**ANNEX 4**

**THE MINISTRY OF EDUCATION OF THE REPUBLIC OF AZERBAIJAN**

**Approved by the decree No … of the Ministry of Education of the Republic of Azerbaijan of …**

**STATE STANDARD OF HIGHER EDUCATION**

**State standard of the study field of Physics**

**Specialty ciphers and names: 050503 – Physics**

**BAKU – 2019**

1. **General provisions**

The State standard of Bachelor level “050503 – Physics” (hereinafter, the State standard) has been developed pursuant to the “Law on Education” of the Republic of Azerbaijan, the “State standard and programme for higher education” approved by the relevant decisions of the Cabinet of Ministers of the Republic of Azerbaijan, the requirements of the “Rules on the content and organization of bachelor education”, the “Classification of bachelor level specialties of higher education”, “National Qualifications Framework for Lifelong Learning of the Republic of Azerbaijan”, “ Rules on Organizing the Credit system education at bachelor and master levels of higher education institutions, main (basic higher) medical education and master level studies of Azerbaijan National Academy of Sciences” .

The State standard shall be applied to the first cycle university study programmes. Study programmes may be organised on a full-time and/or part-time basis. This State standard aims to:

* Assist higher education institutions in designing, implementing and assessing study programmes;
* Inform students and employers about the knowledge and skills acquired by the graduates;
* Give guidelines to experts who assess the study programmes.

The State standard is obligatory for all higher education institutions which function in the territory of the Republic of Azerbaijan regardless of their subordination, ownership and organizational and legal forms and carry out studies in this specialty.

Abbreviations used in the document:

**SP** - Study Programme

**GC -** General competences

**PC** - Professional competences

**2. Competences and learning outcomes**

The following general and professional competences shall be developed, and following learning outcomes should be attained within the study programme of **Bachelor of Physics**:

