Subject identification

Subject	11018 - Turbulence and nonlinear phenomena in fluids
Credits	0.75 in-class (18.75 hours) 2.25 distance (56.25 hours) 3 totals (75 hours).
Group	Group 1, 2S
Teaching period	2nd semester
Teaching language	English

Lecturers

Lecturers	Timetable for student attention					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Cristóbal López Sánchez	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 courses of the Specific Module of the master of Physics of Complex Systems.

Requirements

Recommendable

It is recommended that the student has a basic knowledge of fluid mechanics, at the level of the undergraduate studies in the degree of physics.

Skills

Specific

1. E8: Understand generic behavior of dynamical systems and their instabilities.
2. E10: To acquire the capability to characterize chaos and compute Lyapunov exponents.

Date of publication: 20/07/2012

Generic

1. TG2: To acquire the capability to develop a research plan covering from the bibliographic research and strategy to the conclusions.
2. TG3: To be able to write in a clear and precise way the different steps of the research work and to present the results to an expert audience.
3. TG6: To develop the capability to understand and to apply knowledge of high perfomance computation and advanced numerical methos to the field of complex systems.

Content

Theme content

Chapter 1. Instabilities and transition to turbulence.

Chapter 2. Eulerian and Lagrangian description of fluid flows. The equations of fluid dynamics.

Chapter 3. Fully developed turbulence.
- 2/3 Law and the Law of energy disipation.
- Kolmogorov's 41 Theory.
- Two dimensional flows.

Chapter 4. Intermittency and Multifractality.

Chapter 5. Dispersion in fluid flows.
- Turbulent and shear dispersion.
- Relative dispersion.

Chapter 6. Chaotic Advection.
- Hamiltonian Dynamics and KAM tori.
- Open flows.

Chapter 7. Lyapunov Exponents.
- Finite-time and Finite-size Lyapunov Exponents.
- Hyperbolic structures and manifolds.
- Applications to ocean dynamics.

Chapter 8. Mixing of the passive scalar.

Teaching methodology

In-class work activities

Modality	Name	Typ.Gr.	Description
Theory classes	Lectures	Large group (G)	Explanation of theoretical concepts by the professor.

Date of publication: 20/07/2012

Modality	Name	Typ.Gr.	Description
Assessment	Oral presentation	Large group (G)	Oral presentation to the whole class of an assigned problem.

Distance education work activities

Modality	Name	Description
Individual self-study	Autonomous work	The students have to apply the concepts and techniques learned during the lectures to solve assigned exercises, and present the solutions in written form.

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	17.75	0.71	23.67
Assessment	Oral presentation	1	0.04	1.33
Distance education work activities		**56.25**	**2.25**	**75**
Individual self-study	Autonomous work	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

Date of publication: 20/07/2012

Oral presentation

Modality	Assessment
Technique	Objective tests **(Non-recoverable)**
Description	Oral presentation to the whole class of an assigned problem.
Assessment criteria	Quality and accuracy of the presented work, as well as the clarity in the oral exposition.

Percentage of final qualification: 50% following path A

Autonomous work

Modality	Individual self-study
Technique	Papers and projects **(Non-recoverable)**
Description	The students have to apply the concepts and techniques learned during the lectures to solve assigned exercises, and present the solutions in written form.
Assessment criteria	The students have to apply the concepts and techniques learned during the lectures to solve assigned exercises, and present the solutions in written form.

Percentage of final qualification: 50% following path A

Resources, bibliography and additional documentation

Basic bibliography

U. Frisch. *Turbulence: the legacy of A.N. Kolmogorov.* Cambridge Univ. Press, 1995

E. Hernandez-Garcia and Z. Neufeld. *Chemical and Biological Processes in Fluid Flows: A Dynamical Systems Approach,* Imperial College Press, 2009.

Complementary bibliography

Other resources

The lecture notes, presentations and other additional material will be available at the master's webpage.

Date of publication: 20/07/2012