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INFORMATION PACKAGE

/ECTS/

FIELD OF HIGHER EDUCATION: **4. NATURAL SCIENCES, MATHEMATICS AND INFORMATICS**

PROFESSIONAL FIELD: **4.1 PHYSICS SCIENCES**

MASTER PROGRAMME: **MODERN ENERGY SOURCES AND ENVIRONMENTAL PROTECTION**

QUALIFICATION CHARACTERIZATION

OF MASTER PROGRAMME: **MODERN ENERGY SOURCES AND ENVIRONMENTAL PROTECTION**

EDUCATIONAL AND QUALIFICATION DEGREE: **MASTER**

PROFESSIONAL QUALIFICATION: **PHYSICIST, MODERN ENERGY SOURCES AND ENVIRONMENTAL PROTECTION**

DURATION: **1 YEAR (2 SEMESTERS)**

FORM OF TRAINING: **REGULAR**

The Master's program in “Modern energy sources and environmental protection” with a study period of 2 semesters is intended for students with an acquired educational and qualification degree “*Bachelor*”/ “*Master*” in specialties in the professional field of *Physical Sciences* and in specialties *Physics and Mathematics*, *Chemistry and Physics* from the professional field of *Pedagogy of Education in ...* .

The Master's program in “Modern Energy Sources and Environmental Protection” prepares qualified specialists with knowledge in the field of physical problems of the environment, ecology, biophysics, non-traditional energy sources, methods for environmental control, solar energy, etc. During their studies, students receive additional theoretical and applied knowledge and skills in informatics and information technologies.

Graduates of the master's program are prepared to work as specialists in environmental protection laboratories - RIOS, HEI, environmental monitoring base stations, in companies using non-traditional energy sources for energy production, in scientific institutes and laboratories in the field of physical sciences and related ones (chemistry, biology, geology), which use physical methods for environmental monitoring and control. They can hold the positions of head of a scientific program; head of a scientific section; head of a scientific laboratory; head of a production unit; head of a laboratory in an enterprise; analyst, air pollution; expert, environmental conservation; consultant, ecology; advisor, ecology; researcher, ecology; scientist, ecology; analyst, water quality; lecturer, higher education institution; assistant, higher education institution; part-time lecturer, higher education institution; and others.

CURRICULUM

(Adopted in 2010, updated 2021)

First year			
First semester	ECTS credits	Second semester	ECTS credits
Obligatory disciplines		***Obligatory disciplines***	
Physical methods in environmental research	6	Ecological expertise	5
Chemical methods in environmental research	6	Elective discipline group II	5
Elective discipline group I	6	Elective discipline group II	5
Elective discipline group I	6	State graduation examination in physics or Diploma theses	15
Elective discipline group I	6		
Elective disciplines group I		***Elective disciplines group II***	
Modern energy sources		Energy and ecological problems	
Visual programming		Photovoltaic conversion of solar energy	
Solar architectures		Laser methods in environmental research	
Applied informatics		Fundamentals of biophysics	
Modern methods in aerospace and environmental research		Philosophical problems of physics	
Ecology			
	Total 30		Total 30

TOTAL FOR ONE YEAR: 60 CREDITS

DESCRIPTIONS OF THE COURSES

PHYSICAL METHODS IN ENVIRONMENTAL RESEARCH

ECTS credits: 6 credits
Hours per week: 2 Lec. + 0 Sem. +2 Lab.
Assessment method: Examination
Course Status: Obligatory
Semester: I

Methodical leadership:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Annotation: The course includes studying of the basic physical phenomena in the environment, including the Distribution and properties of the water, structure and energy balance of the atmosphere, heat, electromagnetic, noise and aerosol-pollutions.
Course aims: The students in physics have to receive ground knowledge about using the contemporary physical Methods in the monitoring of the environment.
Pedagogical Methods: Lectures, laboratory, homework, tutorials.

Preliminary Requirements: Basic knowledge in General Physics – parts mechanics, molecular physics, thermodynamics and electricity.

