MINISTER OF EDUCATION, SCIENCE AND SPORT OF THE REPUBLIC OF LITHUANIA

ORDER
ON APPROVAL OF THE DESCRIPTOR OF THE STUDY FIELD OF PHYSICS

16 November 2020 No. V-1767
Vilnius

In accordance with Paragraph 11 of Article 53 of the Law on Higher Education and Research of the Republic of Lithuania:

1. I approve the Descriptor of the Study Field of Physics (enclosed).

2. I determine that the higher education institutions have to adjust their study programmes to the Descriptor of the Study Field of Physics approved by Clause 1 hereby until 01 September 2021.

3. I recognize Order No. V-809 of the Minister of Education and Science of the Republic of Lithuania of 23 July 2015 “On Approval of the Descriptor of the Study Field of Physics” as invalid.

Minister of Education, Science and Sport at interim Algirdas Monkevičius

APPROVED
by Order No. V-1767 of the Minister of
Education, Science and Sport of the Republic
of Lithuania of 16 November 2020

DESCRIPTOR OF THE STUDY FIELD OF PHYSICS

CHAPTER I
GENERAL PROVISIONS

1. The Descriptor of the Study Field of Physics (hereinafter – Descriptor) regulates the special requirements for the study programmes in the study field of physics (C02) that belongs to the group of study fields of physical sciences (C). The Descriptor regulates the study field of physics in the scope not covered by the General Requirements for the Studies approved by Order No. V-1168 of the Minister of Education and Science of the Republic of Lithuania of 30 December 2016 "On approval of the General Requirements for the Studies."

2. The Descriptor was prepared in consideration of the recommendations of the European Physical Society for the study programmes of physics of the first and second cycles (European specification for physics bachelor studies, EPS Publications, 2009; European specification for physics master studies, EPS Publications, 2010).

3. The Descriptor's requirements shall be applied for university studies of the first cycle and second cycle in the field of physics conducted as full-time or part-time studies.

4. Upon completion of the studies in the field of physics, the bachelor's /master's degree in physical sciences that is in conformity with the sixth/seventh level of the Lithuanian Qualifications Framework and the European Qualifications Framework for lifelong learning, and first/second cycles of the Framework for Qualifications of the European Higher Education Area attested by the diploma of bachelor's/ master's degree in physical sciences and diploma supplement issued by the higher education institution.

5. The studies in the field of physics may also be provided as studies within the study programmes classified under two study fields and within interdisciplinary study programmes.

6. The volume of the studies in the field of physics in the study programmes of the first cycle in the field of pedagogy, where physics teachers are prepared, cannot be smaller than 90 credits, while the minimal volume of the studies in the field of physics in the programmes preparing teachers of natural science education cannot be below 60 credits.

7. There are no special requirements established in the Descriptor for the persons, who want to be admitted to the study programmes in the field of physics of the first cycle. The persons, who have the bachelor's degree and satisfy the entrance requirements established by the higher education institution, may be admitted to the study programmes of the second cycle; the persons, who have the professional bachelor's degree, have to complete the compensating for differences and/or bridging courses at university.

8. The main objective of the study field of physics is to provide comprehensive understanding about the physical principles of the universe, and to use them to develop critical thinking, reasoning skills, and to enable the students to assess physical problems, experimental and theoretical tasks creatively and critically.

9. Upon completion of the studies in the field of physics, the graduates will be able to apply knowledge of physics, mathematics and information technologies in their activities; they will be competent to perform research, to analyse, evaluate and apply the physical principles and methods; they will have the ability of creative and critical thinking and the ability to solve complex problems, to reason and communicate the solutions and ideas, to cooperate with representatives of other scientific fields; they will be able to assess critically the achievements of the science of physics,

their impact and significance for the society's development, and to maintain and raise own professional competences through lifelong learning.

CHAPTER II
CONCEPT AND SCOPE OF THE STUDY FIELD

10. Physics is a fundamental science that analyses the matter, its structure and behaviour and interaction between its elements, generalizes its regularities, explains the natural phenomena on the basis of the obtained results, provides the ways of its application. The object of the physical research may be elementary constituents and processes in the microworld, macroobjects and phenomena, problems of the universe's structure and its evolution, new materials and technologies, and research methods. The experimental results and the theoretical generalisations in physics must be compatible.

11. The studies in the field of physics may be based on either experimental, theoretical or applied physics.

12. The study programmes in the field of physics may be specialised according to particular areas of the science of physics and relate physics with other scientific fields (for example, chemistry, biophysics, biochemistry, medical physics, geophysics, or engineering). They may also cover applied aspects of physics, e.g., environmental physics, technical and technological physics, energy physics, materials science, etc.