|  |  |  |  |
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| **Generic competences** | | **Programme learning outcomes** | |
| **1** | Ability to communicate effectively in writing and orally in first and one foreign language |  | Communicate in Azeri and in English in the academic setting   * Read and understand scientific texts, in Azeri and English. * Follow a scientific presentation in English. * Orally present a topic in a way that is structured in Azeri * Write scientific reports in a structured way * Use media and computer tools varied to communicate and explain concepts and scientific results. |
| **2** | Ability for abstract thinking, analysis and synthesis, and to develop argumentation with critical mind. |  | Describe and apply the scientific approach and the scientific reasoning  - Evaluate the simplicity, clarity and rigor of scientific reasoning  - build physical reasoning and formalize it.  - argue the validity of a scientific result.  - calculating the orders of magnitude of a problem in physics.  - recognize similarities between different problems in physics  - judging the relevance of a scientific approach and interest of a physical theory. |
| **3** | Ability to identify, select, analyse and summarize various specialized resources to document a subject |  | Demonstrate methodological, technical and practical skills useful to the resolution of the problems in physics.  - justify the choice of methods and tools used for the resolution of the problems in physics.  - use instruments to measure or to study a physical system.  - properly manipulate tools to aid in the resolution of problems in physics.  - apply basic tools to model simple physical systems and resolve known problems in the basic areas of physics. |
| **4** | Ability to use digital tools of reference and rules of computer security to acquire, process, produce and disseminate information as well as to collaborate internally and externally |  | Use the current office computer applications (commercial and/or free) |
| **5** | Ability to plan and organise one’s own activities, self-learning and skills enhancement |  | Learn and act autonomously.   * search using relevant references, additional information about the basic concepts of physics. * read and interpret alone information. * integrate this information in order to have a complete understanding of a concept.   organize and manage his time and his study. |
| **6** | Ability to act with social and environmental responsibility, civic awareness and ethical reasoning |  | Show an inclusive way to apply their knowledge   * demonstrate the ability to comprehend, express, and adapt to ideas based on others' perspectives. * Independently and accurately apply ethical perspectives and concepts to ethical questions or civic projects as appropriate and demonstrate the ability to consider the full implications of this application. * Demonstrate an ability to recognize ethical and professional responsibilities. |
| **7** | Able to step back from a situation, self-evaluate and questioning himself in order to improve knowledge and skills |  | Demonstrate the ability to be aware of what is not understood   * ask sophisticated, specific questions * articulate where they experience difficulty * take actions to move beyond difficulty. |
| **8** | Ability to establish their role and mission within an organization, to adapt and take initiatives. |  | Identify the functional organizational chart and hierarchy   * Develop a range of leadership skills and abilities |
| **9** | Ability to work as part of a team while being independent and responsible with respect to a project |  | Work in a team and collaborate with students and teachers in order to achieve common objectives and to produce results.   * share knowledge and methods. * identify individual and collective goals and responsibilities and work in accordance with these roles. * fit into a team. * acknowledge and respect the views and opinions of the members of a team. |
| **Professional competences** | | **Programme learning outcomes** | |
| **1** | Mobilize fundamental concepts in order to simulate, analyze and solve simple physics problems. | **…** | - formulate and tackle problems in physics.  - identify the appropriate physical principles, use special and limiting cases and order-of-magnitude  - present a solution by making assumptions and approximations explicit |
| **2** | Identify and lead independently the different steps of an experimental approach using common devices and techniques in the different fields of physics. |  | - plan and execute an experiment or investigation  and report the results.  - are proficient in presenting experimental results or theoretical  conclusions and in the writing of scientific reports  - enhance their ability to assess critically the link between theoretical results and experimental observation |
| **3** | Analyze and exploit experimental data, taking into account sources of errors and uncertainty and probe a model by comparing its predictions to the experimental results |  | - use appropriate methods to analyse data and evaluate the level of uncertainty  - relate conclusions to current theories of the physics involved |
| **4** | Use a programming language and analysis software with a critical mind to collect and  exploit data |  | - use appropriate software such as programming languages and software packages |
| **5** | Use the main mathematical tools relevant for physics. |  | - have an understanding of mathematical modelling and the role of approximation |
| **6** | Apply concepts and experimental methods of physics in the fields of civil engineering, fluid and solid mechanics and mechanical engineering, thermodynamics and heat, materials physics, chemical sciences, geosciences, astronomy. |  | - have understood the interdisciplinary aspects  - may transfer concepts and methods to other fields than pure physics |
| **7** | Identify specific regulations and implement the main prevention measures in terms of health, safety and environmental responsibility |  | - recognize the potential risks of instrumentation and measurements within a lab |

The **Master level** general and professional competencies must be built up on the general and professional competencies acquired in the studies at Bachelor level. Additionally, graduate of Master level shall master the general and professional competences by achievement the following learning outcomes within the study programme at Master level:

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| **Generic competences** | | **Programme learning outcomes** | |
| **1** | Ability to work in a team, in an interdisciplinary and international environment |  | * is familiar with contemporary research within various fields of physics and related fields * has an international perspective on her/his discipline. |
| **2** | Ability to address and respond well to situations in a new and original ways within the given context |  | * is able to gather, assess, and make use of new information. * is able to enter new problem areas that require an analytic and innovative approach. |
| **3** | Ability to identify, analyse and define the significant elements constituting a problem in order to solve it effectively and with good criteria |  | * can critically and independently assess and evaluate research methods and results. |
| **4** | Ability to do fundamental and applied research and apply its results independently for solving tasks in new or unfamiliar environment, implement innovations |  | * has the ability to develop and renew scientific competence -- independently, via courses or through PhD studies in physics or related disciplines. |
| **Professional competences** | | **Programme learning outcomes** | |
| **1** | Document in an exhaustive and synthetic way an emerging research subject in his field of competences |  | * has the background and experience required to model, analyse, and solve advanced problems in physics. * has substantial knowledge in physics, basic knowledge in mathematics, and knowledge in supported fields like computer science. |
| **2** | Identify, analyze and assimilate the main concepts of the new research theme |
| **3** | Build, plan and implement a starting research project |  | * has some research experience within a specific field of physics, through a supervised project. |
| **4** | Design and implement an experimental and/or theoretical approach on a research problematic of its disciplinary field, using autonomously experimental methods and adapted scientific equipments. |  | * is able to apply advanced theoretical and/or experimental methods, including the use of numerical methods and simulations. |
| **5** | Formatting and presenting research results according to international standards of the field for oral presentation and publication in A level scientific reviews |  | * can disseminate subject matter and results to both specialists and a broader audience. |

