

Syllabus

Subject

Subject / Group	11018 - Turbulence and Nonlinear Phenomena in Fluids / 1
Degree	Master's Degree in Physics of Complex Systems
Credits	3
Period	Second semester
Language of instruction	English

Professors

Lecturers	Office hours for students					
	Starting time	Finishing time	Day	Start date	End date	Office / Building
Cristóbal López Sánchez	13:00	14:00	Monday	17/09/2018	05/07/2019	Edificio Instituts Universitaris

Context

This is one of the courses of the Specific Module of the master of Physics of Complex Systems.

Requirements

Recommended

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

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

Generic

- * TG2: To acquire the capability to develop a research plan covering from the bibliographic research and strategy to the conclusions .
- * 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 .
- * TG6: To develop the capability to understand and to apply knowledge of high performance computation and advanced numerical methods to the field of complex systems .

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Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Range of topics

- 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 dissipation.
 - 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 (0.75 credits, 18.75 hours)

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Lectures	Large group (G)	Explanation of theoretical concepts by the professor.	17.75
Assessment	Oral presentation	Large group (G)	Oral presentation to the whole class of an assigned problem.	1

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

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whether the subject work plan will be carried out through the schedule or through another way included in the Aula Digital platform.

Distance education tasks (2.25 credits, 56.25 hours)

Modality	Name	Description	Hours
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.	56.25

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Frau en elements d'avaluació

In accordance with article 33 of Academic regulations, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

Oral presentation

Modality	Assessment
Technique	Objective tests (non-retrievable)
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.

Final grade percentage: 50%

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Autonomous work

Modality	Individual self-study
Technique	Papers and projects (non-retrievable)
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.

Final grade percentage: 50%

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.

Other resources

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

