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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: **NUCLEAR AND PARTICLE PHYSICS**

QUALIFICATION CHARACTERIZATION

OF MASTER PROGRAMME: **NUCLEAR AND PARTICLE PHYSICS**

EDUCATIONAL AND QUALIFICATION DEGREE: **MASTER**

PROFESSIONAL QUALIFICATION: **PHYSICIST, NUCLEAR AND PARTICLE PHYSICS**

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

FORM OF TRAINING: **REGULAR**

The Master's program in “Nuclear and Particle Physics” 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 ...* .

Students who graduate from the master program “Nuclear and Particle Physics” acquire fundamental and specialized knowledge in the area of physical problems of atomic and nuclear physics, theory of the atomic nucleus, particle physics, relativistic physics, cosmic rays, nuclear reactions, etc. During their studies the students acquire also theoretical and applied knowledge and skills in informatics and information technologies.

The master program in “Nuclear and Particle Physics” prepares for work in laboratories and research institutions (in relation to physics, chemistry, biology, geology) that use physical methods of atomic and nuclear physics as well as in particle physics. The master degree allows the graduates to be employed as specialists in research organizations, physicist, chief of laboratory, researcher, assistant professor and lecturer in higher schools after an admission examination.

CURRICULUM

(Adopted in 2014, updated 2021)

First year			
First semester	ECTS credits	Second semester	ECTS credits
Obligatory disciplines		***Obligatory disciplines***	
Theory of atomic nuclei	6	Elective discipline group II	5
Particle Physics	6	Elective discipline group II	5
Elective discipline group I	6	Elective discipline group II	5
Elective discipline group I	6		
Elective discipline group I	6	State graduation examination in physics or Diploma theses	15
Elective disciplines group I		***Elective disciplines group II***	
Contemporary models of the atomic nucleus		Experimental methods of nuclear physics	
Nuclear reactions with heavy ions		Nuclear reactions with neutrons and photons	
Modern computer technologies		Relativistic nuclear physics	
Visual programming		Electron and ion methods for material analysis	
Quantum physics		Radiation of charged particles	
Radiation biophysics		Physics of cosmic rays	
	Total 30		Total 30

TOTAL FOR ONE YEAR: 60 CREDITS

DESCRIPTIONS OF THE COURSES

THEORY OF ATOMIC NUCLEI

ECTS credits: 6 credits
Hours per week: 2 lecture hours, 2 laboratory hours
Assessment method: Examination
Course Status: Obligatory
Semester: I

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

Annotation: Basic concepts of Nuclear Physics. Nuclear structure. Nuclear models. Peculiaritys of Nuclear Forces. Isotopic Spin. Investigation Methods of Atomic Nuclei. Basic concepts of Radiation Safety.

Course Aims: The students acquire basic knowledges required about Nuclear and Neutron Physics and Radiation Safety. Material is selected depending of the specificity of the speciality. For that reason some specific topics are presented which are not included in the Physics programme for non-Physical subjects.

Teaching Methods: The lectures are visualised by demonstrations and laboratory tasks performance during the laboratory classes. From methods point of view teaching material is grouped in sections by logical consistency from Structure of Nuclei and Nuclear Models via Nuclear reactions, Neutron Physics to Radiation and Radiation Safety. Parts of topics with practical importance are directed to the laboratory classes.

Evaluation Method: Assessment determined by a written exam and by ongoing control of exercises taken with a certain weight.

PARTICLE PHYSICS

ECTS credits: 6 credits
Hours per week: 2 lecture hours, 2 laboratory hours
Assessment method: Examination
Course Status: Obligatory
Semester: I

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

Annotation: The discipline "Particle physics" is compulsory for the specialty. The main objective of the course is to acquire knowledge about basic properties and interactions of elementary particles, experimental techniques in particle physics.

Course Aims: The aim of the course is to acquaint students with the basic processes in elementary particle physics, experimental methods and existing particle detectors.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: Basic knowledge in Atomic and Nuclear Physics.

Subsidiary Materials: Educational literature on Particle Physics.

Evaluation Method: 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.

CONTEMPORARY MODELS OF THE ATOMIC NUCLEUS

Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/FS
ECTS credits: 6 credits
Status of the Subject: Elective course

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

Subject Description: The discipline contains materials from fundamental nuclear models, nucleon - nucleon interaction and probabilities of electromagnetic transitions.

Specific Goals of the Subject: The course aims at giving fundamental knowledge for contemporary models of the atomic nucleus and to serve as a foundation for the future worker in the fields of nuclear physics, astrophysics, accelerators and fundamental interactions.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: Basic knowledge in Atomic and Nuclear Physics and Mathematical Calculus.

Subsidiary Materials: Educational literature on Theoretical Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

NUCLEAR REACTIONS WITH HEAVY IONS

Semester: 1 semester
Cours Tipe: Lectures and seminar exercises
Hours per week/FS/SS: 2 lecture hours, 2 seminar exercises hours per week/FS
ECTS credits: 6 credits
Status of the Subject: Elective course

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

Subject Description: The course considers basic principles and different mechanisms of nuclear reactions, elastic and inelastic scattering of nucleons and heavy ions reactions involving radioactive nuclei, fragmentation and others.

