# EDUCATIONAL PLAN

Valid from the academic year 2025-2026

| | |
|---|---|
| **Faculty:** | Physics |
| **The cycle of university studies:** | Master |
| **Name of the master's degree program:** | Fizica Energiilor Înalte/ High Energy Physics |
| **Name of the qualification acquired after graduating from the study program:** | Specialist in physics |
| **Title awarded:** | Master in Physics |
| **Duration of studies (in years):** | 2 years |
| **Number of credits (ECTS):** | 120 |
| **Form of education:** | Full-time education |
| **Language of instruction:** | English |
| **Geographical location of studies:** | București, Cluj-Napoca, Iași, Timișoara |
| **The framing of the study program in science fields** | |
| **Fundamental field:** | Mathematics and natural sciences |
| **Science Branch:** | Physics |
| **The field of university master's studies:** | Physics |
| **Name of the broad field of study (according to DL-ISCED F-2013):** | Natural sciences, mathematics and statistics |
| **Name of the restricted field of studies (according to DR-ISCED F-2013):** | Physical sciences |
| **Name of the detailed field of study (according to DDS-ISCED F-2013):** | Physics |

# GENERAL PRESENTATION OF THE PROGRAM OF UNIVERSITY STUDIES

## 1. The mission of the study program [1]

The mission of the master's studies in **"High Energy Physics (HEP)"** is to prepare qualified personnel for higher education and researchers in high energy physics joining together the expertise of academics and researchers from the Faculties of Physics of University of Bucharest, "Alexandru Ioan Cuza" University of Iași, "Babeș-Bolyai" University of Cluj-Napoca și West University of Timișoara. The Master's programme is open to students with a background in physics who are eager to expand their knowledge and experience in a modern physics research environment and develop a career in HEP advanced research. Thanks to the experimental and theoretical skills acquired during the study, students will also have the ability to respond to the needs of the national and international research facilities on high energy physics. The master's degree will ensure a continuous, uninterrupted training of the staff necessary for the participation of the Romanian HEP community in the research projects in this field of CERN.

The track on high energy physics studies will convey to students the current view (Standard Model) about the fundamental building blocks of Matter, about the elementary forces, about cosmic objects, about the future and the past of the Universe. As is known, the main research center in fundamental physics, CERN, is the largest civilian consumer of computing power in the world. They will learn about the modern technologies involved in these activities at the frontiers of Science and will be integrated in the research groups from the universities or from the collaborating institutes. The HEP master's degree will ensure the effective involvement of students in scientific research, by participating in the realization of research projects and the preparation of the dissertation with a specific HEP research topic.

## 2. Competencies and expected learning outcomes formed within the study program

# A. COMPETENCIES

**Key-Competences:**

- Multilingual competences
- Competences in the field of science, technology, engineering and mathematics
- Digital competences
- Personal, social and learning competences

**Professional Competencies:**

- Apply scientific methods
- Operate scientific research and laboratory equipment

[1] *Misiunea și obiectivele programului de studii trebuie să fie în concordanță cu misiunea universităților implicate în program și cu cerințele identificate pe piața muncii.*

- Manage research data
- Gather experimental data
- Analyse experimental laboratory data
- Demonstrate disciplinary expertise
- Prepare work reports
- Execute analytical mathematical calculations
- Analyze scientific data
- Apply statistical analysis techniques
- Interact professionally in research and professional environments
- Manage personal professional development
- Think abstractly
- Perform scientific research
- Promote open innovation in research
- Develop professional network with researchers and scientists

**Transversal Competencies:**

- Work in teams
- Calculates probabilities
- Apply knowledge of scientific, technological and engineering

**Other competencies:**

- Create software design
- Use application-specific interfaces
- Design the informatic system
- Use software libraries

# EXPECTED LEARNING OUTCOMES [2]

**a) Knowledge -** According to the European Qualifications Framework (EQF), the learning outcomes related to qualification level 7, corresponding to university master's studies, require highly specialized knowledge and their critical awareness, some of them being at the vanguard of the level of knowledge from a field of work or study, as a basis for original thinking and/or research:

• to know the fundamental constituents of matter and their interactions described by quantum field theory;
• to know the high energy particle physics open questions;
• to know the concepts related to high energy physics, which involves a critical understanding of theories and principles of Standard Model of elementary particles and its extensions;
• to know the computational approaches in high-energy physics;

[2] *Rezultatele învățării (learning outcomes)* înseamnă enunțuri care se referă la ceea ce cunoaște, înțelege și este capabil să facă un cursant la terminarea unui proces de învățare și care sunt definite sub formă de cunoștințe, abilități, responsabilitate și autonomie.

• to know the methods of analysis and the criteria for choosing the appropriate solutions to achieve specific performances;
• to know the working formulas for calculations with physical quantities using properly the principles and laws of physics;
• to know the programing languages and software applications specific to high energy physics;
• to know physical phenomena and interpret them by formulating hypotheses and operationalizing key concepts and the appropriate use of laboratory equipment;
• to know the constructive and operating principles of the particle detectors and to explain how to use it;
• to know the basic concepts from related fields in order to use them appropriately in complex teams;

**b) Skills** - According to the European Qualifications Framework (EQF), the learning outcomes related to qualification level 7, corresponding to university master's studies, assume specialized skills for solving research and/or innovation problems, for the development of new knowledge and procedures and for the integration of knowledge from different fields:

• to apply the methods of analysis and the criteria for choosing the appropriate solutions to achieve specific performances;
• to deduce working formulas for calculations with physical quantities using the principles and laws of physics appropriately;
• to perform comparison studies between theoretical and experimental results with the aim of advancing knowledge
• to deduce the working formulas for calculations with physical quantities, using appropriately the principles and laws of physics;
• describe physical systems using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.);
• describe and explain the fundamental principles of physics, including those of Standard Model and its extensions, astrophysics, cosmology;
• to apply the principles and laws of physics in solving theoretical or practical problems, under conditions of qualified assistance;
• to apply the analysis methods and the criteria for choosing the appropriate solutions to achieve the specified performances;
• to describe crucial experiments in the history of high-energy physics and explain how they led to revisions of our theoretical descriptions of nature;
• to use the computer and specific software tools for the numerical simulation of the physical processes;
• to acquire a coherent and functional system of fundamental knowledge in the field of science;
• to elaborate and present reports on the physical principles in front of an informed public;
• to write and present scientific reports in the field of high-energy physics;
• to make associations between high-energy physics concepts and other related fields;

**c) Responsibility and autonomy** - According to the European Qualifications Framework (EQF), the learning outcomes related to qualification level 7, corresponding to university

master's studies, involve the management and transformation of work or study situations that are complex, unpredictable and require new strategic approaches, by taking responsibility to contribute to professional knowledge and practices and/or to review the strategic performance of teams:

- to assume responsibility for managing professional development;
- to solve concrete tasks related to high-energy physics experiments;
- to present and popularize high energy particle physics across all audiences and age groups;
- to critically analyze a specialized report, scientific communication with a medium degree of difficulty in the field of high-energy physics;
- to be autonomous in the context of handling physical data, including in situations requiring an interdisciplinary approach;
- to autonomously use information sources and resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) in English;
- to carry out research internships in various research units related to high-energy physics experiments in order to become familiar with and operate modern equipment, obtain interesting results and prepare reports on the activity carried out;
- to manage complex technical or professional activities or projects, by assuming responsibility for decision-making in unpredictable study situations.

# 3. Occupations that can be practiced on the labor market

**2111 Physicists and astronomers**

Physicists and astronomers conduct research and improve or develop concepts, theories and operational methods relating to matter, space, time, energy, forces and fields and the interactions that occur within these physical phenomena. They apply scientific knowledge related to physics and astronomy in fields such as industry, medicine and the military (or other fields).

