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I. DESCRIPTION OF STUDY PROGRAMME FORM

BASIC INFORMATION	
Title of study programme	**Physics**
Study programme coordinator	**University of Rijeka - Department of Physics**
Study programme implementor	Department of Physics, University of Rijeka (*Study programme coordinator*) Department of Mathematics, University of Rijeka Department of Informatics, University of Rijeka Department of Biotechnology, University of Rijeka Faculty of Arts and Sciences in Rijeka
Type of study programme	university
Level of study programme	undergraduate
Academic/professional degree awarded upon completion of study	**Bachelor of Physics**

1. INTRODUCTION

1.1 Reasons for launching the study programme

To keep up with the fast development in science and technology there is an increased demand for science graduates. The proposed study programme is based on the 45-years long tradition of teacher training in natural sciences and mathematics at the University of Rijeka and on the recent strategy of University of Rijeka which has been emphasising a need for expanding R&D capacities of the Department of Physics. We are committed to our mission to educate a new generation of bachelors that will be equipped with the functional knowledge that will enable them to adapt to demanding future needs of industry and educational institutions.

Within the first three years of undergraduate studies students will be acquainted with the fundamental laws of physics as well as with the supportive sciences such as mathematics and computer science. By introducing a number of problem solving subjects, students will be encouraged to think creatively. To make the physics course attractive to a wider range of interests, in frame of five different optional subjects (*Physics, Environmental science, Mathematics, Computer science* and *Philosophy*), starting from the second year of study, a large number of elective courses are offered. With such a wide choice of subjects we expect an increased interest for physics studies.
After having finished this undergraduate study programme, the students are expected to be able to work effectively in educational and R&D institutions and laboratories as well as in the industry, banks, etc.

Optional subject ***Physics*****:** within this option, students will focus on theoretical and experimental aspects of physics. This option will prepare students for R&D work either locally or in the international arena.

Optional subject ***Environmental science*****:** beside being trained in fundamental physics, students will be acquainted with the basic principles of biology, chemistry, geology and ecology. With these basic skills and knowledge students will be ready to take up jobs like laboratory analysis and data processing in various laboratories, or inspection and controlling service in government offices. The need for this profile was expressed by our County officials. The County is willing to support this initiative as well as by suggesting the course curriculum depending on the future market needs.

Within the three optional subjects, ***Mathematics, Computer science*** and ***Philosophy***, students may choose *teacher training* elective courses. This option within the undergraduate study program, beeing a preparatory step in education of primary and secondary school teachers of physics and related subjects, is particularly significant because the physics teachers are scarce, and it is estimated that this deficit will be even more pronounced in the future.

Instead of teacher training elective courses, students can choose specialised courses, either in mathematics or in computer science or in philosophy, which will make them even more suitable for the current market demands, already existing in Europe and rising in Croatia. For a large number of jobs, like programmers and web site developers in IT oriented SME-s, bachelors with three years of university education are quite adequate.

Once the first three years of undergraduate studies are completed, more ambitious students will be offered two more years of graduate studies covering educational, research and engineering fields. At present, at the University of Rijeka, it is possible to enroll the graduate study programmes in teacher training (*Physics and mathematics, Physics and computer science*) as well as in engineering (*Engineering and physics of materials*).
In addition, new research graduate study programmes (*Physics, Physics and Evironmental Science*) and a teacher training programme (*Physics and Philosophy*) are in preparation.
All in all, students will have a wide choice of subjects to select from. Once they graduate, they will be equipped with the functional knowledge that will enable them for life-long learning, give them the highest possible mobility to work in the challenging new environment.

1.2 Evaluation of purposefulness in respect to the market needs in public and private sector

Demand for bachelors in the labor market in Croatia is still building up. Although the european experience shows that the general acceptance of bachelors is a relatively long process, we expect an evidence of increasing interest for our graduates in real time. Once their competencies are recognized by local government institutions and SMEs, we believe them to find employment as associates in educational institutions at all levels, laboratories, inspectorates and government offices, IT industry, as coordinators of production processes and social activities, etc.

We estimate the purposefulness of the proposed undergraduate programme high. The proposed programme insures that bachelors will gain knowledge and skills not only in natural science, but also social and humanities. The ability of logical thinking, of independent problem solving and of linking different contents make the bachelors adequate for employment in industry, public and private sector.

1.2.1.Connection with the local community (economy, entrepreneurship, civil society)

The demand for such profiles has been expressed by the local community and by the University of Rijeka as science and education center of the region. The Primorsko-goranska County expressed its interest for multidisciplinary specialists, especially in environmental science, so we expect their corresponding support.

