SPECIALITY: **PHYSICS**
MASTER PROGRAMME: **NUCLEAR AND PARTICLE PHYSICS**
EDUCATIONAL QUALIFICATION DEGREE: **MASTER**
PROFESSIONAL QUALIFICATION: **MASTER IN PHYSICS**
DURATION: **4 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** | |
| Applied mathematics | 12 | Molecular physics | 6 |
| Mathematical methods of physics | 6 | Optics | 6 |
| Mechanics | 6 | Atomic and nuclear physics | 6 |
| Electricity and magnetism | 6 | Astrophysics | 6 |
| | | Theoretical physics | 6 |
| | Total 30 | | Total 30 |

**Second year**

| Third semester | ECTS credits | Fourth 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 TWO YEARS: 120 CREDITS**

# COURSES DESCRIPTION

## Applied Mathematics

**ECTS credits:** 12 credits
**Hours per week: 3 lecture hours, 2 tutorial hours and 2 lab hours per week**
**Assissment method: Examination**
**Course Status: Obligatory**
**Semester:** I
**Department:** Informatics, telephone: 073 / 588 532, e-mail: stefm@swu.bg

**Course Description:** The course includes:

- basic **numerical methods** of Mathematical Analysis (approximation of functions by interpolation and the least suqres data fitting, numerical differentiation, numerical quadrature), of Algebra (solving nonlinear equations and systems of linear equations) and of Ordinary Differential equations (Cauchy problem for ordinary differential equations of I order and boundary problem for ordinary differential equations of order II);
- basic concepts and results of combinatorics and **Theory of Probability** (random events, probability, random variables, probability distributions, basic characteristics of random variables, basic results of theory of probability).

**Course Objectives:** Students should obtain basic knowledge about numerical methods and theory of probability and mathematical statistics.
**Teaching Methods:** lectures, tutorials and lab exercises
**Requirements/Prerequisites**: Mathematical Analysis, Linear Algebra, Analytic Geometry, Differential Equations.
**Assessment:** written final exam covering problems /omitted in case the average grade of two current problem tests is higher than Very Good 4.50/ (grade weight is 30 %) and theory on two topics (grade weight is 30 %); two homework (grade weight is 20 %) and two projects (grade weight is 20 %)
**Registration for the course:** not necessary
**Registration for the exam:** coordinated with the lecturer and Student Service Department

## Mathematical Methods in Physics

**ECTS credits:** 6.0
**Hours per week:** 2 Lectures + 1 Seminar
**Assessment:** exam
**Course Status:** Obligatory course
**Semester**: I
**Department of Physics**
**Faculty:** Natural Sciences & Mathematics

**Specific Goals of the Course:** the course aims at introducing some of the aspects of the theory of partial differential equations and the basis of vector and tensor analysis. The course focuses on physical aspect of basic mathematical notions and methods for the solving of important types of problems in order to clarify the possibility to practically apply the knowledge acquired in the course.

**Short Description:** Main topics to be considered:

- First degree partial differential equations
- Linear second degree partial differential equations from hyperbolic, parabolic and elliptic kind
- Wave equation, heat equation, Laplac's and Poisson's equations
- Vector and Tensor Analysis

**Pedagogical Methods and Assessment:**

The course includes lectures, seminars, consultations, course assignments and tests. Evaluation is made on the basis of term and final tests based on the contents of the lectures and the seminars. Only students who have positive evaluation mark on the term tests are allowed to take the final test. The students with high term evaluation marks varying between 5.00 and 5.50 only have to take theoretical exam, those who have term evaluation mark between 5.50 - 6.00 do not have to take the final exam and are given an excellent final mark for the course. The course grade (CG) is only assigned to students who have passed successfully and with a positive marks both their term and final tests. The final course grade is calculated with the help of the following formula:

CG = 0.6 X Term test results + 0.4 X Final test result

## Mechanics

**ECTS credits:** 6.0
**Hours per week:** 2 Lectures + 1 Lab.
**Assessment:** exam
**Course Status:** Obligatory course
**Semester**: I
**Department of Physics**
**Faculty:** Natural Sciences & Mathematics

**Subject Description:**

The course considers classical mechanics phenomena. It starts with kinematics and dynamics of point particle and system of point particles. The Newtonian principles of dynamics are considered in details. Particular attention is paid to motion in inertial and noninertial frames of reference, laws of conservation of energy and momentum, gravitation, such phenomena as mechanics harmonic oscillatory motions and waves. In addition the basic principles of the special theory of relatively and fluids mechanics are present.