1. **The scope of study programme**

The **scope of a Bachelor level** **study programme in Physics** shall be:

no less than 240 credits, of which:

no less than 150 credits should be for special subjects in the study field of Mathematics, Physics, Chemistry and Computer Science: it should consist of the theoretical studies (75 %) and practical studies – laboratory training, research project (25%);

no less than 15 credits should be for the general university study subjects.

The minimum overall size of work placements should be 30 credits.

A degree programme ends in the assessment of the graduate’s competences based on written report and defence of internship project, for which at least 12 credits are allocated.

The **scope of a Master level** study programme in Physics shall be:

no less than 120 credits, of which:

70 credits at least should be assigned to the core subjects of the study field, the content of which must be of a higher problematic and scientific level than the basic subjects taught as part of the Bachelor level programme;

the minimum overall size of work placements should be 30 credits, including completion, writing and presentation of the internship project;

1. **Teaching, learning and assessment**

**Teaching, learning and assessment activities** shall be organised in such a way that students can effectively achieve the intended learning outcomes of the study programme.

The applicable **teaching and learning methods** shall be described, constantly reviewed and improved in light of changing needs of the labour force, the latest scientific achievements in Physics. The reaching and learning strategy shall help the students acquire relevant expertise, skills and practical skills necessary for professional activities.

The content of teaching shall be constantly updated and improved by integrating new knowledge and teaching methods in the study process corresponding to the **concept of lifelong learning**. Students shall be prepared and encouraged to follow the principles of this concept during their studies.

The studies shall provide for **practical training** to strengthen practical skills of students and form their working skills. In different stages of studies, the same **teaching and learning methods** may be used, differing in **scope and complexity of tasks, student’s autonomy,** etc.:

**Knowledge transfer and knowledge application techniques**: presentations and discussions, debates, independent study materials (e.g. case studies), projects, problem-based teaching, field visits, role plays, projects, reports, collegiate assessment, expert method, video and audio conferencing, video and audio lectures, distance learning and others. These techniques shall bring an active study-oriented study concept, applied in interactive lectures, seminars, practical activities, independent individual and team work.

The study **assessment system shall ensure feedback to students** about their learning achievements and the justification of assessment of their works.

A **variety of assessment methods** for students’ achievements shall be used.

The system for assessing student achievement should help to shape and monitor progress and evaluate the extent to which study program outcomes are achieved, maintain feedback with students, and create preconditions for improving study programs.

Education studies must apply **different methods for assessment learning outcomes**: written assignments, oral reports, practices, projects and individual work reports, competency portfolio assessment, collegiate assessment, supervisors, public discussions, computer testing and others. Student achievements must be based on clear and objective criteria. The final study work of pedagogical studies should be evaluated as evidence of the achievement of study results, focusing on problem solving by applying quantitative and qualitative research and interpreting and reflecting their results.

When assessing learning outcomes, teachers should follow the principles of objectivity, transparency, impartiality, mutual respect and benevolence.

The methods applied to the assessment of learning achievements shall be based on **clearly formulated criteria** allowing to correctly and reliably reflect the level of knowledge, abilities and skills achieved by the student during (subject) studies. Assessment criteria shall demonstrate how the level of student’s acquired knowledge and skills corresponds to the intended learning outcomes defined by the study programme.

