SPECIALITY: **PHYSICS**
MASTER PROGRAMME: **NUCLEAR AND PARTICLE PHYSICS**
EDUCATIONAL QUALIFICATION DEGREE: **MASTER**
PROFESSIONAL QUALIFICATION: **MASTER IN PHYSICS**
DURATION: **2 SEMESTERS**
FORM: **REGULAR**

Master program "Nuclear and Particle Physics" has a one-year duration for students graduated from bachelor programs in professional division Physics or bachelor programs Physics & Mathematics, Chemistry & Physics in professional division Pedagogy of Education in… and a two-year duration for students graduated from bachelor programs in other professional divisions.

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 microprocessors, computer architecture, computer modeling and WEB design, communication 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

First year

First semester	ECTS credits	Second semester	ECTS credits
Obligatory disciplines		**Obligatory disciplines**	
Theory of atomic nuclei	6	Computer modeling of physical processes	5
Particle Physics	6	Elective discipline group II	5
Visual programming	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	
Applied informatics		Electron and ion methods for material analysis	
Specialized foreign language preparation		Radiation of charged particles	
Radiation biophysics		Physics of cosmic rays	
		Philosophical problems of physics	
	Total 30		Total 30

TOTAL FOR ONE YEAR: 60 CREDITS

COURSES DESCRIPTION

THEORY OF ATOMIC NUCLEI

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

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

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: Praxis Assessments A & Written final exam upon the lecture course.
Rating: = 0,2.A + 0,8 (Exam)

PARTICLE PHYSICS

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

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

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.

VISUAL PROGRAMMING

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

University/Faculty/Department: SWU "Neofit Rilski", Blagoevgrad, Ivan Michailov 66/ Faculty of Natural Sciences &Mathematics

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.

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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, 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.

MODERN COMPUTER TECHNOLOGIES

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

Departments involved: Department of 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 (60 %) and from the current control (40 %).

References:

1. **Bangia, R.** Computer fundamentals and information technology. New Delhi: Firewall Media, 2008.
2. **Brookshear, G., D. Brylow.** Computer Science: An Overview (12th Edition). Boston, Pearson, 2014.
3. **Chapman N., J. Chapman.** Digital Multimedia. John Wiley & Sons Ltd., 2009.
4. **Elmasri, R., S. Navathe.** Fundamentals of Database Systems. Pearson, 2015.
5. **Laplante, P.** Encyclopedia of Computer Science and Technology. CRC Press, 2016.
6. Mano, M., C. Kime. Logic and computer design fundamentals. N. J., Pearson Prentice Hall, 2008.
7. **Ламбърт, Д., К. Фрай.** Microsoft Office 2019 – Step by Step. С., Алекс Софт, 2019.

APPLIED INFORMATICS

Semester: 1st semester
Type of Course: lectures and labs
Hours per week – 2 lectures + 2 labs per week
Credits Numbers: 6.0
Department: Informatics, Tel.: +359 73 8889 132
Course Status: Elective course from the physics Curriculum.
Course description: The course is providing basic knowledge in development of algorithms, their programming using particular programming language and running and testing of the programs under certain operation system. The structure and the main operational principles of the computer systems are given. The means and accuracy of information presentation are also considered. Some of the key classes of algorithms and data structures are studied. The main techniques of the structural approach of programming and their application using C++ programming language are introduced. The aim of the course is to teach the students with the techniques in development of algorithms and programs using C++ programming language.

Objectives:

Basic objectives and tasks:

- The students give knowledge for algorithm thinking;
- to give knowledge for Data structures, that can process with computer;
- to give knowledge for methods and skills in programming.
- to give knowledge for syntax of a program language (C++);
- to give knowledge for good style in programming;
- to give knowledge for basic principles when develop applications
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Methods of teaching: lectures, tutorials, projects, other methods

Pre- requirements: Basic knowledge in Mathematic.

Exam: Written examination and discussion at the end of the semester, individual tasks and the general student's work during the semester.

SPECIALIZED FOREIGN LANGUEGE PREPARATION

Semester: 1. (winter) semester
Course type: Seminars, out-of-class work
Hours per week: 4 seminar hours
ECTS credits: 6 credits

University/Faculty/Department: Sowthwest University "Neophit Rilsky", Blagoevgrad, 66 bul. Ivan Michailov, Science and Mathematics Faculty, Department of Physics

Statute of the discipline in the curriculum: Optional

Description of the discipline: The discipline "Specialized preparation in a foreign language" is constructed as a necessary component of the whole preparation of future physicists with a master degree. The course aims at broadening of the foreign language preparation by enriching it with general and special science vocabulary and showing the ways of its specific uses in different texts – abstracts, articles, announcements, monographs, textbooks in physics.

Course objectives: The main objective of the course is the students, to enrich their science vocabulary, to acquire some basic skills to comprehend and interprete different scientific texts, and to know how they are prepared.

Teaching methods: Seninars, individual student out-of-class work

Requirements/Prerequisites: Basic knowledge of English

Assessment: Permanent control, written test.

Registration for the course: It is necessary to apply in the administrative department during the previous semester

RADIATION BIOPHYSICS

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

Department: Physics Department

Course Status: Elective course in the Physics Science M.Sc. Curriculum

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: Praxis Assessments A & Written final exam upon the lecture course.
Rating: = 0,2.A + 0,8 (Exam)

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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.

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course
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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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

University/Faculty/Department: SWU "Neofit Rilsky"- Blagoevgrad; 66 Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

Status of the Subject: Elective course

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.

PHILOSOPHYCAL PROBLEMS OF PHYSICS

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

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

Annotation:

The course "Philosophical Problems of Physics" 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 "Philosophical Problems of Physics" is with total workload 60 hours, which includes 30 hours lectures and 30 hours seminars. The students' self-study is 90 hours.

Teaching on the course "Philosophical Problems of Physics" 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.

студентите да усвоят основни знания и да се формират у тях компетентности по темата.

Course content:

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

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 "Philosophical Problems of Physics" 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 %).

References:

1. **Гейзенберг, В.** Физика и философия. Часть и целое. М., Наука, 1989**.**
2. **Николов, А.** Към смяна на идеите във философията и физиката. С., Паралакс, 1999.
3. **Философия на науката. Антология.** С., ЛИК, 1999 (съст. С. Герджиков, К. Янакиев).
4. **Хокинг, С.** Кратка история на времето. От Големия взрив до черните дупки. С., Бард, 2016.
5. **Heisenberg, W**. Philosophical Problems of Quantum Physics. Ox Bow Press,1979.
6. **Mittelstaedt, P.** Philosophical Problems of Modern Physics. Holland, D. Reidel Publishing Company, 1976.