13. The intended learning outcomes, gained knowlenge and skills of the study programmes in the study field of physics may be obtained in the study programmes designed based on the specific topics including subjects that cover several branches and explore the relations of physics with other subjects of studies (for example, chemistry, biophysics, biochemistry, medical physics, geophysics), as well as applied aspects (e.g., environmental physics, technical and technological physics, energy physics, materials science, etc).

14. The graduates of the physical studies may work in educational, research and higher education institutions, high-tech and traditional industrial, research and development and manufacturing companies and other institutions, in the areas of analytics and in other areas, and they may establish new businesses.

15. The knowledge obtained in the years of studies will create preconditions for independent lifelong learning for the graduates of physics.

CHAPTER III
GENERAL AND SPECIAL LEARNING OUTCOMES

16. The learning outcomes of the first cycle of studies in the field of physics:

16.1. knowledge and its application. The person:

16.1.1. will know and understand systematically the fundamental laws of electromagnetism, classical and quantum mechanics, statistical physics and thermodynamics, wave phenomena, structure and properties of matter, structure of the universe, their experimental and theoretical background, will be able to apply them for solution of theoretical and practical tasks; the person will have knowledge about application of these laws in individual branches of physics, such as atomic, nuclear, particle, condensed matter physics, physics of materials, etc.;

16.1.2. will know and be able to apply the main qualitative and quantitative methods of analysis to solve fundamental and applied physical problems;

16.1.3. will know and understand the achievements and problems of modern physics;

16.1.5. will know and be able to apply the mathematical methods and information technologies for analytical and numerical description and modelling of physical phenomena and problems;

16.2. research skills. The person:

16.2.1. will be able to formulate the purpose and tasks of the research work;

16.2.2. will be able to use information technologies and resources, to find subject-related information, and to analyse sources;

16.2.3. will be able to select a research methodology, to summarise the scientific research results and to formulate conclusions;

16.2.4. will be able to apply knowledge in physics, to perform researches, to analyse and assess results;

16.3. special abilities. The person:

16.3.1. will know and understand the main organisation principles of physical investigations and research activities;

16.3.2. will be able to formulate the problems of practical activities related to physical investigations, to plan, design and control research, to select and apply the appropriate equipment and methods;

16.3.3. will be able to interpret the results of observations, physical experiments and modelling;

16.3.5. will be able to process the data of performed researches and to apply information technologies;

16.4. social abilities. The person:

16.4.1. will be able to work independently and in team, and to cooperate in pursue of common goals;

16.4.2. will be able to communicate, to look deeper into the presented arguments, to communicate information and research results to both specialist and non-specialist audiences;

16.4.3. will be able to make reasoned decisions and to evaluate their social consequences;

16.5. personal abilities. The person:

16.5.1. will be able to apply the obtained knowledge and skills when changing the area and character of work, to act and adjust to the new situations by expanding the competences of own professional activities;

16.5.2. will be able to assess critically the information, own work results, to make decisions and to assess their consequences, and to improve the activities;

16.5.3. will be able to maintain own professional competences through lifelong learning;

16.5.4. will be able to take responsibility for own work and its quality, and to comply with professional ethics.

17. The learning outcomes of the second cycle of studies in the field of physics:

17.1. knowledge and its application. The person:

17.1.1. will know and understand the theories, concepts, principles and facts of specialised physics;

17.1.2. will know the latest achievements, theories, ideas, principles in physics, be able to evaluate them critically, and to apply in work;

17.1.3. will be able to integrate the knowledge of physics to solve the problems of a new character in various areas;

17.2. research skills. The person:

17.2.1. will be able to formulate independently the purpose and tasks of the research work;

17.2.2. will be able to find independently, to analyse and assess critically the scientific and informational literature;

17.2.3. will be able to prepare a research methodology, while solving scientifically new problems, and to assess critically the theoretical presumptions and research methods;

17.2.4. will be able to plan and perform independently the analytical, modelling and experimental researches, to assess critically the experimental or modelling procedures, the received results and their reliability;

17.2.5. will be able to systemise and interpret independently the research data, to generalise the research results, to validate the conclusions by arguments, and to give recommendations;

17.3. special abilities. The person:

17.3.1. will be able to model the physical processes, to use modelling or experimental results for new researches;

17.3.2. will be able to carry out researches independently, to use special physical and technological equipment;

17.3.3. will be able to formulate independently a problem of practical work, to plan, design course of work, and to control its performance;

17.3.4. will be able to recognise and observe independently the physical phenomena in new and atypical environments, to carry out qualitative and quantitative measurements and modelling, to collect, process and interpret the research data systemically and reliably;

17.4. social abilities. The person:

17.4.1. will be able to organise and coordinate the research activities, to work independently and in team;

17.4.2. will be able to work in the interdisciplinary and intercultural environment;

17.4.3. will be able to present the results of scientific or applied research and rationale underpinning these and to discuss with both specialist and non-specialist audiences;

17.5. personal abilities. The person:

17.5.1. will be able to recognise and assess critically the emerging scientific knowledge and problems in accordance with the concept of physical world;

17.5.2. will be able to apply the obtained knowledge and skills when changing the area and character of work, to act and adjust to the new situations by expanding the competences of own professional activities independently;

17.5.3. will be able to assess critically the information, to make decisions and to assess their consequences, and to improve the activities.