Students shall be given the opportunity to discuss with the teachers/assessors all the aspects of their studies, including their assessments. An appeal concerning the assessment process or assessment grade shall be submitted and considered in the procedure established by a higher education institution.

Individual assessments of students’ study subjects shall not be made public.

1. **Subjects in study field of Physics**

Based on the Bachelor and Master level studies learning outcomes in the study field of Physics the learning outcomes of the subjects and description of subjects, the number of ECTS allocation for each subject and application of teaching, learning and assessment methods must be developed by teaching staff of the universities.

A special **matrix** to determine the **correlation of learning outcomes and the study subjects** that make the programme must be used at the University. The learning outcomes of the programme should be listed in the matrix and be related to single subjects of the programme by which the particular learning outcomes of study programme is developed (Annex 1). Each subject must be described **showing correlation of learning outcomes of the subject with learning outcomes of the study programme** (Annex 2).

When designing a study programme, the needs and recommendations of Physics knowledge-intensive activities and the needs of the state and the public shall be considered. The study programme shall be regularly improved and updated and reflect the new changes of science and methodical studies. Programme developers shall ensure that the study programme includes innovative and relevant topics. The list of recommended subjects for Bachelor level is presented in Annex 3. This list must be updated at least each 3 years to meet the latest scientific developments and society requirements.

1. **Infrastructure, teaching base and staff capacity**

Teaching of subjects, organization of internships and realization of scientific research according to the syllabus drafted in compliance with the study programme of “050503 – Physics” of the higher education institution require infrastructure like: up-to-date practical work labs, supporting research labs, computer rooms, workshops etc. Learners shall have access to local network, internet, databases, e-libraries, search systems of HEI.

As a rule, HEI professor-teaching staff with scientific degrees or titles teach the subjects. Persons from other institutions and organizations meeting these criteria may also be engaged in teaching.

1. **Requirements on final state examination (attestation) and assessment**

Comment from RTA: This part is to be revised as per recommendations in the mission report.

Rules on organization and holding of final attestation are determined by the Cabinet of Ministers of the Republic of Azerbaijan.

1. **Employability and further education of graduate**

Graduates of Physics teacher studies may work in educational institutions, research institutes.

The knowledge, skills and attitudes acquired during Physics studies shall be preconditions for graduates to engage independently in lifelong learning.

**Agreed with:**

Director of Education Problems Institute of the Ministry of Education of the Republic of Azerbaijan

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_A.Mehrabov

Head of higher and specialized education department of the Ministry of Education

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ I.Mustafayev

Chairman of Working Group of developing State Education Standards for Education specialties group

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ M.Jabrayilov

Chairman of the Scientific Methodogical Council for “Physics” of the Ministry of Education of the Republic of Azerbaijan

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ M.Murquzov

**Annex 1. Matrix of correlation of study subjects and learning outcomes** *(to be filled by universities)*

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| **Subject group** | **Subject** | **Learning outcomes** | | | | | | | | | | | | | | | | | | | | | | | |
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| **A1** | **A2** | **A3** | **A4** | **A5** | **A6** | **A7** | **B1** | **B2** | **B3** | **C1** | **C2** | **D1** | **D2** | **D3** | **D4** | **D5** | **E1** | **E2** | **E3** | **F1** | **F2** | **F3** | **F4** |
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**Annex 2. Learning outcomes for particular subjects** *(to be filled by universities)*

**1.**

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| **Subject title** | **Code** |
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**2.**

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| --- | --- |
| **Name of lecturer(s) (provide information as to how, when and where they can be in contact)** | **Department(s)** |
| **Coordinator:**  **Other lecturer(s):** |  |

**3.**

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| --- | --- |
| **Cycle of Subject** | **Type of course unit** |
| Bachelor  Or  Master | Mandatory  or  Optional (elective) |

