



SOFIA UNIVERSITY ST. KLIMENY OHRIDSKI

FACULTY: Physics

CURRICULUM

Approved by:

Approved by the Academic Council with Record of Proceedings
№ /

Professional Field: 4.1 Physical Sciences

Educational and Qualification Degree: Bachelor of Physics

Bachelor's Degree Program: Quantum, Nuclear and Particle Physics
(in English)

P	H	H	1	2	0	1	2	4
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Form of Study: full time
Length of Study: 8 semesters

Professional Qualification: Bachelor of Physics (specialty Quantum, Nuclear and Particle Physics)

Qualification Description

Bachelor's Degree Program: *Quantum, Nuclear and Particle Physics*

1. Aims and Educational Objectives

The programme of Quantum, Nuclear and Particle Physics (QNPP) comprises courses related to studies of matter at the atomic and subatomic level, and to the application of physical methods developed in other areas of physics and engineering. The programme provides the students with specific expertise allowing for immediate employment in the corporate research world or in government laboratories, or for further graduate study. Students obtain a solid physics background and significant experience in computational science, quantum physics, physics of elementary particles and fundamental and applied nuclear physics, dosimetry of ionizing radiation, radioecology, particle accelerators and their applications. The education is entirely in English. The training methods are based on modern information technologies that rely on the well-developed educational infrastructure of the Sofia University. Workload allows students to perform scientific research in one of the research groups at the Department of Atomic Physics and the Department of Theoretical Physics from the beginning of their training.

2. Admission requirements

The programme is open to citizens of countries from the European Union (EU, including Bulgarian citizens) as well as to citizens of countries outside the EU.

The EU and Bulgarian citizens are admitted according to the general rules of the St. Kliment Ohridski University of Sofia available at: https://www.uni-sofia.bg/index.php/eng/admission/international_students/application_procedure/applicants_from_eu_member_countries

The candidates from non-EU member countries must comply with the general rules for admission in the St. Kliment Ohridski University of Sofia as foreign students available at:

http://www.uni-sofia.bg/index.php/eng/admission/international_students/applicants_from_non_eu_member_countries

In addition to the general requirements, they must provide a grade in physics from the high-school diploma and an internationally recognized certificate in English corresponding to the Level B1 or higher according to the Common European Framework of Reference for Languages.

3. Description of the educational content (knowledge and skills required for a successful professional realization; general and theoretical background, specific areas of study, etc.)

To perform their professional activities in accordance with the expectations the QNPP bachelors must be well educated and must possess practical skills in the following fields:

1. Mathematics and Information Technology - linear algebra and analytic geometry; analysis of functions of one or more variables; probability theory and mathematical statistics; vector, tensor and complex analysis; differential equations; basic computer skills, programming and computational physics; fundamentals of information technology including object-oriented programming and database architectures.
2. Physics - mechanics, molecular physics, electricity and magnetism, optics, atomic, nuclear, and elementary particle physics, thermodynamics and statistical physics, theoretical mechanics, electrodynamics, quantum mechanics, astrophysics and cosmology.
3. Special training in dosimetry and radiation protection, nuclear electronics, applications of the methods of mathematical statistics in the data analysis, computer simulation of physical processes, quantum informatics.

4. Professional and general competences, specific competences

QNPP bachelors can perform advanced research in all areas where the quantum physics plays a central role. This includes both fundamental and applied research in quantum technologies, nuclear and particle physics, computer science and computational physics, dosimetry and radiation protection, and technological developments in nuclear engineering. QNPP bachelors can be involved in activities related to measurements and construction of detectors of ionizing and non-ionizing radiation, and radiation exposure assessment, including in emergency situations. QNPP bachelors can identify various radiological factors of natural and technogenic origin, can establish procedures for monitoring and evaluation of radiation risks, and can determine the mitigation criteria for implementation and use of new technologies.

5. Professional realization (according to the National Classification of Occupations in the Republic of Bulgaria /based on the International Standard Classification of Occupations (ISCO)/ and in reference to the place of the future specialists in the National Qualifications Framework for higher education and the European Qualifications Framework for higher education)

According to the National Classification of Occupations in the Republic of Bulgaria, bachelors who graduated from QNPP fall into the group of professions "physicists and astronomers", and the positions they can hold are in a wide range (physicist; physicist, atomic physics; physicist, physics of elementary particles; physicist, theoretical physics; physicist, radiation hygiene, etc.). According to the International Standard Classification of Occupations, the group of professions is the same - "physicists and astronomers", and the position is "physicist". According to the classifications of the National Qualifications Framework and the European Qualifications Framework for higher education, bachelor's degree holders at QNPP fall into Level 6.