COR 211101 / ESCO 2111.3 - Fizician
COR 211103 Asistent de Cercetare in Fizica
ESCO 2111.3 - Physics analyst

# 4. Ensuring flexible learning paths within the study program

*The flexibility of the study program is ensured through optional subjects, optional subjects and complementary subjects.*

**The disciplines of choice (optional)** are proposed for semesters 2 and 3 and are grouped into optional packages, which complete the student's specialization path. The choice of the route is made by the student, before the start of each academic year.

**The noncompulsory disciplines** are proposed for semesters 1-4 by the faculties of physics, which manages the study program, but they can also be chosen from the packages offered by other faculties of the universities involved.

## 5. Professional activity and student assessment

The rights, obligations and conditions of the professional activity of students at University of Bucharest (UB), "Alexandru Ioan Cuza" University of Iași (UAIC), "Babeș-Bolyai" University of Cluj-Napoca (UBB) și West University of Timișoara (UVT) are regulated by Codes of student rights and obligations and the Regulation on the professional activity of students from the bachelor's and master's study cycles, approved by each university's senate.
The form and assessment/examination methods for each subject in the curriculum are established by the subject sheets.

## 6. Final studies exam

In accordance with the Regulation on the organization and conduct of the final exams for bachelor's and master's university studies, the final exam for master's university studies consists of a sample of elaboration and support of the dissertation work, for which 10 credits are awarded.
The topic and the bibliography corresponding to the final exam tests are published on each faculty's own website and/or on the university's website before the beginning of each academic year.
Enrolment in the graduation exam is conditional on the student choosing the theme of the graduation thesis within 60 days at most from the beginning of the academic year of the final year of study.
The submission of the final version of the thesis on the e-learning platform is done at least 5 working days before the date scheduled for the start of the exam.
Each thesis will be accompanied, at the time of submission, by the Similarity Report resulting from the verification of the originality of the thesis through a specialized software.
According to the structure of the academic year, the exams for completing university studies can be organized in 2 or 3 sessions, usually in the months of July, September and February.

## 7. Preparation for the teaching profession (if applicable)

Students who wish to opt for a teaching career in pre-university education must enrol to (in addition to this study program) and complete the Psycho-Pedagogical Training Program in order to certify the skills for the teaching profession and obtain the Certificate of Completion of this program. This program is organized at each of the participating universities and the students can enrol through the designated department.

# LIST OF DISCIPLINES STUDIED, GROUPED BY YEARS AND SEMESTER OF STUDY

| Study year I<br>Academic year 2025-2026 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nr. crt.** | **Discipline** | **C1** | **Teaching university** | **C2. Discipline Code** | **Semester I** | | | | | **Semester II** | | | | |
| | | | | | **Number of hours/ week** | | | | **No. of credits** | **Number of hours/ week** | | | | **No. of credits** |
| | | | | | **C** | **S** | **L** | **P** | | **C** | **S** | **L** | **P** | |
| 1. | Relativistic Quantum Mechanics and Quantum Electrodynamics | DF | UBB/ UAIC | DI.101.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| 2. | Introduction to the standard model of elementary particles | DF | UB | DI.102.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| 3. | Particle Detectors Fundamentals I | DF | UB | DI.103.HEP | 2 | - | 2 | - | 6 | - | - | - | - | - |
| 4. | Data analysis in high energy physics: a practical guide to statistical methods I | DS | UB | DI.104.HEP | 2 | - | 2 | - | 6 | - | - | - | - | - |
| 5. | Ethics in research | DC | UAIC/ UB/ UBB/ UVT | DI.105.HEP | 1 | - | - | - | 2 | | | | | |
| 6. | Research Practice | DS | UAIC/ UB/ UBB/ UVT | DI.106.HEP | - | - | - | 3 | 3 | - | - | - | - | - |
| 7. | The standard model | DF | UB/ UVT | DI.107.HEP | - | - | - | - | - | 2 | 2 | - | - | 6 |
| 8. | Particle Detectors II | DF | UB | DI.108.HEP | - | - | - | - | - | 2 | - | 2 | - | 6 |
| 9. | Computational approaches in high-energy physics | DS | UAIC/ UB | DO.109.1.HEP | - | - | - | - | - | 2 | - | 2 | - | 6 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Data analysis in high energy physics: a practical guide to statistical methods II | | UB | DO.109.2.HEP | | | | | | | - | 2 | | |
| | Introduction to gravity theory and cosmology | | UVT | DO.109.3.HEP | | | | | | 2 | 2 | - | - | |
| 10. | Programming in C++ and Python for HEP | DS | UAIC/UBB | DO.110.1.HEP | - | - | - | - | - | 2 | - | 2 | - | 6 |
| | Data Aquisition Methods in HEP I | | UB | DO.110.2.HEP | | | | | | | | | | |
| 11. | Research Practice | DS | UAIC/UB/UBB/UVT | DI.111.HEP | - | - | - | - | - | - | - | - | 4 | 6 |
| **Total** | | | | | 9 | 8 | | 3 | | 8 | 8 | | 4 | |
| **Total teaching hours per week** | | | | | 20 | | | | 30 | 20 | | | | 30 |

