21-22

DEGREE

MÁSTER UNIVERSITARIO EN FÍSICA AVANZADA

CODE 215801

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INTRODUCTION

This master's degree is conceived as an academic training and initiation to research in Advanced Physics, complementary to undergraduate studies in Physics. Students can establish their own curricular lines, according to their expectations, being advised by the Master's tutor assigned by the Coordination Committee.
The Master's Degree in Advanced Physics is a postgraduate program of 60 ECTS credits, with five modules and three specialties: Theoretical Physics, Computational Physics, and Fluid Physics. More than 20 professors and researchers with recognized teaching and research experience in the areas of the different subjects of the degree guarantee its quality.
The social demand for research in the area covered by the Master's Degree in Advanced Physics is very notable, which undoubtedly has an impact on the sustainability of the degree. This demand is evidenced by the repercussion in the media of the news on the applications of neural networks, data science, advances in the discovery of new elementary particles such as the Higgs Boson, artificial intelligence, or the very worrying climate change. The mathematical methodologies and techniques learned in this master's degree, in addition to applications to physical systems, can be used in a wide range of disciplines, such as sociology, climatology and economics. Many of the big questions posed by researchers and citizens, such as those mentioned above, correspond to some of the research lines in which the student is initiated in the Master in Advanced Physics and in which the researchers assigned that participate in it work actively.

OBJECTIVES AND COMPETENCES

The objective of the Master's Degree in Advanced Physics is to expand the general studies of the Degree in Physics. It provides a deep knowledge in different areas of Physics, including fundamental theoretical aspects, computational and experimental methods and techniques, technological applications, etc. Mainly, the Master is focused on forming academic and research profiles. By taking this Master's Degree, the students will delve into areas of physics that are applicable to different fields of Science. They will also acquire the necessary skills to start a PhD, and to enter into the labor market in various areas: Physics, Mathematics, Biophysics, Physical Chemistry, Materials Engineering, Econophysics, Sociophysics, and so on.
Graduate students will know and understand the most relevant and current concepts of theoretical, computational and fluid physics. They will know how to deepen their understanding of cutting-edge theories in these fields, including their mathematical structure, their comparison with experimental results, and the description of the physical phenomena that these theories explain. They will acquire the ability to tackle and solve challenging problems in theoretical, computational or fluid physics, through the appropriate choice of the theoretical context, the identification of the relevant concepts and the use of the mathematical techniques that constitute the best approach to obtain the solution.

CAREER OPPORTUNITIES

This master's degree does not have specific professional attributions since it falls within the field of fundamental research. As such, its main objective is to train future researchers in areas related to the lines of research that are developed in the Faculty of Sciences of the UNED. This master's degree will study aspects of physics that are directly applicable to different fields of science. Its academic and research orientation will allow a graduate to develop a set of skills aimed at deepening in each of the areas covered and allow the subsequent performance of research work, leading for example to the completion of a doctorate.

The research orientation of the master's degree is of interest to prospective students, not only because it provides them with the possibility of starting an academic career, but also because it allows them to access professional opportunities with a research profile in industry. The research areas in which the professors of the master's degree develop their activity are related to the three specialties offered: theoretical physics, physics of fluids and computational physics. These areas include, among others:

- Statistical mechanics: critical phenomena, synchronization, neural systems, polymers, fluctuations, stochastic resonance, statistical mechanics of out-of-equilibrium systems, biophysics, sociophysics.
- Density functional theory: fundamentals, information theory, cooperative effects, superconductors.
- Quantum mechanics: quantum technologies, quantum complex systems, quantum information, quantum many-body systems, conformal field theory.
- Fluid mechanics and complex fluids: hydrodynamic instabilities, turbulence, rheology, magneto-rheological fluids, mesoscopic description of fluids, liquid crystals, colloidal systems, polymeric fluids, transport phenomena in fluids, multiphase flows, reactive flows.
- New materials and interfaces: nanometric aggregates, liquid-solid interface, spatiotemporal dynamics of threshold processes (fracture of materials and friction between solids), study of ices and aggregates of atmospheric and astrophysical interest, instabilities in liquids with free surfaces, stability of fronts in crystalline growth, kinetic roughness theory of surfaces, heterogeneous kinetics at interfaces, surface growth.
- Aggregation, particles, aerosol mechanics: transport properties of particles and vapors in gases, nucleation, condensation, deposition and coagulation of particles, structure and morphology of granular deposits, electrosprays, electrohydrodynamic atomization of liquid suspensions.
- Energy: dynamics of flame propagation, combustion, fuel cells.
- Medical imaging and remote sensing: remote sensing and hydroacoustics, medical imaging, magnetic resonance imaging.
- Classical and quantum general relativity: observers, observables and measurement processes.

Researchers trained in these and other aspects, both in characterization techniques and in analytical and numerical prediction techniques, are of maximum interest for industrial sectors as varied as:

- The petrochemical industry, particularly in the development of models for the optimization of hydrocarbon transport. The behavior of complex fluids is studied in detail in several subjects of the study plan, which allows to deepen the knowledge of this type of problems. It is not only a theoretical formulation of the physical fundamentals of complex fluids, but the behavior of these fluids confined in different elements is studied in detail, allowing the extraction of properties that are useful in practice.
- The energy industry, particularly that focused on renewable energy solutions such as solar energy, is also very interested in the study of complex fluids. The development of products that enable the transport and storage of sustainable forms of energy requires not only experimentation, but the development of theoretical models that are seen in depth in the Master's studies.
- Industrial sectors with processes involving polymeric fluids, emulsions, suspensions or interfacial processes.
- Sectors such as the design of advanced materials (including nanodevices, biosensors and, in general, functionalized nanomaterials).
- The development of renewable energy sources (photovoltaic devices, for example).
- Medical technology sectors, in the field of diagnostic imaging and instrumentation.
- The aerospace industry which, in addition to its traditional interest in research in aerodynamics and turbulence problems, develops research activities in lines related to the topics of the master's degree, such as new structural materials that improve mechanical properties, or microfluidics.
- Innovation companies in Information Technology and information security.

The training acquired by our students also makes them very competitive in scientific knowledge management sectors such as university-industry knowledge transfer offices, quality control and assurance companies, and specialized software design.

ACCESS PREREQUISITES

Access to official Master's Degree courses

The requirements are those established in article 16.1 of Royal Decree 1393/2007, of October 29, which establishes the organization of official university education: "In order to access official Master's degree courses, it will be necessary to hold an official Spanish university degree or another issued by a higher education institution belonging to another member state of the European Higher Education Area that entitles access to Master's degree courses in that country".

Likewise, graduates from educational systems outside the European Higher Education Area may be admitted without the need for the homologation of their degrees, after verification by

the University that they accredit a level of education equivalent to the corresponding official Spanish university degrees, and that they are authorized in the country issuing the degree to enroll in postgraduate studies. Access by this route will not imply, in any case, the homologation of the previous degree held by the interested party, nor its recognition for purposes other than that of taking the Master's degree.

Specific requirements for access to the Master's Degree

The preferred entrance qualification is that of graduate or undergraduate in Physics. If there is sufficient accredited training in physics studies, students with a degree in Mathematics, a degree in Chemistry, a degree in Engineering or related areas will also be considered for admission.

ADMISSION CRITERIA

The admission and selection of students to the Master's Degree in Advanced Physics will be based on the academic background and the evaluation of the applicant's Curriculum Vitae. It will be carried out by the Master's Coordination Committee, which will also assign a Master's Tutor to each of the admitted students. The Master's Tutor will advise the student, during the duration of his or her studies, on the completion of the appropriate courses that will allow him or her to develop a curricular line adapted to the needs and objectives of the interested party. The Master's Coordination Committee will evaluate each application for admission taking into account the degree and the student's previous training. The Commission may require, in exceptional cases, an interview with the applicant before accepting or denying admission.