CHAPTER IV
TEACHING, LEARNING AND ASSESSMENT

18. The teaching, learning and assessment activities have to be organised in such a way so that the students would be able to achieve effectively the learning outcomes provided in the study programme.

19. The applied learning methods have to be defined in the subject's descriptor, reviewed and improved regularly, with regard to the changing needs of the labour market and society, the latest achievements of the science of physics, and requirements of modern didactics. The teaching and learning strategy has to be developed in such a way that the students would be able to obtain relevant professional knowledge, abilities and practical skills necessary for professional activities.

20. The teaching content has to be updated and improved regularly. The new knowledge and teaching methods in compliance with the concept of lifelong learning have to be integrated into the study process. The students have to be prepared and encouraged to use the principles of the above concept in the course of their studies.

21. The learning methods necessary to consolidate practical abilities have to be provided in the studies.

22. The didactic system of the programmes has to train critical thinking, creativity, analytical, metacognition and generic abilities. It is recommended to include complex tasks and researches applicable in business, industry or other areas into the study process.

23. The university teachers have to know the didactic concept of the study programme and to apply various teaching methods in order to use optimally the available material resources.

24. The choice of the teaching methodology shall depend on the particular learning outcomes of the taught subject, intended learning outcomes, and skills and knowledge granted to the student. It is recommended to use the student-oriented educational methods that enable the students to play an active role in the process of studies.

25. The same teaching and learning methods may be applied in different cycles of studies; however, the volume and complexity of tasks, independent input of the student, etc. must differ.

Possible teaching and learning methods and modes are the following: lectures (interactive lectures); laboratory exercises; seminars (studies in small groups); workshops (modelling, solution of physical exercises); individual consultations; practical training (recommended in an industrial company or in another research and higher education institution); individual and/or team projects (solution of real problems in projects); interactive learning methods; field trips; case analysis; written papers (reports, essay, papers); search and generalisation of the needed information, reading of books and original scientific articles; preparation, public presentation and defence of reports; discussions, debates; other innovative methods.

26. In the beginning of each semester, the university teachers have to introduce thorough curriculum, goals of the subject, their relations to generic goals of the study programme, expected learning outcomes, expected learning load, assessment procedure and criteria of learning achievements (influence of the examination and interim tests on final grade, examination terms, etc.) to the students.

27. The assessment system of studies has to ensure a constant feedback to the students about their learning achievements and validity of evaluation of performed works. An important part of the students' achievements is a feedback provided by the students to the teacher, as it creates preconditions for development and improvement of the efficiency of the study process and to improve the teaching quality.

28. The assessment methods may be of generalising, forming and diagnostic character. The generalising assessment allows measuring the students' achievements at the end of the subject's studies, semester, course or study programme. The forming and diagnostic assessment allow the teacher and the student to observe the course of studies, to identify the difficulties, and to analyse the achievements.

29. The university teachers have to be familiar with various assessment methods and their application methodology. The university teacher may choose the most appropriate assessment methods, depending on the aims of assessment and the taught subject, expected results, and other factors. The students' participation in the (self-)assessment process should be aimed at.

30. The procedures applied to assess the students' achievements have to be based on clearly formulated criteria that enable to reflect correctly and reliably the level of knowledge, abilities and practical skills achieved by the student in the course of studies (of the subject). The assessment criteria have to manifest, how the level of knowledge and skills obtained by the student comply with the aimed outcomes of the study programme and the aimed competences.

31. The achieved learning results are graded according to the ten-point grading system. Various assessment methods of learning achievements may be applied: written examination; written or oral examination; testing; report on results of laboratory works and their defence; modelling works; solution of exercises; report on individual or team work; oral and stand-based presentations; presentation and defence of reports on practical work (research); colloquium; tests when questions of closed and/or open type are asked; written works (review of literature, report, essay, etc); course, final paper and its defence; and other assessment methods;

32. The final work (project), its defence and assessment summarise general and special abilities that are obtained by the student and that satisfy qualification requirements for the degrees of bachelor or master.

33. The appeals regarding the assessment process have to be submitted and considered in the procedure established by the higher education institution.