| **Noncompulsory Disciplines** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nr. crt.** | **Disciplina** | **C1** | **Teaching university** | **Discipline Code** | **Semester I** | | | | | **Semester II** | | | | |
| | | | | | **Number of hours/ week** | | | | **Number of credits** | **Number of hours/ week** | | | | **Number of credits** |
| | | | | | **C** | **S** | **L** | **P** | | **C** | **S** | **L** | **P** | |
| 1. | Programming through Python | DC | UAIC /UBB | DFC.111.HEP | 2 | - | 2 | - | 4 | - | - | - | - | - |
| 2. | Non-abelian gauge theories | DS | UB | DFC.112.HEP | 2 | 2 | - | - | 4 | - | - | - | - | - |
| 3. | Volunteering | DC | | DFC.113.HEP | | | | | 1 | | | | | 1 |

# Study year II

**Academic year 2026-2027**

| Nr. crt. | Discipline | C1 | Teaching university | C2. Discipline Code | Semester I | | | | | Semester II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Number of hours/ week | | | | No. of credits | Number of hours/ week | | | | No. of credits |
| | | | | | C | S | L | P | | C | S | L | P | |
| 1. | Extensions of the standard model of elementary particles (BSM) | DS | UB | DI.201.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| 2. | Monte Carlo simulations in particle physics I | DF | UBB/UB | DI.202.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| 3. | Frontiers in Particle Physics | DS | UBB | DO.203.1.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| | Computational frameworks for particle physics theoretical models | | UB | DO.203.2.HEP | 2 | - | 2 | | | | | | | |
| | Stellar Astrophysics | | UVT | DO.203.3.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| 4. | Particle Physics at the LHC | DS | UB/UAIC | DO.204.1.HEP | 2 | 2 | - | - | 6 | - | - | - | - | - |
| | Data Aquisition Methods in HEP II | | UB | DO.204.3.HEP | 2 | - | 2 | | 6 | | | | | |
| 5. | Research Practice | DS | UAIC/ UB/ UBB/ UVT | DI.205.HEP | - | - | - | 4 | 6 | - | - | - | - | - |
| 6. | Monte Carlo simulations in particle physics II (in high energy physics) | DS | UBB/UB | DI.206.HEP | - | - | - | - | - | 2 | - | 2 | - | 6 |
| 7. | Specialization practice | DS | UAIC/ UB/ UBB/ UVT | DI.207.HEP | - | - | - | - | - | - | - | - | 8 | 12 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8. | Scientific research internship | DS | UAIC/ UB/ UBB/ UVT | DI.208.HEP | - | - | - | - | - | - | - | - | 4 | 6 |
| 9. | Practice for elaboration of dissertation | DS | UAIC/ UB/ UBB/ UVT | DI.209.HEP | - | - | - | - | - | - | - | - | 4 | 6 |
| **Total** | | | | | 8 | 8 | | 4 | | 2 | 2 | | 16 | |
| **Total teaching hours per week** | | | | | 20 | | | | 30 | 20 | | | | 30 |