Assessment: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: Not necessary.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

CHEMICAL METHODS IN ENVIRONMENTAL RESEARCH

ECTS credits: 6 credits
Hours per week: 2 Lec. + 0 Sem. +2 Lab.
Assessment method: Examination
Course Status: Obligatory
Semester: I

Methodical leadership:
Department of Chemistry,
Faculty of Mathematics and Natural Sciences

Annotation: The main stages of analysis using instrumental methods are considered; absolute and relative methods; calibration methods and basic metrological characteristics of instrumental methods of analysis. The most commonly used spectral, magnetochemical and chromatographic methods of analysis are presented in a systematic manner.

Course Aims: The course aims to familiarize students with the basic principles of the most commonly used instrumental methods for analyzing the composition and structure of various objects. The physical basis, advantages and limitations of the considered analytical methods are discussed. The aim is for students to acquire the knowledge necessary for selecting a method and adequately formulating an analytical problem.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Evaluation Method: Written examination.

Registration for the course: Not necessary.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

ECOLOGICAL EXPERTISE

ECTS credits: 6 credits
Hours per week: 2 Lec. + 0 Sem. + 2 Lab.
Assessment method: Examination
Course Status: Obligatory
Semester: I

Methodical leadership:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Subject Description: A key approach to environmental protection is the implementation of preventive actions and measures that, before the implementation of investment intentions, ensure the prevention of significant adverse impacts on environmental components and natural ecosystems. An important tool in this direction, regulated in European and national environmental legislation, are the procedures for the implementation of regulated, preventive activities.

The course is aimed at presenting the stages, procedures and legislative framework for the development of environmental assessments and compatibility assessments as preventive tools for assessing possible significant impacts on environmental components, as a result of the implementation of investment proposals, plans and programs at national, regional and local levels, which are in the process of being prepared.

Course content: The curriculum contains 15 topics dedicated to environmental legislation in the field of preparing environmental assessments. Practical exercises are included to familiarize with and prepare different types of environmental assessments.

Pedagogical Methods: Lectures, exercises, homework, tutorials.

Assessment: Written examination.

Registration for the course: not necessary.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

MODERN ENERGY SOURCES

Semester: 1 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory/FS
ECTS credits: 6.0 credits
Department: Mathematics and Physics
Status of the Subject: Elective course

Subject Description: The course introduces students to the basic physical aspects and technology of radiant energy conversion. The general energy resources of the earth and the place of solar energy in the general energy balance, the physical and technical features of the elements for the utilization of solar energy, as well as some general problems of energy as a main branch of the economy are considered. Attention is paid to the most important theoretically and practically problems related to the use, transfer and accumulation of solar energy, energy saving and the protection of the environment from harmful effects related to the production and consumption of energy.

Course aims: The aim of the course is for students to become familiar with the physical principles of solar energy conversion and its use for the production of electrical energy. They should receive information about the resource possibilities and prospects for the development of various technologies and the possibilities for their use in the domestic and industrial sectors.

Pedagogical Methods: Lectures, laboratory, homework, tutorials.

Preliminary Requirements: Knowledge from courses in General Physics, Atomic and Nuclear Physics, etc.

Assessment: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: By request at the end of the current semester.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

VISUAL PROGRAMMING

Semester: 1 semester
Course Type: lectures and laboratory exercises
Hours per week FS/SS: 2 lectures hours and 2 laboratory hours per week /FS
ECTS credits: 6 credits
Department: Mathematics and Physics
Course Status: Optional Course

Subject Description: The course is designed to introduce students to the methods and tools of visual programming in the Visual Studio 2019 IDE. The course includes topics: programming languages such as C #, HTML, CSS, PHP, SQL, JavaScript, XML.

Course Objectives: Students should obtain fundamental knowledge and skills related to the basics of the visual programing and related technologies.

Teaching Methods: lectures and laboratory exercises

Requirements/Prerequisites: Basic knowledge and skills for information systems and technology.

Assessment: written final exam

Registration for the Course: by request at the end of the previous academic year

Registration for the Exam: coordinated with lecturer and Student Service Department

SOLAR ARCHITECTURES

ECTS credits: 6,0
Weekly workload: 2 Lec. + 2 Sem. + 0 Lab.
Form of assessment: Written exam
Statute of the course: Elective
Semester: I

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Description of Subject: Solar Energy. Thermal solar applications. Passive solar systems. Types of passive solar systems. Direct passive solar systems. Efficient building orientation and form. Indirect Passive solar systems.