**4.**

|  |  |  |
| --- | --- | --- |
| **Mode of delivery** | **Year of study and semester when the course unit is delivered** | **Language of instruction** |
| Face-to-face  Or  Distance |  |  |

**5.**

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| **Number of ECTS credits allocated** | **Student’s workload** | **Contact work hours** | **Independent work hours** |
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**6.**

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|  | **Purpose of the subject:** | | |
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| **Learning outcomes of the programme** | **Learning outcomes of the subject** | **Teaching and learning methods** | **Assessment methods** |
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|  | **Course contents** | | | | | | | | | | |
| **Topics** | |  | **Contact work hours and planned learning activities** | | | | | | | **Independent work hours and tasks** | |
| Lectures | Consultations | Seminars | Training exercises | Laboratory work | Internship | Assessment | **All contact work hours** | **Independent work hours** | **Tasks** |
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| **Overall** | |  |  |  |  |  |  |  |  |  |  |

**8.**

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| **Assessment strategy** | **Weighting percentage** | **Period or date of assessment** | **Assessment criteria** |
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**9.**

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| **Required reading** |
|  |
| **Recommended reading** |
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**Annex 3. Recommended list of subjects**

**Teaching Unit 1 : Humanities - 24 ECTS, including :**

Azeri language (5 ECTS)

Foreign language (13 ECTS) of which English (9 ECTS), and another language (Russian, French, German) (4 ECTS)

History (6 ECTS)

**Teaching Unit 2 : Soft skills - 18 ECTS, including :**

Personal and interpersonal development; introduction into management; introduction to the business world/ professional environment (18 ECTS)

**Teaching Unit 3: Physics specific subjects - 103 ECTS, including:**

* **Compulsory subjects - 94 ECTS**

Mechanics & relativity (6 ECTS)

Electrostatics (4 ECTS)

Electricity, electronics (6 ECTS)

Lagrange Hamilton-Jacobi Mechanics (4 ECTS)

Thermodynamics (5 ECTS)

Molecular physics (4 ECTS)

Magnetism (5 ECTS)

Optics (4 ECTS)

Electrodynamics (5 ECTS)

Statistical physics (6 ECTS)

Quantum mechanics (6 ECTS)

Condensed matter physics (6 ECTS)

Modern physics research methods (6 ECTS)

Nuclear physics (3 ECTS)

Practical work / Lab training – Research project (24 ECTS)

* **Elective subjects - 9 to 18 ECTS depending on the internship duration and weight**

Suggested by the institution according to local expertise of the teaching staff, research infrastructures, local and national job perspectives.

**Teaching Unit 4 : Chemistry - 12 ECTS, including :**

Atomistics (4 ECTS)

Molecules and binding (4 ECTS)

Organic chemistry (4 ECTS)

**Teaching Unit 5 : Maths - 32 ECTS, including :**

Analysis-1 (4 ECTS)

Analysis-2 (4 ECTS)

Algebra (6 ECTS)

Analytical geometry (4 ECTS)

Differential and integral calculus (9 ECTS)

Functions of a complex variable (5 ECTS)

**Teaching Unit 6: Computer sciences (Informatics) - 18 ECTS**

Safety rules – 3 ECTS

**Internship** – **21 to 30 ECTS for 6 weeks to one semester duration, including achievement of the internship project, written report, and defense.**

