

20-21

DEGREE



# MÁSTER UNIVERSITARIO EN FÍSICA DE SISTEMAS COMPLEJOS

CODE 215601

UNED

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## INTRODUCTION

This master's degree is intended as an academic training and/or initiation to research in advanced physics, and complements undergraduate studies in Sciences (Physics, Chemistry, Mathematics) and Engineering. Students are allowed to establish their own curricular lines according to their expectations, being always advised by a master's tutor who is assigned by the Coordinating Committee.

From a general point of view, complex systems are characterized by a rich and complicated behavior rather than by their intrinsic definition. They appear in many and very diverse fields: Physics, Mathematics, Biology, Chemistry, Engineering, Economics, etc. These systems are characterized by the existence of a very high number of "agents" that interact with each other. As a consequence, new emergent behaviors, and in many cases surprising, arise. Following the approach of Statistical Mechanics, which successfully interpreted Thermodynamics as the macroscopic (emergent) statistical result of the interaction of a large number of atoms or molecules (microscopic agents), the more general field of Statistical Physics has extended its scope during the 20th Century to include these "complex systems", hence the current name of "Physics of Complex Systems".

For a summary of the master's degree and its contents the following keynote is available: presentation (in spanish).

## OBJECTIVES AND COMPETENCES

Master's program includes a set of training activities aimed at providing a solid postgraduate skills with the following objectives: the initiation to research activities and the academic specialization in the field of Physics of Complex Systems. Two main topics are addressed: systems exhibiting complex temporal or spatio-temporal dynamics, and systems displaying emergent properties as the level of complexity increases.

It is expected that graduated students will achieve the following skills:

- To develop and apply their own original ideas within the context of research. For that purpose they must broaden their previous foundation in physics and gain a specialized knowledge in specific aspects of the Physics of Complex Systems such as: the different levels of description of physical phenomena (microscopic, mesoscopic and macroscopic), the qualitative properties of the dynamics equations and their dependence on parameters, the importance of noise and fluctuations, and the relationship between the microscopic elements of a system, their interactions and the system geometry, with the macroscopic properties.
- To apply the knowledge achieved to solve practical problems both in the academic and professional domain. This will be accomplished by improving their capabilities in modeling and simulation, as well as their experimental skills, in aspects related to the construction of numerical models, the design of experimental systems, and the knowledge of the properties and microscopic structure of solid materials and fluids.

## CAREER OPPORTUNITIES

This master is not focused on professional practice. Master's program is highly focused on research and academic specialization. Main professional outings include teaching and professional research in public and private organizations. The research-based approach followed in the master may facilitate access to professional outings with a research profile in the industry.

The study of complex systems is not only part of basic science and research, but it is also part of applied areas of innovation in a wide variety of fields. As examples we can mention: the study and decoding of the human genome, the analysis and prediction of the evolution of indicators and economic (Stock Market, macroeconomic data) or industrial variable (electrical or water consumption), the design and manufacture of new materials (for the semiconductor industry, plastics and polymers, etc.) or the study of meteorology and the global ocean dynamics. We can also cite the field of complex fluids as one of the most active ones in the demand for researchers in the industry. Indeed, the relationship between microscopic structure and macroscopic dynamics achieves utmost relevance in every industrial process involving polymeric fluids, emulsions, suspensions or interfacial processes. From this perspective, this program is aimed at training researchers in methods for studying complex systems and their scientific and technological applications. Furthermore, since the study of complex systems involves topics that traditionally and academically belonged to different fields, the master program has a strong interdisciplinary nature.

## ACCESS PREREQUISITES

In order to access the Master, it is necessary to have an official Spanish university degree or another official degree issued by a higher education institution of the European Higher Education Area, and which entitles to access Master's courses in the country that issued the title. The required degrees are Bachelor or Graduate in Physics, Chemistry, Mathematics or Engineering.

- It is mandatory to have a solid foundation in different subjects of physics that are considered as necessary to adequately follow the program: mechanics, thermodynamics, quantum physics, statistical physics and others.
- Although no language degree is required, applicants should be aware that **this degree is taught in Spanish**. Study materials may include documents, videos, and articles both in Spanish and English.