Specific goals of Subject: Students will acquire knowledge for modern building technologies and practical experience to use this system.

Pedagogical methods: Lectures will be visualized by tables, slides and presentations. In seminar exercises a real computer application will be observed and simple examples will be developed.

Preliminary requirements: Basic knowledge in heat physics and mechanics.

Help Materials: Lectures disposed in Internet (Web site of department), copies of teaching materials and publications.

Assessment: Examination upon the lecture material. During the semester there are interim tests.

APPLIED INFORMATICS

Semester: 1 semester
Course Type: lectures and laboratory exercises
Hours per week FS/SS: 2 lectures hours and 2 laboratory hours per week /FS
ECTS credits: 6 credits
Department: Mathematics and Physics
Course Status: Optional Course

Subject Description: The course is designed to introduce students to the main methods and tools applied informatics and program language C++.

Course Objectives: Students should obtain fundamental knowledge and skills related to the basics of the visual programing and related technologies.

Teaching Methods: lectures and laboratory exercises

Requirements/Prerequisites: Basic knowledge and skills for information systems and technology.

Assessment: written final exam

Registration for the Course: by request at the end of the previous academic year

Registration for the Exam: coordinated with lecturer and Student Service Department.

MODERN METHODS IN EXAMINATION OF THE AEROSPACE AND NATURAL ENVIRONMENT

ECTS credits: 6,0
Weekly workload: 2 + 0 + 2
Form of assessment: Written exam
Statute of the course: Elective
Semester: 1

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Annotation: The course „Modern methods in examination of the aerospace and natural environment" is included as elective course in the master program „Modern Energy Sources and Environmental Protection". The course is with total workload 60 hours, which includes 30 hours lectures and 30 hours laboratory exercises. The students' self-study is 90 hours.

Current control of the students' educational achievements is carried out during the semester in the hours of laboratory exercises. Teaching on the course ends with a written exam.

Course content:
1. Sun. Solar System. Planet Earth. Basic methods of their examination.
2. Lithosphere. Magnetosphere. Atmosphere. Hydrosphere. Biosphere. Main characteristics. Methods for examining.
3. Cosmic rays background and magnetosphere. Correlations and methods of their examination.
4. Aerospace environment. Basic parameters of the aerospace environment.
5. Basic methods and instrumentation for study of the aerospace environment. Telescopes, satellite detectors and others.
6. Meteorological parameters. Basic methods for their measurement.
7. Aerosols. Physical characteristics. Atmospheric transport. Basic methods for their measurement.
8. Atmospheric transport of heavy and toxic metals.
9. Atmospheric transport of chemical contaminants. Basic methods for their measurement.
10. Ozone, radon, CO_2 and their role in the atmosphere.
11. Cosmic rays background and meteorological effects.
12. Cosmic rays background, atmosphere and biosphere.
13. Natural environment. Basic parameters and characteristics. Approaches in the study of the natural environment. Control and management of the natural environment.
14. Radioecology and natural environment. Migration of radionuclides. Engineered barriers. Management.
15. Information systems and natural environment. Transmission and analysis of data for the natural environment.

Teaching methods and evaluation: Lectures are held in a lecture hall, that is equipped with the necessary technique – computer and multimedia projector, using the computer presentations, which are developed in accordance with the educational content of the lectures.

Current control of the students' educational achievements is carried out during the semester. Certification of the semester get students who have done all laboratory exercises, who have submitted and defended the relevant protocols and who have received an evaluation of the current control at least „Satisfied 3" (D).

Teaching on the course ends with a written exam on the educational content. A final evaluation is formed only if the student has received an evaluation of the written exam at least

„Satisfied 3" (D). In forming of the final evaluation are reported the evaluations from the written exam (40 %) and from the current control (60 %).