1.2.2.Compliance with professional association's requirements (recommendations)

The proposed undergraduate programme agrees with the demands, recommendations and strategy of the relevant organizations such as: Croatian Physical Society, Mathematical and Physical Society of Rijeka, Golden Section. The multidisciplinary orientation, being the world wide trend, is belived to be attractive to students.

1.2.3. Name possible partners outside higher education system that showed interest in the study programme

Primorsko-goranska County, City of Rijeka.

1.3 Comparability of the study programme with similar programmes of accredited higher education institutions in the Republic of Croatia and the EU (name and explain comparability of the proposed programme with two programmes, whereas at least one of which should be from the EU (provide their web sites))

The concept of the proposed undergraduate studies in physics is similar to the corresponding programme of the Faculty of Mathematics and physics in Ljubljana (http://www.fmf.uni-lj.si), which also has different options at the undergraduate level (general physics, astronomy, education). In both programmes there is a number of courses common to all options, courses specific to each particular option, and a certain number of elective courses. An advantage of our undergraduate study programme relative to Ljubljana is greater number of options. Furthermore, unlike Ljubljana, where the choice has to be made at the beginning of the study, we offer the possibility of choice from the second year of study to give the students more time to make their decision.

Our undergraduate program is similar to the corresponding ones from two other croatian universities in Osijek and Split. Although their programs do not offer different options, they, in particular in Split, allow refined differentiation in the third (last) year of the undergraduate study. The core of all mentioned undergraduate studies consisting of courses in physics, mathematics and computer science, is almost identical. Note that our programme offers a greater number of courses in each particular optional subject.

During the preparation of the program we used the curricula of several croatian and foreign universities:
Osijek: http://www.fizika.unios.hr/
Split: http://fizika.pmfst.hr/
Zagreb: http://www.phy.hr
Maribor (Slovenia): http://www.fizika.uni-mb.si/
Bochum (Germany): http://physik.ruhr-uni-bochum.de/
Bath (UK): http://www.bath.ac.uk/physics/
Prag (Chech Republic): http://www.mff.cuni.cz/
Buffalo (USA): http://electron.physics.buffalo.edu/

1.4. Openness of the study programme towards horizontal and vertical mobility of students within national and international higher education area

Students choose the optional subject in the second year. During the undergraduate study it is possibile to change the selected option or to enroll additional courses from other optional subjects. In order to enroll a particular course, account should be taken of prerequisites defined in the course programme. The conditions of transition to a corresponding undergraduate programme at another university is regulated by that university.
Upon completion of the proposed undergraduate study programme *Physics*, it is possible to enroll the graduate study programmes at the Department of Physics, University of Rijeka. Admission to similar and related graduate studies at other high educational institutions in Croatia and beyond, is regulated by the relevant institutions.

1.5. Alignment with the Mission and the Strategy of the University of Rijeka

One of the goals of the University of Rijeka is to create flexible academic profiles at all three levels of university studies, in agreement with the needs of the community, economy and society development. The number and wide range of optional subjects represents the starting point of such education.
In addition, such study represents the indispensable teaching basis for the realization of the scientific-research mission of the University. The study programme is expected to contribute to the implementation of the University in the economy and social development of the community.

1.6 .Institutional strategy for study programmes development

Implementation of the new study programme will significantly increase the quality of the scientific activities at the Department of Physics, which is one of the primary strategic goals of the Department. In addition, raising the quallity of the current teacher training programmes is in interest of the Department and of the wider community.

1.7. Other important data – according to the coordinator's opinion

The proposed undergraduate study programme consists of five optional subjects: ***Physics, Environmental Science, Mathematics, Computer science, Philosophy***. The options *Mathematics, Computer science* and *Philosophy* offer additionally a *teacher training orientation*.
Beside courses which are characteristic for each particular optional subject, the common core consists of the following physics and mathematic courses:
Analysis I, Analysis II, Linear Algebra I , Linear Algebra II, Physics I: Mechanics, Physics II: Electricity and Magnetism, Physics III: Waves and Optics, Physics IV: Thermodynamics and Basic Statistical Physics, Physics Laboratory I, Physics Laboratory II, Physics Laboratory III, Physics Laboratory IV, Modern Physics I, Modern Physics II, Classical Mechanics, Data Analysis, Programming, Methodology of Elaborating Professional and Scientific Papers, Undergraduate Thesis.
All options, except for mathematics, have additionally two coursec in comon: Mathematical Methods of Physics I and Mathematical Methods of Physics II.
Pedagogical and psychological courses implemented in this undergraduate study are a part of the teacher training curriculum adopted by the Commission of the Faculty of Arts and Sciences at the University of Rijeka, based on the recent reforms aiming to improve the quality of teaching.