The evaluation of the admission criteria is as follows:

•Adequacy of the degree (title and credits): up to 4 points.

•Average grade of the academic record: up to 4 points.

•Curriculum Vitae (professional experience will be valued): up to 2 points.

In the case of students with special educational needs derived from any disability, they will be provided with the appropriate support and counseling services, which will evaluate the need for possible curricular adaptations, itineraries or alternative studies. For this type of students, the UNED has a Center for Attention to University Students with Disabilities (UNIDIS), a service under the Vice-Rectorate for Students of the UNED, whose main objective is that students with disabilities who wish to study at this University can enjoy the same opportunities as the rest of the students of the UNED. To this end, UNIDIS coordinates and develops a series of actions aimed at assistance, support and advice to enable them, as far as possible, a full development in the field of university life. UNIDIS serves as an interlocutor for students with special educational needs, requesting the teaching staff to prepare specific teaching material or special exams (with audiotape response, written on computer, etc.).

NUMBER OF NEW STUDENTS

The maximum number of new admission places is 75 in each academic year.

CURRICULUM

GENERAL OVERVIEW OF THE CURRICULUM

1. Basic outline

The Master´s Degree in Advanced Physics is a university postgraduate study program of 60 ECTS credits, and consists of five modules and three specialties. All subjects (except the Master´s Thesis, TFM) are 6 ECTS credits. The TFM is 12 ECTS credits and is carried out in the second semester of the course.

COMPULSORY MODULE		
1C –Advanced numerical methods		
1C –Complements of mathematical methods		
THEORETICAL PHYSICS MODULE	**COMPUTATIONAL PHYSICS MODULE**	**FLUID PHYSICS MODULE**
1C –Information theory	1C - Modeling and simulation of complex systems	1C - Statistical mechanics of complex fluids
1C - Density functional theory	1C - Introduction to science and data analysis	1C - Compressible fluid dynamics
1C –Field Theory	1C - Digital image processing	1C - Mechanical properties in soft matter
2C –Relativistic effects in curved space-times	2C –Out-of-equilibrium growth	2C - Instabilities and turbulence
2C –Introduction to quantum information and computing	2C - Neural and complex networks	2C - Transport phenomena
2C - Quantum methods in polyatomic systems	2C - Sociophysics and social networks	2C - Microhydrodynamics
MASTER´S THESIS MODULE		
2C –Master´s Thesis (TFM)		

Table 1. MFA´s curriculum. 1C –First semester. 2C –Second semester.

2. Time sequence

All students must study 3 compulsory subjects (one of them, the TFM) and 6 optional subjects out of the 18 available, which guarantees a sufficient level of electiveness. Master´s

curriculum is organized in such a way that a full-time enrolled student can study 30 ECTS credits per semester:

•*First semester (5 subjects, 30 credits)*

12 credits of the compulsory module, in two subjects.

18 credits of any of the modules of specialty. The student must choose three subjects from among the nine optional subjects taught during the first semester.

•*Second semester (4 subjects, 30 credits)*

18 credits of any of the modules of specialty. The student must choose three subjects from among the nine optional subjects taught during the second semester.

12 credits of the Master´s Thesis module.

In view of the specificity of the UNED, where 80% of the students carry out their studies part-time, we can propose an alternative itinerary that encompasses two academic years, with between 12 and 18 ECTS credits per semester:

•*Year 1. First semester (3 subjects, 18 credits)*

12 credits of the compulsory module, in two subjects.

6 credits of any of the modules of specialty. The student must choose one subject from among the nine optional subjects taught during the first semester.

•*Year 1. Second semester (3 subjects, 18 credits)*

18 credits of any of the modules of specialty. The student must choose three subjects from among the nine optional subjects taught during the second semester.

•*Year 2. First semester (2 subjects, 12 credits)*

12 credits of any of the modules of specialty. The student must choose two subjects from among the nine optional subjects taught during the first semester.