| **Noncompulsory Disciplines** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Nr. crt.** | **Disciplina** | **C1** | **Teaching university** | **Discipline Code** | **Semester I** | | | | | **Semester II** | | | | |
| | | | | | **Number of hours/ week** | | | | **Number of credits** | **Number of hours/ week** | | | | **Number of credits** |
| | | | | | **C** | **S** | **L** | **P** | | **C** | **S** | **L** | **P** | |
| 1. | Introduction to VHDL | DC | UBB/UB | DFC.210.HEP | 2 | - | 2 | - | 4 | - | - | - | - | - |
| 2. | Volunteering | DC | | DFC.211.HEP | | | | | 1 | | | | | |

**Legend**

| | |
|---|---|
| **C1** | content criterion |
| **C2** | the obligation criterion |
| **DF** | fundamental disciplines |
| **DD** | field disciplines (where applicable) |
| **DS** | specialized disciplines |
| **DC** | complementary disciplines |
| **DI** | compulsory (imposed) disciplines |
| **DO** | Optional/ ellective disciplines (of your choice) |
| **DFC** | Noncompulsory disciplines |
| **CP** | professional competency |
| **CT** | transversal competence |
| **C** | course-type didactic activity |
| **S** | seminar-type didactic activity |
| **L** | didactic activity of practical laboratory type |
| **P** | didactic activity of the internship type |

**Discipline code:** <the obligation criterion ><year of study *x* no. discipline *yy*><acronym of the study programme>

# GENERAL ASSESSMENT I

# (by content criterion)

| Nr. crt. | Tip disciplină/ *Type of discipline* | Număr total de ore | | | | | | | % din total | Prevedere standard specific ARACIS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Anul I/ *Year I* | | Anul II/ *Year II* | | Întreg programul de studii | | | | |
| | | Curs | S/L/P | Curs | S/L/P | Curs | S/L/P | **Total** | | |
| 1. | Fundamentale/ *Fundamental* | 140 | 140 | 28 | 28 | 168 | 168 | 336 | **32,3%** | - |
| 2. | De domeniu (dacă există) | - | - | - | - | - | - | - | **-** | - |
| 3. | De specialitate/ *Specialised* | 84 | 182 | 104 | 320 | 188 | 502 | 690 | **66,3%** | - |
| 4. | Complementare/ *Complementary* | 14 | - | - | | 14 | 0 | 14 | **1,4%** | - |
| **TOTAL** | | **238** | **322** | **132** | **348** | **370** | **670** | **1040** | **100%** | - |

| |
|---|
| **Total ore:1040** |
| **Total ore de curs: 370 din care 60% online** |
| **Total ore de activități practice: 670 din care 30% online** |

# GENERAL ASSESSMENT II

# (according to the mandatory criterion)

| Nr. crt. | Tip disciplină/ *Type of discipline* | Număr total de ore | | | | | | | % din total | Prevedere standard specific ARACIS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Anul I/ *Year I* | | Anul II/ *Year II* | | Întreg programul de studii | | | | |
| | | Curs | S/L/P | Curs | S/L/P | Curs | S/L/P | **Total** | | |
| 1. | Obligatorie/ Compulsory | 182 | 266 | 76 | 292 | 258 | 558 | 816 | 78,5% | - |
| 2. | Opțională/ Elective | 56 | 56 | 56 | 56 | 112 | 112 | 224 | 21,5% | - |
| **TOTAL** | | **238** | **322** | **132** | **348** | **370** | **670** | **1040** | 100% | - |
| *Facultative/ Optional* | | 56 | 56 | 28 | 28 | **84** | **84** | **168** | | Suplimentar |
| **Raport total (ore de seminar/laborator/practică) / ore de curs** | | | | | | **1,81** | | | | ***1<R<2*** |