QNPP bachelors hold a university bachelor's degree in physics and can work in research institutes and laboratories, universities, high-tech companies and enterprises, as well as in many state institutions where the respective knowledge and skills are relevant.

The acquired knowledge and skills allow them to develop a career in international research institutes such as the European Organization for Nuclear Research (CERN) in Geneva, the Joint Institute for Nuclear Research (JINR) in Dubna, near Moscow, European Space Agency (ESA) and others. Expanded training in computer science, electronics and applications of statistical methods in various fields enables the QNPP bachelor diploma holders to be employed in R&D departments in industrial, financial and statistical institutions.

The high and broad academic level of education in the program allows the QNPP bachelors to continue their education in MSc and PhD programs in well-recognized universities all over the world.

PHH 1 2 0 1
Program code

Bachelor's Degree Program "Quantum, Nuclear and Particle Physics"

admission winter semester of 2024/2025 academic year

№	Course Code	Course Title	Type- C, E, O	Semester	ECTS credits	Classes - total number					Classes per week	Assessment* - e, ca, ce, cont.
						Total	Lectures	Seminars	Practical Classes/ Observation	Self study		
1	2	3	4	5	6	7	8	9	10	11	12	13

Core Subjects

1	H	2	3	8	Linear Algebra and Analytical Geometry	C	1	8	240	60	60	0	120	4+4+0	E
2	H	2	3	9	Calculus of a Function of a Single Real Variable	C	1	8	240	60	60	0	120	4+4+0	E
3	H	2	3	0	Mechanics	C	1	10	300	45	30	45	180	3+2+3	E
4	H	2	4	1	Programming in Unix Environment	C	1	4	120	30	0	30	60	2+0+2	CE
5	H	2	4	2	Calculus of a Function of Several Real Variables	C	2	8	240	60	60	0	120	4+4+0	E
6	H	2	4	3	Calculus of Complex Functions	C	2	4	120	30	30	0	60	2+2+0	E
7	H	2	4	4	Probability and Statistics in Physics	C	2	4	120	30	0	30	60	2+0+2	E
8	H	2	4	5	Molecular Physics	C	2	9	270	30	30	45	165	2+2+3	E
9	H	2	4	6	Object-oriented Programming	C	2	5	150	45	30	0	75	3+2+0	CE
10	H	2	4	7	Vectors and Tensors	C	3	5	150	30	30	0	90	2+2+0	E
11	H	2	4	8	Ordinary Differential Equations	C	3	5	150	30	30	0	90	2+2+0	E
12	H	2	4	9	Electricity and Magnetism	C	3	10	300	60	30	45	165	4+2+3	E
13	H	2	5	0	Basics of Electronics	C	3	6	180	30	0	45	105	2+0+3	E

form of assessment:
e-exam, ca-current assessment
ce-combined examination
cont.- continues in the next semester

By decision of the Faculty Council, the ratio of in-class to out-of-class engagement for students is 1:1.

14	H	2	5	1	Partial Differential Equations	C	4	4	120	30	30	0	60	2+2+0	E
15	H	2	5	2	Theoretical Mechanics	C	4	6.5	195	60	30	0	105	4+2+0	E
16	H	2	5	3	Optics	C	4	9.5	285	60	15	45	165	4+1+3	E
17	H	2	5	4	Programming and Computational Physics	C	4	4	120	30	0	30	60	2+0+2	E
18	H	2	5	5	Atomic Physics and Interaction of Ionizing Radiation with Matter	C	5	10	300	45	30	45	180	3+2+3	E
19	H	2	5	6	Electrodynamics	C	5	6	180	60	30	0	90	4+2+0	E
20	H	2	5	7	Basic Quantum Mechanics	C	5	6	180	60	30	0	90	4+2+0	E
21	H	2	5	8	Nuclear Physics	C	6	9.5	285	45	30	45	165	3+2+3	E
22	H	2	5	9	Advanced Quantum Mechanics	C	6	5.5	165	45	30	0	90	3+2+0	E
23	H	2	6	0	Nuclear Electronics	C	6	6	180	45	0	45	90	3+0+3	E
24	H	2	6	1	Detectors of Ionizing Radiation	C	6	5	150	30	30	0	90	2+2+0	E
25	H	2	6	2	Thermodynamics and Statistical Physics	C	7	7	210	60	30	0	120	4+2+0	E
26	H	2	6	3	Introduction to Particle Physics	C	7	7.5	225	45	30	30	120	3+2+2	E
27	H	2	6	4	Astrophysics	C	7	4	120	45	15	0	60	3+1+0	E
28	H	2	6	5	Dosimetry and Radiation Protection	C	7	7.5	225	45	0	60	120	3+0+4	E
29	H	2	6	6	Advanced Particle Physics	C	8	5	150	45	30	0	75	3+2+0	E
30	H	2	6	7	Theoretical Nuclear Physics	C	8	5	150	45	30	0	75	3+2+0	E
31	H	2	6	8	Experimental Nuclear Physics	C	8	6	180	45	0	45	90	3+0+3	E