ECOLOGY

ECTS credits: 6,0
Weekly workload: 2 Lec. + 0 Sem. + 2 Lab.
Form of assessment: Written exam
Statute of the course: Elective
Semester: 1

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Course Description: The course "Ecology" focuses on basic concepts, approaches and concepts in ecology as an interdisciplinary science that unites biological, physical and social sciences and is closely related to environmental protection. During the course, students become familiar with the object, subject, tasks and methods of research in ecology, with the main ecological factors - abiotic, biotic and anthropogenic; with the concept of the limiting effect of environmental factors and the adaptations of organisms to them; with the composition, structure, development and productivity of biological macrosystems - populations, biocenoses, ecosystems; with the cycle of substances and the flow of energy in ecosystems; with the essence and organization of the biosphere, with the concept of the ecosphere.

Course Objective: Students to obtain basic knowledge of concepts, approaches and concepts in ecology.

Teaching method: Lectures and practical (laboratory) exercises, Lectures are read to the entire stream simultaneously. Practical exercises are conducted in groups.

Prerequisites: Basic knowledge from the courses in General Physics-Mechanics, Molecular Physics, Thermodynamics and Electromagnetism.

Assessment method: Grade determined by a written exam and by ongoing control of laboratory exercises, taken with a certain weight.

Registration for the Course: by request at the end of the previous academic year

Registration for the Exam: coordinated with lecturer and Student Service Department.

ENERGY AND ECOLOGICAL PROBLEMS

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory/FS
ECTS credits: 5.0 credits
Department: Mathematics and Physics
Status of the Subject: Elective course

Subject Description: Introduction. Thermal motors and machines. Organic fuels. Processes and products of combustion. Industrial and power boilers. Thermal and Nuclear power plants. Basics of

the Building Physics. Energy efficiency and environmental saving. Kyoto Protocol and Energy Efficiency Act.

Course aims: The students acquire basic knowledges about methods of effective output, transformation, transfer and use of energy from conventional and alternative sources, as well as with methods for environmental protection and legislative framework for that.

Pedagogical Methods: Lectures, laboratory, homework, tutorials.

Preliminary Requirements: Fundamental Physics and Mathematics.

Assessment: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: By request at the end of the current semester.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

PHOTOVOLTAIC CONVERSION OF SOLAR ENERGY

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory/FS
ECTS credits: 5.0 credits
Department: Mathematics and Physics
Status of the Subject: Elective course

Subject Description: This course is not obligatory course with general loading of 60 hours in fact 30 lecture hours and 30 hours exercises. The course purpose is to introduce the student with physical bases of the photovoltaic converting as well as with the possibilities of the photovoltaic effect's practical realizations

Course aims: Students will acquire knowledge for modern solar technologies and practical experience to use this system.

Pedagogical Methods: Lectures, laboratory, homework, tutorials.

Preliminary Requirements: Fundamental Physics, Mathematic Methods Physics, Quantum Mechanics and Quantum Electronics.

Assessment: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: By request at the end of the current semester.

Registration for the Exam: coordinated with the lecturer and Students Service Department.

LASER METHODS IN ENVIRONMENTAL RESEARCH

ECTS credits: 5,0
Weekly workload: 2 Lec. + 0 Sem. + 2 Lab.
Form of assessment: Written exam
Statute of the course: Elective
Semester: 2

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Abstract: The discipline is built on the basis of the previous mandatory and elective disciplines “Optics”, “Atomic Physics”, “Quantum Electronics”, “Biophysics”. The best development has been achieved by laser methods in the identification of soil pollution, the study of the concentration of impurities in the atmospheric air and laser diagnostics of pollution in the troposphere and stratosphere. The bioactivity of natural aquatic environments has been studied with mapping of water pollution. As a result of the study of the natural landscape, data have been collected for the use and mapping of protected natural sites, the structure has been studied and the sizes of the main ecological reserves have been determined.

The course aims to provide basic knowledge of modern laser methods for studying the components of the natural environment and their protection. In addition, students will receive the necessary skills and habits for the practical rational use of natural resources and ecological reserves.

Course content:

- Main types of lasers and their main characteristics
- Sources of soil pollution and laser methods for determining the amount of heavy metals, hydrocarbons, ethylene, ammonia, chlorides, fluorides, etc. in the soil.
- Atmospheric pollutants and the impact of pollution on the climate. Laser diagnostics of the atmosphere.
- Mineral, organic and thermal pollution of water. Laser ecology of water.
- Protected natural sites. Biosphere reserves. Laser methods for studying components of the natural environment in reserves.
- Characteristics of sound and noise. Requirements for meteorological factors in determining noise levels.