2. GENERAL PART

2.1. Title of study programme

Physics

2.1.1. Type of study programme

university

2.1.2. Level of study programme

undergraduate

2.1.3. Area of study programme (scientific/artistic) – indicate the title

Natural sciences, the field of physics

2.2. Study programme coordinator

University of Rijeka - Department of Physics

2.3. Implementor/s of study programme

Department of Physics, University of Rijeka (*Study programme coordinator*)
Department of Mathematics, University of Rijeka
Department of Informatics, University of Rijeka
Department of Biotechnology, University of Rijeka
Faculty of Arts and Sciences in Rijeka

2.4. Duration of study programme (indicate possibilities of part-time study, long distance study)

Undergraduate study Physics takes 3 academic years, i.e., 6 semesters. The programme is primarily designed as a full-time study, with a possibility of part-time studying.

2.4.1. ECTS credits – minimal number of credits required for completion of study programme

Minimum number of ECTS credits required for completion of the undergraduate study programme is 180.

2.5. Enrolment requirements and selection procedure

Applicants who have completed a four-year secondary school and passed the state graduation exam can enroll the undergraduate study programme under valid conditions in agreement with law.

2.6. Study programme learning outcomes

2.6.1. Competences which student gains upon completion of study (according to CROQF (HKO): knowledge, skills and competences in a restricted sense –independence and responsibility)

General competences:

Students will be capable to:
-carry out precise measurement, display results in tables and graphs; perfom the statistical data analysis and interprete the results of the measurements; describe and explain the physical phenomena and processes related to specific measurements and discuss causal relationships in given subjects
- define and distinguish the basic concepts and principles of mechanics, heat, electricity, magnetism and optics, and apply them to solve numerical problems;
- define, distinguish and describe the basic concepts of modern physics and apply its laws to solve numerical problems;

Specific competences acoording to the choice of the optional subject:

Physics
- define, distinguish and describe the basic concepts of theoretical physics, of special branches of physics in the elective courses, to become familiar with the experimental methodology of scientific research in the real laboratory environment

Environmental science
- define and distinguish the basic concepts and principles of general, cellular and molecular biology; ecology; geology;
- define and distinguish the basic concepts and principles, derive and interpret the measurements in general, inorganic, organic and analytical chemistry.

Mathematics
- define and distinguish the basic concepts and principles of mathematical analysis, linear algebra, combinatorics, discrete and numerical mathematics, geometry, differential equations, Euclidean spaces, differential geometry and mathematical logic, and apply them to solve numerical problems

Computer science
- define and distinguish the basic concepts of analysis and data processing, programming, basics of digital techniques, dynamic web applications, architecture and computer organization, databases, operating systems, computer networks, algorithms and data structures

Philosophy
- define and distinguish the basic concepts of philosophy, ancient philosophy, ethics and epistemology, the basic concepts of aesthetics, the history of classical German idealism, logic, metaphysics, modern philosophy from Descartes to Kant

*Teacher training (*orientation within the optional subjects *Mathematics, Computer Science* and *Philosophy)*
- Define and distinguish the basic concepts of developmental psychology, psychology of learning and teaching, general pedagogy and didactics

2.6.2. Employment possibility (list of possible employers and compliance with professional association's requirements)

Bachelors of physics can be employed in research laboratories of commercial companies to work on development of advanced technologies (Ericsson Nikola Tesla). Further, thev might be included as collaborators in research institutes and high education institutions (Institute Ruđer Bošković, Institute of Physics, universities and high schools), in laboratories and departments of public health institutes. Due to their ability of analytical approach in solving problems, they could also find a job beyond the field of physics (for example, management).
Regarding the particular features of optional subjects, bachelors of physics can also be employed in chemical laboratories (DINA Petrochemical Inc., INA rafinery, public health institutes), in the IT sector, in the Institute of Philosophy, as assistants / teaching associates in primary and secondary schools, in the media (especially for scientific columns).

2.6.3. Possibility of continuation of study on higher level

Depending on the optional subjects and orientation of the undergraduate study, physics bachelors can continue their education in graduate programs of the Department of Physics, University of Rijeka:

- bachelors who have completed one of the teacher training orientation (*Mathematics, Computer Science, Philosophy*) can enroll either a corresponding graduate teacher training study programme (*Physics and Mathematics*, *Physics and Computer Science*) or the graduate study programme *Engineering and physics of materials*. In addition, bachelors who have completed the optional subject *Philosophy* can continue to study Philosophy at the Department of Philosophy at the Faculty of Arts and Sciences in Rijeka, without differential exams. Another possibility is expected to be the graduate study programme *Physics and philosophy* which is in preparation.