**Specific Goals of the Subject:**

The university course “Mechanics” is aimed to ensure basic knowledge on mechanics phenomena as a foundation of the physics. Receiving this grounding the students are getting ready for others special courses studying during the next years. Laboratory classes give the students practical skills for physics observations.

**Pedagogical Methods:** Lectures are visualized by demonstrations. During the seminar classes students solve varied problems on optics. Parts of topics with practical importance are directed to the laboratory classes.

**Preliminary Requirements:** Basic knowledge in Physics and Mathematics.

**Subsidiary Materials:** Educational literature on General and Applied Physics and printed materials on the topics given by lecturer.

**Evaluation Method:** Written examination and additional conversation with the lecturer upon course topics. Some intermediate tests conduct through the semester.

**Inscribing for tuition:** Not necessary.

**Inscribing for exam:** Agreement with the lecturer.

## Electricity and Magnetism

**ECTS credits:** 6.0
**Hours per week:** 2 Lec/ 1 Lab
**Assessment:** exam
**Course Status:** Obligatory course
**Semester**: I
**University/Faculty/Department:** SWU "Neofit Rilsky"-Blagoevgrad; 66, Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

**Subject Description:** The course considers the general laws of electrical and magnetic phenomena. The first part studies basic laws of electrical phenomena such as electromotive force, electric fields, electrical potential, Gauss law, dielectrics and metals in electrical field, conductors, and electrical current. The second part considers magnetic phenomena and includes field of moving charge, electrical dipole, magnetic forces, electromagnetic induction, and magnetic properties of mater. The third section concern questions of movement of the electrical parts in electric and magnetic fields.

**Specific Goals of the Subject:** Students acquire knowledge about Electromagnetism, Optics, Quantum Mechanics, Modern Atomic and Nuclear Physics. Material is selected depending of the specificity of the speciality. For that reason some specific topics are presented in details. Parts of topics with practical importance are directed to the laboratory classes.

**Pedagogical Methods:** Lectures are visualized by demonstrations and laboratory tasks performance during the laboratory classes. From methods point of view teaching material is grouped in sections following logical consistency of the cause.

**Preliminary Requirements:** Basic knowledge in Physics and Mathematics.

**Subsidiary Materials:** Educational literature on General and Applied Physics and printed materials on the topics given by lecturer.
**Evaluation Method:** Final examination in written form and subsequent conversation with the lecturer. Some intermediate tests conduct through the semester.

**Inscribing for tuition:** Not necessary.

**Inscribing for exam:** Agreement with the lecturer.

## Molecular physics

**ECTS credits:** 6.0
**Hours per week:** 2 Lectures + 1 Lab.
**Assessment:** exam
**Course Status:** Obligatory course
**Semester**: II
**Department of Physics**
**Faculty:** Natural Sciences & Mathematics

**Subject Description:** The course is basic in the physical education and has two parts in the general physics – thermodynamics and molecular physics. They continues one semester and ends with an examination. The course combines the fondation of the reversible thermodynamics, statistical and thermodynamical treatment of its basic values, surface tension, viscosity difusion, physical acustics and elements of nonreversible thermodynamics.

**Specific Goals of the Subject:** The course gives to the students minimal knowledge required about the basic macroscopic physical phenomena in the region of the thermodynamics and molecular physics. The pracrical appliation of the knowledges is the object of treatment in the seminars and laboratory.

**Pedagogical Methods:** Lectures visualized by physical demonstrations, seminars with decision of physical problems, laboratory classes. Some of the lectures are in a multimedia form.

**Preliniuary Requirements:** Basic Knowledge in mathematical analysis.

**Subsidiary Materials:** Educational literature on general physics (parts molecular physics and thermodynamics), printed materials on the some topics, given wy the lectures to the students.

**Evaluation Methods:** Every part ends with written and oral examination. The results from the test examination during lectures, seminars and laboratory take place in the full evaluation.