Specific Goals of the Subject: The course aims to give basic knowledge about the processes occurring at the reaction of atomic nuclei at low energies. These nuclear reactions are an essential tool to study the properties of atomic nuclei, the receipt and study of exotic nuclear states synthesis of new elements and isotopes.

Pedagogical Methods: Lectures, laboratory, home work, tutorials

Preliminary Requirements: Basic knowledge in Atomic and Nuclear Physics and Mathematical Calculus.

Subsidiary Materials: Educational literature on Theoretical Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

MODERN COMPUTER TECHNOLOGIES

ECTS credits: 6,0
Weekly workload: 2 Lec. + 0 Sem. + 2 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

Annotation:

The course "Modern Computer Technologies" is included as elective course in the specialty curriculum „Physics", master program „Nuclear and Particle Physics". It is studied from students studying at educational and qualification degree „Master", 2 semesters.

The course "Modern Computer Technologies" is with total workload 60 hours, which includes 30 hours lectures and 30 hours laboratory exercises. The students' self-study is 120 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. History and development of the computer systems and technologies.
2. Word processing applications.
3. Spreadsheets.
4. Presentations.
5. Databases.
6. Multimedia technologies.

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 laboratory exercises is used the material base of the department of Physics (computer laboratory). The laboratory exercises are conducted in groups. Each student has workplace. Students work individually and they perform the practical tasks, which are described in the methodological guidelines and discussed in advance with the assistant. The laboratory exercise is considered done after presentation and defense of the performance of assigned tasks.

Certification of the semester get students who have done all laboratory exercises and who have received an evaluation of the current control at least „Satisfied 3" (D).

Teaching on the course "Modern Computer Technologies" 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 %).

VISUAL PROGRAMMING

ECTS credits: 6 credits
Hours per week: 2 lecture hours, 2 laboratory hours
Assessment method: Examination
Course Status: Obligatory
Semester: I

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

Description of Subject:

Programming languages (objective and visual) and different tools for dynamic visual programming technique.

Using the database in visual applications and object oriented anguaget technologies.

Delphi programming environment.

Database in Delphi.

Net and J2EE conception for developing the Web applications.

Specific goals of Subject: Students will acquire knowledge for modern software technologies and how 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 computer programming and logical mathematics.

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.

QUANTUM PHYSICS

Semester: 1 semester
Cours Tipe: Lectures and seminar exercises
Hours per week/FS/SS: 2 lecture hours, 2 seminar exercises hours per week/FS
ECTS credits: 6 credits
Status of the Subject: Elective course
Department: Mathematics and Physics

Subject Description: The discipline „Quantum Physics" is Elective for the major and has the task of creating a basis for learning the material by expanding the knowledge of quantum objects.

Specific Goals of the Subject: The aim of the course is for students to gain knowledge about the modern understanding of the structure of matter and to build an idea of how to describe the subatomic world with the methods of quantum physics.

Pedagogical Methods: Lectures, laboratory, home work, tutorials

Preliminary Requirements: Basic knowledge from previous courses in Differential Equations, Mathematical Methods of Physics, Quantum Mechanics, Atomic Physics, Nuclear Physics, etc.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

RADIATION BIOPHYSICS

Semester: I
Type of presentation: Lectures and Praxis
Hours per week AS / SS: 2 Lecture hours / 2 Praxis / AS
ECTS Credits: 6
Course Status: Elective course

Department: Department of Mathematics and Physics

Short Description: The thermodynamic approach at study of alive systems. Entropy of alive Nature. Basics of non-equilibrium Thermodynamics. Thermodynamics and information. Phase transitions. Chemical bonds. Fractal structures and scales. Biopolymer Physics. Biomembranes. Unique anomalous properties of Water. Solitons. Radioecology.

Course Aims: To acquaint the students with basic physical problems, approaches and methods at study of self-organisation of the Matter and interaction of living organisms with radiation.

Teaching Methods: Lectures and Praxis with decision of theoretical and practical tasks. From methodical point of view the material is arranged from the thermodynamic approach at study of living systems via Biopolymer Physics to the basic problems of Radioecology.

Requirements/Prerequisites: Basic knowledge on Basic knowledge on General, Atomic, Nuclear & Thermal Physics.

Evaluation Method: Assessment determined by a written exam and by ongoing control of exercises taken with a certain weight.

EXPERIMENTAL METHODS OF NUCLEAR PHYSICS

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/SS
ECTS credits: 5 credits
Status of the Subject: Elective course

Department: Mathematics and Physics

Subject Description: The course aims to give basic knowledge about the interaction of nuclear radiation with matter, detectors of nuclear radiation and related with them nuclear-physical instrumentation, calibration, primary processing, interpretation of the spectrometric information and others.

Specific Goals of the Subject: The course aims to familiarize students with basic modern methods of nuclear spectroscopy, staging, techniques and primary data processing from nuclear-physical experiments at low energies, as and the acquisition of practical skills for their use

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: Basic knowledge in Atomic and Nuclear Physics and Mathematical Calculus.

