaching hours per week	Semester	Form of receiving a credit for a course	Number of ECTS credits allocated
PHYSICS – first degree studies					4
Lecture	30	2	VI	Exam	

COURSE AIM:

Student has a thorough knowledge of fundamental concepts of physics for micro world, in particular nuclear physics. He understands conceptionally the spontaneous and stimulated nuclear processes, in particular nuclear fission and fusion which lead to atomic weapons and nuclear power stations. He understands also both of the elementary interactions of nuclear radiation with matter and chemical, biological effects caused by them.

ENTRY REQUIREMENTS:

A thorough knowledge of mathematics and physics at the previous period of first degree study

COURSE CONTENTS:

1. Structure of matter and atomic nuclei
   - Quantum nature of microworld, particle-wave duality
   - Fundamental constituents of matter: quarks and leptons, intermediate bosons as the quanta of the fields representing fundamental interactions, in particular photons as quanta of the electromagnetic field.
   - Model of atoms, level scheme of atomic systems
   - Quantum numbers and the conservation laws related to them
   - Atom in the framework of old quantum theory (Bohr's Model) and Schroedinger's Theory: Atomic shell model and Mendeleev's Periodic Table
   - Hadrons in theory of quarks, in particular protons and neutrons as binding system of quarks
   - Nucleus as a binding system of nucleons (protons and nucleons interacting with gluons which are the quanta of strong-interaction field)
   - Fundamental features of nucleons and atomic nuclei, units in nuclear physics
   - Binding energy
   - Nuclear models: Drop Model, Shell Model and Model of Fermi's Gas
2. Spontaneous processes
   - Exponential Decay Law
   - Decay constant and level width
   - Cross-sections
   - Tunneling effect
   - Alpha, Beta and Gamma decays
   - Spontaneous decays of heavy nuclei
3. Stimulated processes: nuclear reactions
   - Reactions with the creation of complex nuclei
   - Reactions with alpha particle

- Reactions with neutrons
- Cosmic rays

4. Fission reactions of heavy nuclei
    - Fission of uranium
    - Outline of fission theory
    - Energy of nuclear fission
    - Chain reaction of nuclear fission for uranium and plutonium, critical mass
5. Nuclear weapons
    - Manhattan Project: uranium and plutonium atomic bombs
    - Nuclear fusion and thermonuclear bombs
6. Controlled nuclear reactions. Nuclear energy
    - Different types of nuclear reactors
    - Scheme of nuclear power station
    - Projects in the realization of controlled nuclear fusion
7. Interactions of nuclear radiation with matter
    - Interactions of Alpha particles with matter
    - Interactions of Beta particles with matter
    - Interactions of photons (gamma and X) with matter
8. Elements of Dose Measurements
    - Absorbed dose and units
    - Quality factor Q (or radiation weighting factor R)
    - Equivalent dose and units
9. Chemical and biological effects of nuclear radiation
    - Chemical effects: molecular decay
    - Interaction with living organisms: biochemical and biological effect
    - Linear Hypothesis
    - Risk assessment
    - Radiophobia

TEACHING METHODS:

Conventional lecture with the application of multimedia devices.

LEARNING OUTCOMES AND LEARNING OUTCOMES VERIFICATION METHODS:

DESCRIPTION OF THE EFFECT	SYMBOLS OF EFFECTS	VERIFICATION METHODS	FORM OF CLASSES
Knowledge: Student possesses general knowledge in atomic and nuclear physics, in particular necessary knowledge for understanding fundamental phenomena used for energy production, the phenomena existing in nuclear fission and fusion, He understands also both of the elementary interactions of nuclear radiation with matter and chemical, biological effects caused by them. He is also able to use fundamental mathematical tools in the description of physical phenomena in nuclear physics.	K1A_W01 K1A_W02	Exam	Lecture
Abilities: Student can analyze and solve physical problems basing on the knowledge and information obtained from the literature, data bases, internet resources in both polish and English, he can perform the analysis of theoretical considerations, and based on this he can formulate proper conclusions. He will able to talk about physical problems by comprehensible and simple language. He could also find himself a necessary knowledge and develop his abilities using different sources of information.	K1A_U01 K1A_U03	Exam	Lecture
Social competences: Student has an awareness about his knowledge and abilities, understand the need and know the possibilities of continuous gain own qualifications (studies of second	K1A_K01	Exam	Lecture

and third degree, postgraduate studies) – raising the personal, professional and social qualifications. Student understands the role of knowledge popularization in both active and passive side. He possesses the awareness about the importance of professional behavior, caution of ethic principles and respect for variety of views and cultures. Student has the awareness about the responsibility of his work and is ready to respect the rules governing in the team work.	K1A_K02 K1A_K03 K1A_K04		

ASSESSMENT CRITERIA:

Passing the written exam.

STUDENT WORKLOAD:

- Participation on the lecture: 30 hours
- Independent work: 55 hours
- Consultations: 8 hours
- Participation in the exam: 2 hours

In sum: 95 hours, 4 ECTS.

RECOMMENDED READING:

[1] B. Dziunikowski, *O fizyce i energii jądrowej*, Wydawnictwo AGH, Kraków 2001.

[2] Z. Celiński, *Energia jądrowa*, PWN, Warszawa 1991.

[3] W. N. Cottingham, D. A. Greenwood, *An Introduction to Nuclear Physics*, Cambridge University Press 2001.

[4] H. A. Enge, *Introduction to Nuclear Physics*, Addison-Wesley Publishing Company 1972.

OPTIONAL READING:

[1] J. Kubowski, *Broń jądrowa*, Wydawnictwo Naukowo-Techniczne, Warszawa 2008.

[2] W. Greiner, J. A. Maruhn, *Nuclear Models*, Springer-Verlag 1996.

PROGRAM MADE BY: CAO LONG VAN