**Inscribing for tuition:** Not necessary.

**Inscribing for exam:** Agreement with the lecturer.

**Note:** The lecture course is convenient for Students of Physical, Chemistry and other natural and technical sciences.

## Optics

**ECTS credits:** 6.0
**Hours per week:** 2 Lec/ 1 Lab
**Assessment:** exam
**Course Status:** Obligatory course
**Semester**: II
**University/Faculty/Department:** SWU "Neofit Rilsky"-Blagoevgrad; 66, Ivan Mihailov Blvd./ Natural Sciences & Mathematics/ Physics

**Subject Description:** The course considers optics phenomena on the base of theory of electromagnetic wave propagation. It starts with Maxwell's equations and describes the general

properties of the light waves. Particular attention is paid to such phenomena as refraction on the dielectric and metal surface, total internal refraction. Important part of the course is the consideration of the interference and the diffraction of the light, some types of interferometers and principles of the working of diffractive gratings. In addition the basic principles of geometric optics are present**.**

**Specific Goals of the Subject:** Students acquire knowledge about general phenomena and laws of light wave propagation. The course gives a base for others special courses such as Quantum electronics and Optical communication.

**Pedagogical Methods:** Lectures are visualized by demonstrations. During the seminar classes students solve varied problems on optics. Parts of topics with practical importance are directed to the laboratory classes.

**Preliminary Requirements:** Basic knowledge in Physics and Mathematics.

**Subsidiary Materials:** Educational literature on General and Applied Physics and printed materials on the topics given by lecturer.

**Evaluation Method:** Written examination and additional conversation with the lecturer upon course topics. Some intermediate tests conduct through the semester.

**Inscribing for tuition:** Not necessary.

**Inscribing for exam:** Agreement with the lecturer.

**Note:** The lecture course is suitable for students of all natural and technical sciences.

## Atomic and Nuclear Physics

**Course Title:** Atomic and Nuclear Physics
**Semester**: II
**Type of presentation**: Lectures / Laboratory classes
**Hours per week / AS / SS**: 2 Lecture hours / 1 Laboratory hour / SS
**ECTS credits**: 6
**Department**: Physics Department
**Course Status**: Compulsory course in the Physics M.Sc. Curriculum.

**Short Description**: Introduction to Atomic and Molecular Physics. Structure and Models of the Atom. Hydrogen Atom. Interaction of Atoms with Electromagnetic Radiation, External Electric and Magnetic Fields. Zeeman Effect. Intermolecular Interactions. Basic concepts of Nuclear Physics. Nuclear structure. Nuclear Forces. Isotopic Spin. Parity Violation, Neutron- Proton diagrams. Radiation $\alpha$, $\beta$ and $\gamma$. Nuclear models. Nuclear reactions. Neutron Physics. Fission. Fusion. Nuclear reactors. Basic concepts of Radiation Safety. Elementary particles.

**Course Aims**: The students acquire basic 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 nonphysical students.

**Teaching Methods**: Lectures are visualised by demonstrations and laboratory tasks performance during the laboratory classes. Exercises and case studies are decided at seminars. From methods point of view teaching material is grouped in sections by logical consistency from Structure of Atoms and Atomic and Nuclear Models to Nuclear Physics. Practical topics are directed to the laboratory classes.

**Requirements / Prerequisites**: Basic knowledge in General Physics and Mathematics.

**Evaluation Method**: Defence of the Labs Protocols L; Two intermediate tests $K_1$ and $K_2$ conduct through the semester; Written final exam upon the lecture course.

**Rating:** = 0,2.L + 0,2. ($K_1$ + $K_2$)/2 + 0,6 (Exam)

**Inscribing for tuition:** Not necessary.

**Inscribing for exam:** Agreement with the lecturer and the Students Service Department

## Asrtophysics

**ECTS credits:** 6 credits
**Hours per week: 2 lecture hours, 1 seminar hours**
**Assissment method: Examination Course Status:** Compulsory subject
**Semester:** II
**Methodical leadership:**Department of Physics; Faculty of Natural Sciences &Mathematics

**Annotation:**

The course "Astrophysics" has the task to acquaint the students with the basic methods and results in the nowadays astrophysics and gamma-astronomy of the ultra high energies and space physics. This is a new branch of the science, developed on the boundary between astronomy, cosmic rays physics and high and ultra high energy physics. Large scale detector complexes constructed on the base of scintillation, gas filled and cerenkov detectors, connected with complex logic and registering the data in real time are used.