CHAPTER V
REQUIREMENTS FOR IMPLEMENTATION OF STUDY PROGRAMMES

34. General requirements for teachers of the study programmes in the field of physics:

34.1. at least half of the subjects of the university studies of the first cycle in the field of physics have to be taught by scientists;

34.2. at least 80 percent of the teachers in the master's studies must have an academic degree. Other teachers may be practicians, who have acquired the professional work experience of at least 3 years in the recent 7 years in the field, the subjects whereof are taught;

34.3. at least 10 percent of the subjects of the studies of the first cycle in the field of physics, and at least 20 percent of the subjects of the studies of the second cycle have to be taught by persons, who hold an office of a professor;

34.4. at least 80 percent of the subjects in the field of physics have to be taught by scientists working in the field of the science of physics;

34.5. the exchange of teachers and scientists with other Lithuanian or foreign higher education institutions and research centres shall be encouraged in the studies in the field of physics;

34.6. the competence of the university teachers shall be assessed according to the academic level of the taught subjects, pedagogical and scientific research experience, ability to communicate fluently in at least one foreign language used for international scientific cooperation, initiatives to create more effective learning methods, according to the qualification, recognition in professional, scientific and other societies, participation in refresher programmes, and skills of respectful and colleague-like communication with the students;

34.7. the university teacher should be encouraged to write textbooks, to prepare new subjects, methodical aids, and to initiate renewal of the laboratory equipment in order to grant new skills and abilities to the studying persons.

35. General requirements for other employees and persons, who are implementing subjects of the study programmes (supervisors of laboratory works, practical training):

35.1. the laboratory works and other practical exercises of the study programmes of the first cycle should be supervised by the persons, who have at least the master's degree in the field of physical, technological and engineering sciences;

35.2. the laboratory works and other practical exercises of the study programmes of the second should be supervised by the scientists or PhD students in the field of physical, technological and engineering sciences;

35.3. the professional practical training of the students of the first cycle should be supervised by the persons, who have higher education and at least 3 years of practical work experience.

36. General requirements for the process of studies:

36.1. the process of studies has to be based on consistent expansion and development of the student's knowledge and abilities with regard to the subjects taught in the study programme;

36.2. the process of studies shall be conducted in the procedure established by the higher education institution.

37. The higher education institution has to create conditions for the teachers and students to use the possibilities of academic mobility by integrating knowledge and experience of international level into the process of studies. The inclusion of positive learning outcomes achieved during the academic mobility has to be guaranteed for the students.

38. The studies of the first and second cycle shall end in a final work (project) prepared independently by the student:

38.1. the final work (project) of the studies of the first cycle has to be based on researches, application of knowledge or it has to be prepared as a project that manifests the skills complying with the programme's goals. The final work (project) serves for the student to show his or her adequate level of knowledge in physics and initial level of performance of independent experimental or theoretical work, ability to analyse the selected topic, to take the previous works performed by other persons into consideration, to describe own research work and its results in correct and coherent language, using the accepted special terms, formulations, measurement units of physical values, and to formulate clear and reasoned research conclusions;

38.2. the final work (project) of the studies of the first cycle has to be presented and defended in the procedure established by the higher education institution;

38.3. the final work (project) of the second cycle has to be based on individual scientific or applied researches, application of acquired knowledge or it has to be prepared as a project that

manifests the skills acquired during the studies. The final work (project) serves for the student to show his or her level of good understanding of the solved physical problem, ability to analyse the selected topic thoroughly, to take the results of earlier researchers under the same topic in consideration, to plan and carry out physical researches independently, to describe own research work in correct and coherent language, using the accepted special terms, formulations, measurement units of physical values. The student has to manifest his or her ability to summarise briefly his or her work and to formulate reasoned and generalising conclusions and recommendations on the basis of analysis of the work results;

38.4. the final work (project) of the studies of the second cycle has to be presented and defended in the procedure established by the higher education institution in the assessment commission of final works;

38.5. the assessment commission of the final work (project) shall be formed from competent specialists of the study field – scientists, professional practicians and representatives of probable employers. At least one member of the commission has to be from another research and higher education institution.

39. General requirements for material resources of the studies:

39.1. the lecture halls and number of places in these halls have to satisfy the students' needs. The lecture halls have to satisfy the requirements of hygiene and work safety and to have the necessary demonstration tools and equipment;

39.2. the signs warning about potential hazard must be present in the laboratories. The evacuation schemes must be present in all the premises;

39.3. the laboratory equipment, devices, computers and software have to be sufficient for the student to acquire the practical abilities provided in the study programme;

39.4. it is recommended to create a possibility for the students to use unique scientific research equipment installed in the specialised laboratory if it is beneficial for pursuing of learning outcomes;

39.5. the number of textbooks and other information sources of each subject of the study programme available in the libraries must satisfy the students' needs, while the electronic information sources must be accessible to all participants of the study process;

39.6. the library has to satisfy the requirements of hygiene and work safety, to have appropriate sound insulation, individual work places, and it is recommended to have a room for discussions.

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