Graduates from educational systems outside the European Higher Education Area may also access the Master without the need for the homologation of their degrees, after verification by the University that they accredit a level of academic training equivalent to the corresponding official Spanish university degrees and that they authorise access to postgraduate studies in the country issuing the degree.

Access through this route will not imply, in any case, the homologation of the previous degree of the applicant nor its recognition for other purposes than that of accessing the master's degree.

## ADMISSION CRITERIA

Selection and admission of students to the Master in Physics of Complex Systems will be based on the academic training and the Curriculum Vitae of the applicant.

The process will be carried out by the Coordinating Committee of the Master, which will also assign a master's tutor to each admitted student. During the studies, the master's tutor will provide the student with advice on the suitability of the courses available in order to develop a curricular line adapted to his/her needs and objectives. The Coordinating Committee will evaluate each admission application taking into account the qualification of access and the education in physics and mathematics. The Coordinating Committee may also request an interview with the applicant.

In any case, when choosing the courses for their curricular adaptation, the students will be always supervised by the master's tutor assigned to them when they are admitted to the program.

Weighting of the admission criteria:

- Average grade of the degree that allows access: 60%
- Other complementary qualifications related to the contents of the master: up to 20%
- Professional experience related to the area of knowledge of the master: up to 10%
- Other aspects of the Curriculum Vitae: up to 10%

In the case of students with degrees other than the Degree in Physics, the Coordinating Committee will assess the syllabus of the corresponding degree paying special attention to those courses related to physics and mathematics, and will exclude those students who have insufficient training in these subjects.

## NUMBER OF NEW STUDENTS

The maximum number of new students that will be admitted to this master is 50 per academic year.

## CURRICULUM

Type of course	First semester	Second semester
Compulsory	Introduction to Nonlinear Science	
	Fluctuations in Dynamical Systems	Advanced Numerical Methods
	Selective	Advanced Statistical Mechanics
Neural Networks and Complex Networks	Statistical Mechanics of Complex Fluids	Transport Phenomena: Simulation Techniques in Fluids
Physics of Continuous Media: General Formalism and Applications	Instabilities and Turbulence	Compressible Fluid Dynamics
Microscopic Processes in Condensed Matter	Density Functional Theory: Electronic Systems	Modelization and Simulation of Complex Systems
Electronics	Sociophysics and Social Networks	Compulsory

### Distribution of ECTS by type of credit

Type	ECTS
Compulsory.....	18
Selective.....	30
Master's Thesis.....	12
<b>Total.....</b>	<b>60</b>

European credits ECTS stand for a measure of the workload needed to complete the program of studies. One ECTS represents 25 hours of study, although the number of hours required a week may vary throughout the course. Before enrollment, it is convenient to estimate the daily time available to prepare the courses according to these measures.

## RULES

- RD 1393/2007, de 29 de octubre, por el que se establece la ordenación de las enseñanzas universitarias oficiales
- RD 861/2010, de 2 de julio, por el que se modifica el Real Decreto 1393/2007, de 29 de octubre, por el que se establece la ordenación de las enseñanzas universitarias oficiales
- RD 43/2015, de 2 de febrero, por el que se modifica el Real Decreto 1393/2007, de 29 de octubre, por el que se establece la ordenación de las enseñanzas universitarias oficiales, y

el Real Decreto 99/2011, de 28 de enero, por el que se regulan las enseñanzas oficiales de doctorado.

- Actualización de los procedimientos de organización y gestión académica de los Másteres Universitarios oficiales y Doctorado de la UNED, para su adaptación en lo dispuesto en el RD. 1393/2007.
- Normas y criterios generales de reconocimiento y transferencia de créditos para los másteres.
- Normas de permanencia en estudios conducentes a títulos oficiales de la Universidad Nacional de Educación A Distancia.
- Regulación de los trabajos de fin de master en las enseñanzas conducente al título oficial de master de la UNED.

## PRACTICES

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

The only practical part of the Master is the Master's Thesis (TFM). During the TFM the student will be supervised by a tutor.

### TFM Guidelines

Master's professors will propose different topics for the TFM.