- bachelors who have completed the non-teaching optional subjects *Mathematics, Computer Science* and *Philosophy* can enroll either the graduate study programme *Engineering and physics of materials*, or, after passing differential exams in pedagogical and psychological courses, thes can enroll the corresponding graduate teacher training study programme (*Physics and Mathematics, Physics and Computer Science*). Another possibility is expected to be the graduate study programme *Physics and philosophy* which is in preparation. In addition, bachelors who have completed the optional subjects *Philosophy* can continue to study Philosophy at the Department of Philosophy at the Faculty of Arts and Sciences in Rijeka, without differential exams.

- bachelors who have completed the optional subjects *Environmental science* can enroll the graduate study programme *Engineering and physics of materials*. Another possibility is expected to be the graduate study programme *Physics and environmental science* which is in preparation.

- bachelors who have completed the optional subjects *Physics* can enroll the graduate study programme *Engineering and physics of materials*. Another possibility is expected to be graduate study programme *Physics* which is in preparation.

It is possible to enroll the graduate study programmes at the Department of Physics (at the University in Osijek) and at the Department of Physics at the Faculty of Science in Split, under specific conditions of each particular instution.
Also, students may pursue graduate studies abroad, if they fulfill specific enrollment conditions.

2.7. Upon applying for graduate studies list proposer's or other Croatian institution's undergraduate study programmes which enable enrolment to the proposed study programme
The proposed study is undergraduate university study.
2.8. Upon application of integrated studies - name reasons for integration of undergraduate and graduate level of study programme
The proposed study is not integrated.

3. PROGRAMME DESCRIPTION

3.1. List of compulsory and elective subjects and/or modules (if existing) with the number of active teaching hours required for their implementation and number of ECTS-credits (appendix: Table 1)
See page 8.
3.2. Description of each subject (appendix: Table 2)
Table 2. containing description of all courses in alphabetical order is given in Appendix 2 (page 38) In electronic form (CD), the tables with description of courses are assorted in directories according to the field (physics, mathematics, computer science, philosophy, enviroment, PPD – pedagogy, psychology, didactics, foreing language)
3.3. Structure of study programme, dynamic of study and students' obligations
Dynamic of study and students' obligations are determined by the Rulebook of studies at the University of Rijeka and by programmes of individual courses. The undergraduate study programme Physics consists of different optional subjects and orientations, as described in paragraphs 1.1. and 1.7. Students select an optional subject in the second year of study, but it is possible to change the optional subject by passing differential exames.
3.3.1. Enrolment requirements for the next semester or trimester (course title)
For the enrollment in the higher year of study, minimum of 18 ECTS credits is required (Rulebook of studies at the University of Rijeka). Conditions related to the enrollment of an individuale course, if existing, are given in the programme of the corresponding course.
3.4. List of courses and/or modules student can choose from other study programmes
The proposed undergraduate programme, with all its optional subjects and orientations, has such a complex structure, that inclusion of courses from other study programmes is not anticipated.
3.5. List of courses and/or modules that can be implemented in a foreign language (specify the language)
All courses coordinated by teachers from the Department of Physics can be held in english language, in agreement with the related teacher.
3.6. Allocated ECTS credits that enable national and international mobility
All ECTS credits that the student acquires during the study (30 ECTS credits per semester, a total of 180 ECTS for three years) allow the transfer to other universities in Croatia and abroad.
3.7. Multidisciplinarity/interdisciplinarity of study programme
According to its structure, the proposed study programme is based on principles of multidisciplinarity and interdisciplinarity. Courses in physics, mathematics, computer science, chemistry, biology, geology and ecology provide a good scientific basis. Teacher training orientation include courses in humanities and social sciences. The option *Philosophy* is a unique example of combination of the humanistic and natural sciences. The combination of physics with philosophy is unique in Croatia.

3.8. Mode of study programme completion

Undergraduate study programme *Physics* is completed by successful defense of the final thesis.

3.8.1. Conditions of approval of final work /thesis and/or final/thesis exam application

Students receive an approval of final exam after having passed all the exams of the undergraduate study and with completed thesis approved by the supervisor.

3.8.2. Composing and furnishing of final work/thesis

The student is obliged to choose the supervisor and the subject of the thesis at latest till the end of the fifth semester and complete it under the guidance of the supervisor during the last, sixth semesters of the undergraduate study. The thesis consists of theoretical and/or experimental part related to physics. The final form of the thesis should be in agreement with the Rulebook on final thesis at the Department of Physics, University of Rijeka.

3.8.3. Final work/thesis assessment procedure and evaluation and defense of final work/thesis

The supervisor is permanently supervising the work on the thesis. The thesis is defended during the final exam in front of a three-member commission. The procedure of the defence of the thesis is regulated by the Rulebook on final thesis at the Department of Physics, University of Rijeka.