•*Year 2. Second semester (1 subject, 12 credits)*

12 credits of the Master´s Thesis module.

3. Training itineraries

The Master's curriculum includes three specialties:

•*Specialty in Theoretical Physics*

•*Specialty in Computational Physics*

•*Specialty in Fluid Physics*

To get the specialty mention, a student must complete at least 24 ECTS credits (4 subjects) of the module of the same name.

A student who takes less than 24 credits of the same specialty module, may obtain the title of Master's Degree in Advanced Physics, and no specialty will be associated to the degree obtained.

4. Modules

•*Compulsory Module*

This module contains two compulsory subjects with transversal nature that provide the students with the mathematical and computational tools that will be necessary for the rest of the subjects, regardless of the itinerary they follow.

•*Theoretical Physics Module*

This module, which allows the specialty degree in theoretical physics, provides advanced training in those areas of knowledge of the theoretical physics that are preliminarily studied in undergraduate studies: field theory, density functional theory, and information theory.

•*Computational Physics Module*

This module corresponds to the specialty of computational physics, and develops abilities and skills typical of those branches of physics based on information technologies and the simulation of physical processes using computers.

•*Fluid Physics Module*

This module is associated with the specialty of fluid physics, and provides students with advanced training in fluid phase systems, both in equilibrium and in out-of-equilibrium conditions.

•*Master´s Thesis Module*

The completion of a Master's Thesis is mandatory for all MFA students, as specified in the regulation of official university education (Real Decreto 1393/2007).

RULES

PRACTICES

Given the academic and research nature of the master's degree and taking into account the profile of UNED students, who generally combine their studies with professional activity, no external internships are foreseen.

Some lines of the Master's Thesis may have an experimental component to be developed in laboratories. In these cases, the assignment of the Thesis by the students will be subject to the feasibility of attending them. This work may be carried out in laboratories at the UNED Headquarters (Madrid) or through collaboration agreements with prestigious national and international laboratories.

OFFICIAL DOCUMENTATION

De acuerdo con la legislación vigente, todas las Universidades han de someter sus títulos oficiales a un proceso de verificación, seguimiento y acreditación.
En el caso de la UNED, el Consejo de Universidades recibe la memoria del título y la remite a la ANECA para su evaluación y emisión del Informe de verificación. Si el informe es favorable, el Consejo de Universidades dicta la Resolución de verificación, y el Ministerio de Educación eleva al Gobierno la propuesta de carácter oficial del título, ordena su inclusión en el Registro de Universidades, Centros y Títulos (RUCT) y su posterior publicación en el Boletín Oficial del Estado.
Los títulos oficiales de máster han de renovar su acreditación antes de los seis años, desde la fecha de inicio de impartición del título o de renovación de la acreditación anterior, con el objetivo de comprobar si los resultados obtenidos son adecuados para garantizar la continuidad de su impartición. Si son adecuados, el Consejo de Universidades emite una Resolución de la acreditación del título.
Estas resoluciones e informes quedan recogidos en el Registro de Universidades, Centros y Títulos (RUCT).

VERIFICACIÓN / MODIFICACIÓN

•Memoria del Título

•Informe de Verificación de la ANECA

•Resolución de verificación del Consejo de Universidades

•Informe/s de modificación del Plan de Estudios

•Inscripción del Título en el Registro de Universidades, Centros y Títulos

•Publicación del Plan de Estudios en el BOE

SEGUIMIENTO

ACREDITACIÓN

INTERNAL QUALITY ASSURANCE SYSTEM FOR THE TITLE

PROFESSIONAL ATRRIBUTIONS

This master's degree does not give access to regulated professions.

GENDER EQUALITY

Consistent with the assumed value of gender equality, all the denominations that in this Guide refer to single-person, representative, or members of the university community and are made in the masculine gender, when they have not been replaced by terms generic, shall be understood as interchangeably in female or male gender, depending on the sex of the holder who performs them.