Subsidiary Materials: Educational literature on Experimental Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

NUCLEAR REACTIONS WITH NEUTRONS AND PHOTONS

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/SS
ECTS credits: 5 credits
Status of the Subject: Elective course
Department: Mathematics and Physics

Subject Description: The course "Nuclear reactions with neutrons and photons" is elective for the specialty. The program contains material from neutron physics and the interaction of photons with nuclei. Attention is paid to modern applications of neutron and photonuclear reactions in astrophysics and practical applications of nuclear reactions in the form of neutron activation and photonuclear analysis of the composition of matter.

Specific Goals of the Subject: The aim of the course is for students to acquire basic knowledge about the interactions of nuclei with neutrons and gamma quanta (photons), as well as to acquire practical skills for solving a wide range of specific tasks that occur in this discipline.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: General knowledge in physics and theoretical physics.

Subsidiary Materials: Educational literature on Relativistic Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

ELECTRON AND ION METHODS FOR ANALYSIS OF MATERIALS

ECTS credits 5
Hours per week: 2 Lec./ 2 Lab.
Evaluation Method: Written examination. Some intermediate tests conduct through the semester.
Status of the Subject: Elective course
Semester: II

Department: Mathematics and Physics

Annotation: The course aims to acquaint students with the latest methods for analysis of materials based on the use of electronic and ion fluxes and to show their application in science and technology.

Subject Description: The course in Electron and Ion Methods for Analysis of Materials presents the main methods using electron and ion fluxes in order to study the characteristics of materials - both on the surface and in depth. The general principles of formation and direction of electron and ion fluxes, the interaction of charged particles with the atoms and molecules of the studied substances are considered. The electron and ion methods for studying surfaces of materials are described. X-ray photoelectron spectroscopy, scanning and transmission electron microscopy, electron Auger spectroscopy, secondary ion mass spectroscopy, etc. are considered. Attention is also paid to the in-depth analysis of materials with fast ions and electrons. Ion microprobe, Rutherford ion backscattering and analysis using nuclear reactions, diffraction of high energy electrons are considered.

Pedagogical Methods: Educational literature, lectures illustrated with demonstrations, laboratory exercises with solving practical tasks.

RELATIVISTIC NUCLEAR PHYSICS

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/SS
ECTS credits: 5 credits
Status of the Subject: Elective course

Department: Mathematics and Physics

Subject Description: The discipline contains material from classical relativistic mechanics and electrodynamics, reviewing and extending some elements from bachelor's education level. The discipline contains material from relativistic quantum physics such as: fundamental interactions of elementary particles and their unifications, Feinman diagrams, accelerators, and others.

Specific Goals of the Subject: The course aims at giving fundamental knowledge in classical and quantum relativistic physics and to serve as a foundation for the future worker in the fields of astrophysics, accelerators and fundamental interactions.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: General knowledge in physics and theoretical physics.

Subsidiary Materials: Educational literature on Relativistic Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

RADIATION OF CHARGED PARTICLES

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/SS
ECTS credits: 5 credits
Status of the Subject: Elective course

Department: Mathematics and Physics

Subject Description: The material is selected in accordance with the prescribed workload and within a reasonable compromise between theoretical and applied material giving priority to applied side of issues. The mathematical apparatus is commensurate with the level of preparation of students in the Master's degree. From a methodological point of view the material is divided into parts, following the logical sequence of the physical fundamentals of atomic and quantum mechanical theory of the atomic nucleus and its radioactive decay, interaction of radiation with matter and others.

Specific Goals of the Subject: The students acquire knowledges required about Atomic and Nuclear Physics. Material is selected depending of the specificity of the speciality. For that reason some specific topics are presented which are not included in the Physics programme for non-physical students.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: General knowledge in physics and theoretical physics.

Subsidiary Materials: Educational literature on Relativistic Nuclear Physics.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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

PHYSICS OF COSMIC RAYS

Semester: 2 semester
Cours Tipe: Lectures and laboratory exercises
Hours per week/FS/SS: 2 lecture hours, 2 laboratory exercises hours per week/FS
ECTS credits: 5 credits
Status of the Subject: Elective course
Department: Mathematics and Physics

Subject Description: The discipline "Physics of cosmic rays" is optional for the specialty. The main objective of the course is to acquaint students with the contemporary theoretical ideas about the sources, the mechanisms of acceleration and propagation of the cosmic rays, as well as the basic experimental methods of cosmic ray exploration.

Specific Goals of the Subject: The aim of the course is to acquaint students with the basic processes of cosmic radiation physics, the problems of modern astrophysics, experimental methods, existing cosmic particle detectors, electromagnetic radiation, and neutrinos and gravitational radiation.

Pedagogical Methods: Lectures, laboratory, homework, tutorials

Preliminary Requirements: Basic knowledge in Atomic and Nuclear Physics and Mathematical Calculus.

Evaluation Method: Written examination. Some intermediate tests conduct through the semester.

Registration for the course: It is necessary to submit a request to Head of the Department at the end of the previous semester.

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