# CORELAREA DINTRE COMPETENȚE, REZULTATELE AȘTEPTATE ALE ÎNVĂȚĂRII ȘI DISCIPLINELE STUDIATE

## Correlation of expected learning outcomes with the studied disciplines

| **Rezultate așteptate ale învățării / *expected learning outcomes*** | Relativistic Quantum Mechanics and Quantum Electrodynamics | Introduction to the standard model of elementary particles | Particle Detectors Fundamentals I | Data analysis in high energy physics: a practical guide to statistical methods I | Ethics in research | The standard model | Particle Detectors II | Computational approaches in high-energy physics | Data analysis in high energy physics: a practical guide to statistical methods II | Introduction to gravity theory and cosmology | Programming in C++ and Python for HEP | Data Aquisition Methods in HEP I | Extensions of the standard model of elementary particles (BSM) | Monte Carlo simulations in particle physics I | Frontiers in Particle Physics | Computational frameworks for particle physics theoretical models | Stellar astrophysics | Particle Physics at the LHC | Data Aquisition Methods in HEP II | Monte Carlo simulations in particle physics II (in high energy physics) | Research Practice | Specialization practice | Scientific research internship | Practice for elaboration of dissertation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cunoștințe/ *Knowledge*** | | | | | | | | | | | | | | | | | | | | | | | | |
| to know the fundamental constituents of matter and their interactions described by quantum field theory; | X | X | X | | | X | X | | | X | | | X | | X | | | X | | | X | X | X | X |
| to know the high energy particle physics open questions; | | X | X | | | | | | | X | | | X | | X | | X | X | | | X | | | |
| to know the concepts related to high energy physics, which involves a critical understanding of theories and principles of Standard Model of elementary particles and its extensions; | X | X | X | | | X | X | | | X | | | X | X | X | | | X | | X | X | X | X | X |
| to know the computational approaches in high-energy physics; | | | | X | | | | X | X | | X | | | X | | X | | | X | X | X | X | X | X |
| to know the methods of analysis and the criteria for choosing the appropriate solutions to achieve specific performances; | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to know the working formulas for calculations with physical quantities using properly the principles and laws of physics; | X | X | X | X | | X | X | X | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

| **Rezultate așteptate ale învățării** ***/ expected learning outcomes*** | Relativistic Quantum Mechanics and Quantum Electrodynamics | Introduction to the standard model of elementary particles | Particle Detectors Fundamentals I | Data analysis in high energy physics: a practical guide to statistical methods I | Ethics in research | The standard model | Particle Detectors II | Computational approaches in high-energy physics | Data analysis in high energy physics: a practical guide to statistical methods II | Introduction to gravity theory and cosmology | Programming in C++ and Python for HEP | Data Aquisition Methods in HEP I | Extensions of the standard model of elementary particles (BSM) | Monte Carlo simulations in particle physics I | Frontiers in Particle Physics | Computational frameworks for particle physics theoretical models | Stellar astrophysics | Particle Physics at the LHC | Data Aquisition Methods in HEP II | Monte Carlo simulations in particle physics II (in high energy physics) | Research Practice | Specialization practice | Scientific research internship | Practice for elaboration of dissertation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| to know the programming languages and software applications specific to high-energy physics; | | | | X | | | | X | X | | X | X | | X | | X | | | X | X | X | X | X | X |
| to know physical phenomena and interpret them by formulating hypotheses and operationalizing key concepts and the appropriate use of laboratory equipment; | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to know the constructive and operating principles of the particle detectors and to explain how to use it; | | | X | X | | | X | | X | | | | | | | | | X | | | | X | | |
| to know the basic concepts from related fields in order to use them appropriately in complex teams; | | | | | | | | | | X | | | | | X | | X | | | | | | | |
| **Abilități/** ***Skills*** | | | | | | | | | | | | | | | | | | | | | | | | |
| to apply the methods of analysis and the criteria for choosing the appropriate solutions to achieve specific performances; | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to deduce working formulas for calculations with physical quantities using the principles and laws of physics appropriately; | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to perform comparison studies between theoretical and experimental results with the aim of advancing knowledge; | X | X | X | X | | X | X | | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to deduce the working formulas for calculations with physical quantities, using appropriately the principles and laws of physics; | X | X | X | | | X | | | | X | | X | X | X | X | | X | | | | | | | |
| to describe physical systems using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.); | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to describe and explain the fundamental principles of physics, including those of Standard Model and its extensions, astrophysics, cosmology; | X | X | X | | | X | X | | | X | | | | | X | | X | X | | | X | X | X | X |