**Annex 4. Short presentation of a study programme of B. Sc. in Physics**

|  |  |  |  |
| --- | --- | --- | --- |
| Bachelor of physics  General studies | | | |
| Type of degree & length | | | *Single degree / 240 ECTS (= 8 semesters)* |
| Institution | | | *Title of HEI: to be completed* |
| Accreditation. Organisations(s) | | | *Ministry of Education, Department of Accreditation and Nostrification* |
| Period of Reference | | | *The study program is validated for x years starting from 2018* |
|  | | | *QF for EHEA: 1st cycle; EQF level 6*  *NQF level: to be completed* |
| **A** | **Purpose** | | |
|  | The purpose of this bachelor programme is to provide education in physics, by considering various types of jobs and careers. Prepare students with a special interest in specialty of Physics in pursuit of higher education areas. | | |
| **B** | **Characteristics** | | |
| 1 | Discipline(s)/ Subject areas | The main discipline is general physics. The partition in % is: physics, mathematics, computer science, chemistry, other (55: 13: 8: 5: 19). | |
| 2 | General/ Specialist Focus | General education in experimental and theoretical physics. | |
| 3 | Orientation | Based on previous research and exposed to current research but with specializations considering opportunities specific to job / career: (subjects of theoretical physics and applied physics) physics, biophysics, medical physics, informatics. | |
| 4 | Distinctive Features |  | |
| **C** | **Employability and further Education** | | |
|  | Employability | Positions in companies / businesses and institutions (research / quality assurance, trade) in the areas of technology and Informatics, biomedical and pharmaceutical, the sector of the environment. Positions in financial institutions. Positions in education. | |
|  | Further Education | Master's programmes in Physics (theoretical physics, applied physics), interdisciplinary programs related to Physics (Biophysics, medical physics, geophysics), master's programmes in engineering / physics technology or computer science. | |
| **D** | **Educational style** | | |
|  | Learning/ teaching approaches | Lectures, classes of lab, tutorials, individual study based on text books and reading notes, individual consultations with teachers, internship in a research lab on a given topic. | |
|  | Assessment method | Written tests, oral tests, lab reports, oral presentations, ongoing evaluation, public presentation and defence of the internship project | |
| **E** | **Programme competences** | | |
| 1 | GENERIC   * Ability to communicate effectively in writing and orally in first and one foreign language * Ability for abstract thinking, analysis and synthesis, and to develop argumentation with critical mind. * Ability to identify, select, analyse and summarize various specialized resources to document a subject * Ability to use digital tools of reference and rules of computer security to acquire, process, produce and disseminate information as well as to collaborate internally and externally * Ability to plan and organise one’s own activities, self-learning and skills enhancement * Ability to act with social and environmental responsibility, civic awareness and ethical reasoning * Able to step back from a situation, self-evaluate and questioning himself in order to improve knowledge and skills * Ability to establish their role and mission within an organization, to adapt and take initiatives. * Ability to work as part of a team while being independent and responsible with respect to a project | | |
| 2 | SUBJECT SPECIFIC   * Mobilize fundamental concepts in order to simulate, analyze and solve simple physics problems. * Identify and lead independently the different steps of an experimental approach using common devices and techniques in the different fields of physics. * Analyze and exploit experimental data, taking into account sources of errors and uncertainty and probe a model by comparing its predictions to the experimental results * Use a programming language and analysis software with a critical mind to collect and exploit data * Use the main mathematical tools relevant for physics. * Apply concepts and experimental methods of physics in the fields of civil engineering, fluid and solid mechanics and mechanical engineering, thermodynamics and heat, materials physics, chemical sciences, geosciences, astronomy. * Identify specific regulations and implement the main prevention measures in terms of health, safety and environmental responsibility | | |
| **F** | **Programme learning outcomes** | | |
|  | * Communicate in Azeri and in English in the academic setting * Describe and apply the scientific approach and the scientific reasoning * Demonstrate methodological, technical and practical skills useful to the resolution of the problems in physics. * Use the current office computer applications (commercial and/or free) * Learn and act autonomously. * Show an inclusive way to apply their knowledge * Demonstrate the ability to be aware of what is not understood * Identify the functional organizational chart and hierarchy * Develop a range of leadership skills and abilities * Work in a team and collaborate with students and teachers in order to achieve common objectives and to produce results. * Demonstrate a thorough knowledge of the basic knowledge of physics and master and use the basic concepts of mathematics. | | |