A particular attention to the methods of mathematical modeling of electron-photon and photon-nuclear cascades and extensive air showers which are the main information carrier is given. The requested parameters and characteristics of the primary flux are estimated by solving complex inverse tasks with the help of modern mathematical methods. The energy spectrum and the nuclear composition of the primary cosmic rays flux and its connection with the structure of the Universe and the processes going in it are analyzed. A number of active astrophysical objects as local sources of primary gamma quanta, their photon spectrum and possible models, explaining the intensity and the time dependencies of the registered fluxes are examined.

As a whole the course "Astrophysics" should give the students a concept for the experimental technique and mathematical methods used in the present-days high-technology astrophysical complexes, to acquaint them with the actual problems and connections between the processes in the micro and macro space and with the modern ideas about the structure of the Universe ant the processes in it.

**Course contents:**
**Lectures**
Origin of the modern astrophysics and high energy gamma astronomy.

Universe, structure and basic processes in it.
Final stages in the evolution of stars.
Elementary interactions.
Strong interactions.
Electromagnetic cascade theory.
Nuclear cascade process.
Mathematical modeling of EAS.
Nuclear composition of primary cosmic rays flux.
Energy spectrum of primary cosmic rays flux.
EAS initiated by primary gamma quanta.
Cherenkov gamma telescopes.
Gamma quanta from compact extragalactic sources.

**Teaching Methods and Assessment:**
Two homeworks (marks D1, D2) and two written tests (marks K1, K2) are rated for continuous assessment during the semester. Only students with average rating from the continuous assessment greater than 3 are allowed to go on a examination. The mark at the terminal examination (Exam) has the main weight in the final rating.

**Rating =** *0,05 .(D1 + D2 )/2 + 0,15 .(K1 + K2 )/2 + 0,8 (Exam)*

**Registration for the Course**: by request at the end of the current semester (when is not obligatory course).

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

Final grade calculation is done by using a 6-point rating scale: the rating 6 equals level A on ECTS; the rating 5 equals level B on ECTS; the rating 4 equals level C on ECTS; the rating 3 equals level D on ECTS; the rating 2 equals level E on ECTS.

## Theoretical physics

**Semester**: 2 semester
**Cours Tipe**: Lectures and tutorials
**Hours per week/FS/SS**: 2 lecture hours, 1 tutorial hours per week/SS
**ECTS credits**: 6 credits
**Department**: Department of Physics
**Course Status**: Obligatory course in the B.S. Curriculum of physics

**Short Description**:
The course deals with standard material of theoretical physics from the following areas: mechanics, electrodynamics, quantum mechanics, statistical physics and thermodynamics but adapted to students with a serious mathematical background who have not graduated a bachelor course in physics.

**Course Aims**: The course aims at giving fundamentals knowledge in theoretical Physics and to serve as a foundation for courses in theoretical physics, quantum electronics, astrophysics and other special courses.

**Teaching Methods**: lectures, tutorials, individual student's work

**Requirements/Prerequisites**: General knowledge in mathematical Analysis

**Assessment** Current evaluation at seminars and final written examination with discussion upon the end of the course.

**Registration for the Course**: by request at the end of the current semester (when is not obligatory course).

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

## THEORY OF ATOMIC NUCLEI

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

**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:** III

**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.

**Note:** The lecture course could be suitable for students of other natural sciences

## NUCLEAR REACTIONS WITH HEAVY IONS

**Semester:** 3 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:** III

**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**: 3 semester
**Type of Course**: lectures and labs
**Hours per week** – 2 lectures + 2 labs per week
**Credits Numbers:** 6.0
**Department:** Informatics
**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
-

**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**: 3. (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:** III
**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:** 4 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:** 4 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:** 4 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:** 4 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:** 4 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
**Weekly workload:** 2 + 2 + 0
**Form of assessment:** Written exam
**Statute of the course:** Elective
**Semester:** IV

**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.

**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.