SOFIA UNIVERSITY ST. KLIMENY OHRIDSKI

FACULTY: Physics

C U R R I C U L U M

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

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

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

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

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

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

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

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

Sofia University "St. Kliment Ohridski"

Curriculum Reference Statement

Bachelor's degree Program **"Quantum, Nuclear and Particle Physics"**
form of study **full time**, length of study **8 semesters**

Course hours, ECTS credits and number of grades per semester

Type of courses	I			II			III			IV			V			VI			VII			VIII			Total		
	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades	course hours	ECTS credits	number of grades
compulsory courses	**420**	**30**	**4**	**420**	**30**	**5**	**330**	**26**	**4**	**330**	**24**	**4**	**300**	**22**	**3**	**345**	**26**	**4**	**360**	**26**	**4**	**240**	**16**	**3**	**2745**	**200**	**31**
min. elective courses							**30**	**4**	**1**	**45**	**6**	**1**	**60**	**8**	**2**	**30**	**4**	**1**	**30**	**4**	**1**	**30**	**4**	**1**	**225**	**30**	**7**
optional courses	**30**	**1**	**0**	**30**	**1**	**0**	**30**	**1**	**0**	**30**	**1**	**1**													**120**	**4**	**1**
internships																											
Total:	**420**	**30**	**4**	**420**	**30**	**5**	**360**	**30**	**5**	**375**	**30**	**5**	**360**	**30**	**5**	**375**	**30**	**5**	**390**	**30**	**5**	**270**	**20**	**4**	**2970**	**230**	**38**

Form of degree completion	ECTS credits	Study Hours	First State Exam session	Second State Exam Session
Defence of a Diploma thesis	10	300	July	September

Acquired Professional Qualification: Bachelor of Physics in Quantum, Nuclear and Particle Physics

Record of Proceedings of the Faculty Council № 17 from 12.12.2023 **Dean**