**Annex 5. Master in Physics – Example of a list of subjects according to University of Strasbourg example (maybe not suitable for Azerbaijani institutions: see footnote 2)**

*The structure of the curriculum is a common core for the 1st year, and specialization during the second year (example is given for a master in physics, condensed matter physics & nanophysics, research oriented, i.e. designed for issuing in a PhD as the professional issue).*

**1st semester**

**Teaching Unit 1 : Quantum mechanics & statistical physics - 9 ECTS**

**Teaching Unit 2 : Programming & present days research in physics - 6 ECTS**

**Teaching Unit 3 : Experimental physics 1 - 6 ECTS**

**Teaching Unit 4 : Electives[[1]](#footnote-1) / 2 subject modules to be chosen by student among the following - 6 ECTS**

* **Mechanics of continuous media**
* **The constituents of Universe and their observation**
* **Group theory**
* **Ionizing radiations and their detection**
* **General relativity**
* **Nanostructures and nanophysics**
* **Mentored project**
* **Arow of time & advanced statistical physics**
* **Variational principles and analytical mechanics**
* **Introduction to quantum collisions**
* **Critical phenomena and out of equilibrium statistics**

**Teaching Unit 5**  **:**  **‘Free’ electives (i.e. electives to be chosen by student and validated by the head of master) / 3 ECTS**

**2nd semester**

**Teaching Unit 1 : Nuclear mattet, elementary particles, and condensed matter physics - 9 ECTS**

**Teaching Unit 2 : Computer programming and numerical simulation 1 - 3 ECTS**

**Tecahing Unit 3 : Physics at the lab - 12 ECTS**

**Teaching Unit 4 : Electives2 / 1 subject module to be chosen by student among the following subject modules - 3 ECTS**

* **Particles & astroparticles**
* **Physics of stars**
* **Atomic & molecular physics**
* **Relativistic quantum mechanics**
* **Mentored project**
* **Introduction to the physics of living**
* **Numerical applications in physics**
* **Soft matter physics**
* **Optics & photonics**

**Teaching Unit 5 – Free option (validated by the head of master) - 3 ECTS**

**3rd semester**

**Teaching Unit 1 : Advanced quantum mechanics – applications to condensed matter physics - 6 ECTS**

**Tecahing Unit 2 : Light-matter interaction – applications to condensed matter physics - 6 ECTS**

**Teaching Unit 3 : Advanced statistical physics – out of equilibrium processes - 6 ECTS**

**Teaching Unit 4 : Electives2 / 4 subject modules to be chosen by student among the following - 9 ECTS**

* **Mentored project: computer processing of a project in physics**
* **Magnetism and magnetic nanostructures**
* **Theory and modeling of the electronic structure of solids**
* **Spintronics**
* **Optical microscopies**
* **Interactions in soft condensed matter**
* **Surfaces and Interfaces in soft condensed matter**
* **Electron dynamics: charges and spins**
* **Electronic properties of low dimensional systems**
* **Biophysics**
* **Scanning probe microscopies**
* **Many-body physics applied to condensed matter**
* **Dynamics of complex systems**
* **Scattering technics for condensed matter**
* **Open quantum systems**
* **Electron microscopy**