Teaching and assessment technology: During the lectures, auxiliary aids are used. A computer with a multimedia projector is used to illustrate the lecture material. Physical demonstrations are also held. During the course, laboratory exercises are mandatory. The exercises are conducted in groups. They begin with checking the degree of mastery of the study material and the readiness of the students for the specific exercise. After an introduction to the topic, specific practical tasks are solved. The protocols of the laboratory exercises are defended by the student and are assessed with a grade. Current control is carried out during the lectures and exercises throughout the semester through control checks and homework assignments. The exam is carried out on the basis of written questions developed by the students from a previously distributed outline (up to 2 hours), followed by an oral interview with tests. The final grade takes into account the grades from the current control (control works and homework) and from the semester exam in a ratio of 70/30%.

FUNDAMENTALS OF BIOPHYSICS

ECTS credits: 5,0
Weekly workload: 2 Lec. + 2 Sem. + 0 Lab.
Form of assessment: Written exam
Statute of the course: Elective
Semester: II

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Annotation: The course “Fundamentals of biophysics” is included as elective course in the specialty curriculum. The course “Fundamentals of biophysics” is with total workload 60 hours, which includes 45 hours lectures and 15 hours seminars. The students’ self-study is 90 hours.

Teaching on the course “Fundamentals of biophysics” has theoretic-applied character.

Current control of the students' educational achievements is carried out during the semester in the hours for seminars.

Teaching on the course ends with a written exam.

Course content:

1. Introduction to Biophysics.
2. Biothermodynamics.
3. Biomechanics.
4. Biological and artificial membranes.
5. Transport of substances through biomembranes.
6. Electrical properties of cells and tissues.
7. Nanotechnologies in Biophysics.

Teaching methods and evaluation:

Lectures are held in a lecture hall, that is equipped with the necessary technique – computer and multimedia projector, using the computer presentations, which are developed in accordance with the educational content of the lectures.

To conduct the seminars are used variety of didactic materials – computer presentations, electronic visual materials, tasks and other.

Certification of the semester get students who have received an evaluation of the current control at least “Satisfied 3” (D).

Teaching on the course “Fundamentals of biophysics” ends with a written exam on the educational content. A final evaluation is formed only if the student has received an evaluation of the written exam at least “Satisfied 3” (D). In forming of the final evaluation are reported the evaluations from the written exam (70 %) and from the current control (30 %).

PHILOSOPHICAL PROBLEMS OF PHYSICS

ECTS credits: 5,0
Weekly workload: 2 Lec. + 2 Sem. + 0 Lab.
Form of assessment: Written exam
Statute of the course: Elective
Semester: 2

Departments involved:
Department of Mathematics and Physics,
Faculty of Mathematics and Natural Sciences

Abstract: The course “Philosophical Problems of Physics” is included as an elective in the curriculum of the Master's program “Modern Energy Sources and Environmental Protection”. The course has a total teaching time of 60 hours, of which 30 hours of lectures and 30 hours of seminars. The extracurricular employment of students is 90 hours. The training in the course is of a theoretical and applied nature. Current control of the students' academic achievements is carried out during the semester in the hours for seminars. The training in the course ends with a written exam.

Course content:

1. The image of science.
2. Science as a process of knowledge.
3. Science and philosophy.
4. Structure of scientific knowledge.
5. Theoretical structure of modern physics.
6. Scientific revolutions.
7. Quantum and the Microworld.
8. Gravity and the Universe.
9. Theory of Relativity.
10. Order and Chaos.

Teaching and assessment technology: Lectures are held in a lecture hall, that is equipped with the necessary technique – computer and multimedia projector, using the computer presentations, which are developed in accordance with the educational content of the lectures.

To conduct the seminars are used variety of didactic materials – computer presentations, electronic visual materials, tasks and other.

Certification of the semester get students who have received an evaluation of the current control at least “Satisfied 3” (D).

Teaching on the course ends with a written exam on the educational content. A final evaluation is formed only if the student has received an evaluation of the written exam at least “Satisfied 3” (D). In forming of the final evaluation are reported the evaluations from the written exam (70 %) and from the current control (30 %).