

General information**Course unit name:** Complex Systems**Course unit code:** 572561**Academic year:** 2015-2016**Coordinator:** ALBERT DIAZ GUILERA**Department:** Department of Condensed Matter Physics**Credits:** 3**Single program:** S

Estimated learning time	Total number of hours 75
Face-to-face learning activities	30
- Lecture	24
- Seminar	6
Supervised project	15
Independent learning	30

Competences to be gained during study**BASIC**

CB6 – Having knowledge and understanding that provides a basis or opportunity for originality in developing and/or applying ideas, often in a research context.

CB7 - That the students can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.

CB8 - That students are able to integrate knowledge and handle complexity and formulate judgments based on information that, although incomplete or limited, includes reflections on social and ethical responsibilities linked to the application of their knowledge and judgments.

CB9 - That students can communicate their conclusions and the underpinning knowledge and rationale to specialists and non-specialists in a clear and unambiguous manner.

CB10 - Students must possess the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous.

GENERAL

CG1 - Know how to evaluate and select the appropriate scientific theory and precise methodology of their field of study to make judgments based on incomplete or limited information including, where necessary and appropriate, reflections on the social and ethical responsibilities linked to the solution that is proposed in each case.

CG2 - Being able to check the scientific literature, databases and analyze scientific and technical documents in English.

CG3 – Being able to prepare reports, presentations and scientific publications.

CG4 – Being able to conceive and design a research process.

CG5 – Being able to predict and control the evolution of complex situations by developing new and innovative working methodologies adapted to specific scientific / research, technological or professional contexts, usually multidisciplinary, where his/her activity is developed.

CG6 - Develop sufficient autonomy to participate in research projects and scientific and technological collaboration within their subject area, in interdisciplinary contexts and, where appropriate, with a high component of knowledge transfer.

CROSS

CT1 – To be autonomous, dynamic and organized, with analytical and synthesis capacity, critical thinking skills and ability to be prospective.

CT3 - Being able to work in a team and adapt to multidisciplinary and international teams on different scales.

CT5 - Having the ability to make decisions and adapt to new situations.

SPECIFIC

CE3 - Being able to write programs in high-level programming languages and knowing the basics of parallelization and optimization that enable parallel execution of

tasks in the context of the atomistic and multiscale computational modeling.

CE6 - Understanding the different time and length scales in nature and the physical-mathematical formalisms that can be applied in each of them.

CE10 - Understanding the physical laws that govern the behavior of nonequilibrium systems: relaxation processes and transport phenomena.

CE11 - Understanding the physical laws that govern the behavior of nonequilibrium systems: chemical reactivity, reaction-diffusion processes and phase changes in physicochemical and biochemical systems.

CE13 - Given a material, physical or chemical phenomenon or complex system to be modeled, being able to evaluate and select the time and length scales in which this phenomenon occurs.

Learning objectives

Referring to knowledge

COMPLEX SYSTEMS

- Understand the stability of systems of differential equations representing the dynamics of coupled systems .
- Understand the importance and ubiquity of free scaling behaviors
- Being able to understand generalization of dynamic system to consider spatial dependencies , and structures emerging and characterize a
- Have an overview of the modern theory of networks and provide some applications to different fields.

Teaching blocks

- 1. Introduction to complex systems. Dynamical systems and scaling laws**
- 2. Spatio temporal structures**
- 3. Introduction to complex networks: structure and applications**

Teaching methods and general organization

- Classes magistrals: A les classes magistrals s'exposen els continguts de l'assignatura de forma oral per part d'un professor o professora sense la participació activa de l'alumnat.
- Treball en grup: Activitat d'aprenentatge que s'ha de fer mitjançant la col-laboració entre els membres d'un grup.
- Treball escrit: Activitat consistent en la presentació d'un document escrit.
- Activitats d'aplicació: Amb les activitats d'aplicació s'aconsegueix contextualitzar l'aprenentatge teòric a través de la seva aplicació a un fet, succés, situació, dada o fenomen concret, seleccionat perquè faciliti l'aprendentatge.
- Resolució de problemes: En l'activitat de resolució de problemes, el professorat presenta una qüestió complexa que l'alumnat ha de resoldre, ja sigui treballant individualment, o en equip.
- Exercicis pràctics: l'activitat basada en els exercicis pràctics consisteix en la formulació, anàlisi, resolució o debat d'un problema relacionat amb la temàtica de l'assignatura. Aquesta activitat té com a objectiu l'aprenentatge mitjançant la pràctica de coneixements o habilitats programats.
- Pràctiques: Permeten aplicar i configurar, a nivell pràctic, la teoria d'un àmbit de coneixement en un context concret.

Official assessment of learning outcomes

- Proves escrites: estudi de casos, resolució de problemes (45%)
- Proves orals: exposicions (20%)
- Treballs realitzats per l'estudiant: memòries, projectes (35%)

Examination-based assessment

L'alumnat que ho sol·liciti serà avaluat amb una sola prova global que suposa el 100 % de la qualificació total. Per renunciar a l'avaluació continuada, i demanar l'avaluació única cal que l'estudiant presenti al professor la instància que hi ha a aquest efecte al web de la facultat, abans de la primera prova d'avaluació continuada de l'assignatura.

Els alumnes que hagin estat qualificats amb una nota mínima de 3,5 poden ser reavaluats. La reavaluació consisteix en una prova de síntesi escrita que inclou tot el programa de l'assignatura. La reavaluació es fa en les dates que determini el Consell d'Estudis. La nota final és la més favorable de les dues, la de l'avaluació única o la de la reavaluació. L'estudiant que, havent superat l'assignatura, vulgui millorar la nota a la reavaluació, ha de renunciar a la qualificació mitjançant un escrit presentat al professor amb còpia a la Secretaria del centre.

Aquestes proves poden constar de diverses preguntes curtes, temes, preguntes amb exercicis relacionats i problemes. La puntuació de cada qüestió, pregunta o problema s'indica a l'enunciat de l'examen.

Reading and study resources**Book**

Introduction to the Modeling and Analysis of Complex Systems

Hiroki Sayama

Editat per OpenSUNY, disponible el PDF

PDF disponible a <http://textbooks.opensuny.org/introduction-to-the-modeling-and-analysis-of-complex-systems/>

A First Course in Network Theory

Ernesto Estrada, Philip Knight

Oxford University Press

Nonlinear dynamics and chaos : with applications to physics, biology, chemistry and engineering

Steven H. Strogatz

Reading (Mass.): Addison-Wesley, 1994