| **Rezultate așteptate ale învățării** ***/ expected learning outcomes*** | Relativistic Quantum Mechanics and Quantum Electrodynamics | Introduction to the standard model of elementary particles | Particle Detectors Fundamentals I | Data analysis in high energy physics: a practical guide to statistical methods I | Ethics in research | The standard model | Particle Detectors II | Computational approaches in high-energy physics | Data analysis in high energy physics: a practical guide to statistical methods II | Introduction to gravity theory and cosmology | Programming in C++ and Python for HEP | Data Aquisition Methods in HEP I | Extensions of the standard model of elementary particles (BSM) | Monte Carlo simulations in particle physics I | Frontiers in Particle Physics | Computational frameworks for particle physics theoretical models | Stellar astrophysics | Particle Physics at the LHC | Data Aquisition Methods in HEP II | Monte Carlo simulations in particle physics II (in high energy physics) | Research Practice | Specialization practice | Scientific research internship | Practice for elaboration of dissertation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| to apply the principles and laws of physics in solving theoretical or practical problems, under conditions of qualified assistance; | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to apply the analysis methods and the criteria for choosing the appropriate solutions to achieve the specified performances; | X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to describe crucial experiments in the history of high-energy physics and explain how they led to revisions of our theoretical descriptions of nature; | X | X | X | | | X | X | | | X | | | X | | X | | | X | | | | | | |
| to use the computer and specific software tools for the numerical simulation of the physical processes; | | | | X | | | | X | X | | X | X | | X | | X | | | X | X | X | X | X | X |
| to use the computer to control some experiments or processes and to acquire data | | | X | X | | | X | X | X | | X | X | | X | | X | | X | X | X | X | X | X | X |
| to acquire a coherent and functional system of fundamental knowledge in the field of science; | X | X | X | X | | | X | | | X | | | X | X | X | | X | X | | | X | | | |
| to elaborate and present reports on the physical principles in front of an informed public; | | | | | | | | | | | | | | | | | | | | | X | X | X | X |
| to write and present scientific reports in the field of high-energy physics; | | | | | | | | | | | | | | | | | | | | | X | X | X | X |
| to make associations between high-energy physics concepts and other related fields; | X | X | | | | | | | | X | | | | X | X | | X | | | | | | | |
| **Responsabilitate și autonomie/ Responsibility and autonomy** | | | | | | | | | | | | | | | | | | | | | | | | |
| to assume responsibility for managing professional development; | | | | | X | | | | | | | | | | | | | | | | | X | X | X |
| to solve concrete tasks related to high-energy physics experiments; | | X | X | X | | X | X | X | | | | X | | | | | | X | X | | X | X | X | X |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| to present and popularize high energy particle physics across all audiences and age groups; | | X | X | X | | X | | | | X | | | X | | X | | X | X | | | | X | X | X |
| to critically analyze a specialized report, scientific communication with a medium degree of difficulty in the field of high-energy physics; | | | | X | X | X | | X | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to be autonomous in the context of handling physical data, including in situations requiring an interdisciplinary approach; | | X | | X | | | | X | X | | X | | X | | X | X | X | X | | X | | X | X | X |
| to autonomously use information sources and resources for communication and assisted professional training (Internet portals, specialized software applications, databases, online courses, etc.) in English; | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| to carry out research internships in various research units related to high-energy physics experiments in order to become familiar with and operate modern equipment, obtain interesting results and prepare reports on the activity carried out; | | | | | | | | | | | | | | | | | | | | | X | X | X | X |
| to manage complex technical or professional activities or projects, by assuming responsibility for decision-making in unpredictable study situations. | | | | | | | | | | | | | | | | | | X | | X | X | X | X | X |