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ce-combined examination
cont.- continues in the next semester

Elective courses - Students may enroll in elective courses from the attached list, or from the general list of elective courses in English for The Faculty of Physics or from the mandatory specialized courses in English for other specialties in the Faculty of Physics. The electable disciplines must carry a minimum of 4 credits in the 3th semester, a minimum of 6 credits in the 4th semester, a minimum of 8 credits in the 5th semester, a minimum of 4 credits in the 6th semester, a minimum of 4 credits in the 7th semester and a minimum of 4 credits in the 8th semester.

1	H	2	6	9	Introduction to Machine Learning	E	3 or 5	4	120	30	0	30	60	2+0+2	CE
2	H	2	7	0	Data Analysis	E	3 or 5	4	120	30	0	30	60	2+0+2	CE
3	H	2	7	1	Relativistic Mechanics	E	4 or 6	4	120	30	0	30	60	2+0+2	E
4	H	2	7	2	Data Bases	E	4	4	120	30	0	30	60	2+0+2	E
5	H	2	7	3	Functional Analysis	E	4	3	90	45	0	0	45	3+0+0	E
6	H	2	7	4	Physical Applications of the Group Theory	E	5 or 7	5	150	45	30	0	75	3+2+0	E
7	H	2	7	5	General Astronomy	E	5	4	120	30	0	30	60	2+0+2	CE
8	H	2	7	6	Nuclear Reactions	E	6	4	120	45	0	0	75	3+0+0	E
9	H	2	7	7	Nuclear Astrophysics	E	6	4.5	135	45	15	0	75	3+1+0	CE
10	H	2	7	8	Introduction to Monte Carlo Simulations of Radiation Transport	E	6	4.5	135	30	0	30	75	2+0+2	CE
11	H	2	7	9	Gravitation	E	6 or 8	4	120	30	30	0	60	2+2+0	E
12	H	2	8	0	Introduction to Quantum Field Theory	E	7	6	180	45	30	0	105	3+2+0	E
13	H	2	8	1	Introduction to Quantum Technologies	E	7	5	150	45	30	0	75	3+2+0	E
14	H	2	8	2	Particle Accelerators	E	7	4	120	45	15	0	60	3+1+0	E
15	H	2	8	3	Cosmology and Elementary Particles	E	8	4	120	45	15	0	60	3+1+0	CE
16	H	2	8	4	Nuclear Symmetries	E	8	5	150	45	0	30	75	3+0+2	E
17	H	2	8	5	Quantum Computation	E	8	5	150	45	0	30	75	3+0+2	CE
18	H	2	8	6	Quantum Simulations and Quantum Metrology	E	8	5	150	45	0	30	75	3+0+2	CE

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ce-combined examination
cont.- continues in the next semester

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Optional courses - Sports classes are compulsory in the first four semesters

1	H	1	5	3	Sport	O	1 - 8	1	30	0	30				CE
2	H	1	5	8	Bulgarian language as a foreign language I	O	1	4	120	0	60	0	60	0+4+0	CE
3	H	1	5	9	Bulgarian language as a foreign language II	O	2	4	120	0	60	0	60	0+4+0	CE
4	H	1	6	0	Bulgarian language as a foreign language III	O	3	4	120	0	60	0	60	0+4+0	CE
5	H	1	6	1	Bulgarian language as a foreign language IV	O	4	4	120	0	60	0	60	0+4+0	CE

Degree Completion

Form of degree completion	ECTS credits	First State Exam Session	Second State Exam Session
Defence of a Diploma thesis	10	July	September

The curriculum has been approved by the Faculty Council, Record of Proceedings № 17 from 12.12.2023

DEAN:.....

By decision of the Faculty Council, the ratio of in-class to out-of-class engagement for students is 1:1.

form of assessment:
 e-exam, ca-current assessment
 ce-combined examination
 cont.- continues in the next semester