**Teaching Unit 5 : Free option (validated by the head of master) - 3 ECTS**

**4th semester**

**Internship : 15 weeks internship / written report & defense / 30 ECTS**

**Annex 4. Short presentation of a study programme of M. Sc. in Physics**

|  |  |  |  |
| --- | --- | --- | --- |
| MASTER of physics  CONDENSED MATTER PHYSICS AND NANOPHYSICS | | | |
| Type of degree & length | | | *Single degree / 120 ECTS (= 4 semesters)* |
| Institution | | | *Title of HEI: to be completed* |
| Accreditation. Organisations(s) | | | *Ministry of Education, Department of Accreditation and Nostrification* |
| Period of Reference | | | *The study program is validated for x years starting from 2018* |
|  | | | *QF for EHEA: 1st cycle; EQF level 6*  *NQF level: to be completed* |
| **A** | **Purpose** | | |
|  | The purpose of this master programme is to to form physicists, experimentalists and theorists in the field of condensed matter. This curriculum aims to develop, characterize and understand polymeric or solid objects, and particularly those of reduced size down to a nanometer size. The teaching and research courses are mostly devoted to electronic, optical, magnetic properties and their combinations being strongly oriented towards the study of new phenomena related to the size of the samples. | | |
| **B** | **Characteristics** | | |
| 1 | Discipline(s)/ Subject areas | The main discipline is advanced physics. The partition in % between experimental and theoretical courses is 30:70. | |
| 2 | General/ Specialist Focus | Specialized in nanophysics | |
| 3 | Orientation | Exploring and /or exploiting the nano-world in all classes of materials | |
| 4 | Distinctive Features | Able to access a clean-room for nano-fabrication and characterization of nano-objects | |
| **C** | **Employability and further Education** | | |
|  | Employability | Application to PhD positions within HEI institutions. Positions as R&D engineer within forefront technological companies or start-ups, in the field of nanotechnology | |
|  | Further Education | PhD in physics | |
| **D** | **Educational style** | | |
|  | Learning/ teaching approaches | Lectures, classes of lab, tutorials, individual study based on text books and reading notes, individual consultations with teachers, internship in a research lab or a company based on a one semester project | |
|  | Assessment method | Written tests, oral tests, lab reports, oral presentations, ongoing evaluation, public presentation and defense of the internship project | |
| **E** | **Programme competences** | | |
| 1 | GENERIC   * Ability to work in a team, in an interdisciplinary and international environment * Ability to address and respond well to situations in a new and original ways within the given context * Ability to identify, analyse and define the significant elements constituting a problem in order to solve it effectively and with good criteria * Ability to do fundamental and applied research and apply its results independently for solving tasks in new or unfamiliar environment, implement innovations | | |
| 2 | SUBJECT SPECIFIC   * Document in an exhaustive and synthetic way an emerging research subject in his field of competences * Identify, analyze and assimilate the main concepts of the new research theme * Build, plan and implement a starting research project * Design and implement an experimental and/or theoretical approach on a research problematic of its disciplinary field, using autonomously experimental methods and adapted scientific equipments. * Formatting and presenting research results according to international standards of the field for oral presentation and publication in A level scientific reviews * Integrate and contribute autonomously to a collaborative research project | | |
| **F** | **Programme learning outcomes** | | |
|  | GRADUATE   * is familiar with contemporary research within various fields of physics and related fields, specially addressing nanoscience and nanotechnology * has an international perspective on her/his discipline * is able to gather, assess, and make use of new information. * is able to enter new problem areas that require an analytic and innovative approach. * can critically and independently assess and evaluate research methods and results. * has the ability to develop and renew scientific competence -- independently, via courses or through PhD studies in physics or related disciplines. * work in a team and collaborate with students and teachers in order to achieve common objectives and to produce results. * demonstrate a thorough knowledge of the basic knowledge of physics and master and use the basic concepts of mathematics. * has the background and experience required to model, analyse, and solve advanced problems in physics. * has substantial knowledge in physics, basic knowledge in mathematics, and knowledge in supporting fields like computer science. * has some research experience within a specific field of physics, through a supervised project. * is able to apply advanced theoretical and/or experimental methods, including the use of numerical methods and simulations. * can disseminate subject matter and results to both specialists and a broader audience. * has the ability to successfully carry out advanced tasks and projects, both independently and in collaboration with others, and also across disciplines. | | |

1. Theses options are selected according to the local research expertise and infrastructure [↑](#footnote-ref-1)