Subject identification

Subject	11003 - Complex Networks
Credits	0.75 in-class (18.75 hours) 2.25 distance (56.25 hours) 3 totals (75 hours).
Group	Group 1, 1S
Teaching period	1st semester
Teaching language	English

Lecturers

Lecturers	Timetable for student attention					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Victor Martinez Eguiluz	There are no defined sessions					

Degrees where the subject is taught

Degree	Character	Academic year	Studies
Master's Degree in Physics of Complex Systems	Optional		Postgraduate degree

Contextualisation

This is one of the compulsory courses of the Structural Module of the Master of Physics of Complex Systems.

The aim of this subject is to introduce the recent developments of the so-called Theory of Complex Networks.

Requirements

Recommendable

It is highly recommended that students have taken statistical physics courses during their undergraduate studies and have at least basic knwoledge of computational methods.

Skills

Specific

1. E2: To develop and aplly optimally numerical algorithms for the simulation of complex systems.

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2. E15: To understand the main concepts and techniques of complex networks.

Generic

1. TG2: To acquire the capability to develop a complete research project: bibliographic search, subject development and ellaboration of conclusions.
2. TG3: To be able to write in a clear, precise and rigorous way the different steps of the research process and to present the results to an expert audience.
3. ´TG6: To acquire high computational skills and advanced numerical methods capabilities in applications to problems in the context of complex systems.

Content

Theme content

1. Introduction
   History of complex networks. Sociology and Mathematics.
   Examples of networks. Biological, social, technological networks.
   Random networks. The Erdős-Rényi model.
   Regular Networks.
2. Small-world networks
   Diameter and clustering. Empirical evidence.
   Watts-Strogatz model.
3. Scale-free networks.
   Distribution of degree. Empirical evidence.
   Barabasi-Albert model.
   Choice. Configurational model.
4. Characterization of networks.
   Correlations of degree. Asortativity. Betweenness.
   Communities. Detection of communities.
   Motifs.
5. Resilience of complex networks.
   Percolation theory.
   Tolerance of complex networks to errors and attacks.
6. Directed networks. Weighted nets.

Teaching methodology

In-class work activities

Modality	Name	Typ.Gr.	Description
Theory classes	Lectures	Large group (G)	The students will acquire the concepts and methodology to understand state-of.-the-art research in complex networks.

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Distance education work activities

Modality	Name	Description
Individual self-study	Assigments & oral presentation	The students will apply the concepts and techniques learnt during the lectures to solve assignments. The students will also present the final project as a short oral presentation and as a written report.

Riscs especifics i mesures de protecció

Les activitats d'aprenentatge d'aquesta assignatura no comporten riscs específics per a la seguretat i salut de l'alumnat i, per tant, no cal adoptar mesures de protecció especials.

Workload estimate

Modality	Name	Hours	ECTS	%
In-class work activities		**18.75**	**0.75**	**25**
Theory classes	Lectures	18.75	0.75	25
Distance education work activities		**56.25**	**2.25**	**75**
Individual self-study	Assigments & oral presentation	56.25	2.25	75
	Total	**75**	**3**	**100**

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Student learning assessment

Lectures

Modality	Theory classes
Technique	Papers and projects **(Non-recoverable)**
Description	The students will acquire the concepts and methodology to understand state-of.-the-art research in complex networks.
Assessment criteria	Participation in the lectures.

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Accuracy and quality of the presented work.

Percentage of final qualification: 50% following path A

Assigments & oral presentation

Modality	Individual self-study
Technique	Papers and projects **(Non-recoverable)**
Description	The students will apply the concepts and techniques learnt during the lectures to solve assignments. The students will also present the final project as a short oral presentation and as a written report.
Assessment criteria	Presentation (both oral and written) and quality of the project proposed by the lecturer.

Percentage of final qualification: 50% following path A

Resources, bibliography and additional documentation

Basic bibliography

M.E.J. Newman, Networks: An Introduction (Oxford University Press , 2010).
S Fortunato, Community detection in graphs,Physics Reports 486, 75-174 (2010).
S. Boccaletti et al, Complex networks: structure and dynamics, Phys. Rep. 424, 175-308 (2006).
M.E.J. Newman, The structure and function of complex networks, SIAM Rev. 45, 167-256 (2003).
R. Albert, A.-L. Barabási, Statisical Mechanics of complex networks, Rev. Mod. Phys. 74, 47-97 (2002).

Complementary bibliography

Other resources

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