Each student will be assigned a TFM. This assignment will be carried out trying to balance the offer of TFM matters proposed by the Master's professors and the demand of TFMs from the students.

The TFM can be defended provided the student has passed the remaining courses (48 ECTS).

The defense of TFM must be public and before a committee made up of 3 faculty members/researchers. The defense must be in person at the Faculty of Sciences or through webconference from an Associated Center of the UNED .

## OFFICIAL DOCUMENTATION

It is required by law that all universities submit their official degrees for a verification, monitoring and accreditation process.

In the case of the UNED, the Council of Universities receives the memory of the degree and sends it to the National Quality Agency (ANECA) for its evaluation and issuance of the Verification Report. If the report is favorable, the Council of Universities dictates the Resolution of Verification, and the Ministry of Education submits to the Government the official proposal of the degree, orders its inclusion in the Registry of Universities, Centers and Degrees (RUCT) and its subsequent publication in the Official State Gazette.

Official master's degrees must renew their accreditation before four years from their verification or from the date of their last accreditation, in order to check whether the results obtained are adequate to guarantee the continuity of their teaching. If they are adequate, the Council of Universities issues a Resolution accrediting the degree.

These resolutions and reports are recorded in the Registry of Universities, Centers and Degrees (RUCT).

Official documentation (in Spanish)

### **VERIFICACIÓN / MODIFICACIÓN**

- Memoria del Título
- Informe de Verificación de la ANECA
- Resolución de verificación del CU
- Inscripción del Título en el Registro de Universidades, Centros y Títulos
- Publicación del Plan de Estudios en el BOE
- Informe/s de modificación del Plan de Estudios

### **SEGUIMIENTO**

- Informe de seguimiento del título

### **ACREDITACIÓN**

- Informe de renovación de la acreditación 2014
- Resolución de acreditación del CU 2015
- Informe de renovación de la acreditación 2019
- Resolución de acreditación del CU 2019

## INTERNAL QUALITY ASSURANCE SYSTEM FOR THE TITLE

The UNED has an Internal Quality Assurance System (SGIC-U) that covers all its official undergraduate, master and doctorate degrees, as well as the services it offers, the design of which was certified by the Spanish National Quality Agency ANECA.

The SGIC-U includes all the processes necessary to ensure the quality of its teaching staff,

resources and services for students: access, admission and reception, external internships, mobility programs, academic orientation and job placement, monitoring and evaluation of training results, attention to suggestions and complaints and the adequacy of support staff, among others.

The members of the SGIC are:

- The Degree Coordinating Committee
- The Center's Quality Assurance Committee
- The Dean or Director Team
- The UNED Quality Assurance Committee

Through the Statistical portal, the UNED provides information to the entire university community both on the training results and on the satisfaction results of the different groups involved.

SGIC documents (in spanish):

- Principales resultados de rendimiento
- Resultados de satisfacción de los diferentes colectivos
- Objetivos de Calidad del Centro

## PROFESSIONAL ATTRIBUTIONS

This master does not give access to regulated professions.

## COMISION COORDINADORA DEL MASTER

- Ángel Maroto Valiente (President of the Coordinating Committee),
- Jaime Arturo de la Torre Rodríguez (Coordinator of the Master Program),
- Pedro Córdoba Torres (Secretary of the Master Program),
- Emilia Crespo del Arco (Departamento de Física Fundamental),
- Elka Korutcheva (Departamento de Física Fundamental),
- Víctor Fairén Le Lay (Departamento de Física Interdisciplinar),
- Belén Gallardo Almela (Administrative staff),
- Carlos López Garre (Student).

Contact: ciencias.posgradosoficiales@adm.uned.es

## QUIERO MATRICULARME EN EL MASTER

### PRE-REGISTRATION / ADMISSION

**All students who wish to enroll for an Official Master's Degree at UNED must make an application for admission on the UNED website [www.uned.es](http://www.uned.es). Search and consult the**

**UNED page:**

**Masteres Universitarios EEES**

**for detailed information on pre-registration and enrollment deadlines.**

Students with a non-homologated foreign degree must request, prior to pre-registration, the authorization of the Rector to study in the university, and according to the established procedure.

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## **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.