Universitat Autònoma de Barcelona

2022/2023

Fluids and Superfluids

Code: 100179
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OT	4	1

Contact

Name: Francisco Javier Bafaluy Bafaluy
Email: javier.bafaluy@uab.cat

Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Teachers

Vicenç Mendez Lopez

Prerequisites

There are no official requirements. Knowledge of Newtonian Physics and Thermodynamics, ordinary differential equations and partial derivatives is assumed; also basic knowledge of quantum mechanics.

Objectives and Contextualisation

- Introduce the concepts and methods of the physics of continuous media.
- Understand the basic dynamical properties of liquids.
- Understand and describe the dynamic regimes of Newtonian liquids.
- Apply the fundamental concepts in the previous items to differentapplications and situations of interest.
- Phenomenologically describe the behavior of superfluid helium.
- Use statistical procedures to describe turbulent flows.

Competences

- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.

- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Using appropriate methods, plan and carry out a study or theoretical research and interpret and present the results
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project
- Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

Learning Outcomes

1. Carry out a project that relates the concepts of fluid dynamics with current innovative issues and present the results.
2. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
3. Describe the general aspects of hydrodynamic turbulence.
4. Determine the field of pressures and the forces exerted on walls containing a fluid.
5. Determine the velocity field of dissipative fluids through Navier-Stokes' equation.
6. Determine the velocity field of perfect fluids through Euler's equation.
7. Identify situations in which a change or improvement is needed.
8. Identify the social, economic and environmental implications of academic and professional activities within one's own area of knowledge.
9. Justify Oseen's equation for the movement of a sphere within a fluid of low Reynolds number.
10. Phenomenologically describe the behaviour of superfluid helium on the model of Tisza.
11. Reduce Navier-Stokes' equation in the boundary Establisher of an analytically solvable expression.
12. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
13. Use statistical procedures to describe turbulent flow.
14. Use the methods of solving partials differential equations to solve the equations of fluid and solid movement in fluids.
15. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
16. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
17. Carry out academic work independently using bibliography (especially in English), databases and through collaboration with other professionals

Content

1. Physics of continuous media
2. Fluid kinematics
3. Perfect fluids
4. Newtonian fluids
5. Dynamic similarity
6. Flow atlarge and small Reynolds numbers
7. Boundary layers
8. Superfluids: liquid helium
9. Hydrodynamic instabilities
10. Turbulence

Methodology

Theory and pratical clases, autonomous exercice solution and delivery.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical classes	16	0.64	3, 10, 4, 5, 6, 1, 9, 12, 11, 14, 13
Theory classes	33	1.32	2, 3, 10, 4, 5, 6, 1, 9, 12, 11, 14, 13
Type: Autonomous			
Exercise solving	47	1.88	2, 17, 12, 15, 16
Personal or group study	45	1.8	3, 10, 4, 5, 6, 1, 9, 11, 16, 14, 13

Assessment

- Two partial tests including theory and problems (80% of the final grade, each 40%); delivery of selected exercices (20% of the final grade).

- In case of not reaching the minimum grade to pass, a recovery exam with all the topics of the course may be carried out. The grade of this exam will replace the grade corresponding to the partial exams.

- In order to be able to take the recovery exam it will be necessary to have submitted to the two partial exams.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exercices delivery	20 %	0	0	2, 17, 8, 12, 15, 16
First term test	40 %	3	0.12	2, 3, 10, 4, 5, 6, 1, 9, 12, 11, 14, 13
Recovery exam	80%	3	0.12	2, 3, 10, 4, 5, 6, 1, 7, 9, 12, 11, 15, 14, 13
Second term test	40 %	3	0.12	2, 3, 10, 4, 5, 9, 12, 11, 15, 14, 13

Bibliography

- Kundu, P.K. *Fluid Mechanics*, Elsevier Academic Press (2016). http://www.sciencedirect.com/science/book/9780123821003 (ebook 2012 ed.)
- Landau, L.D. & Lifshitz, E.M. *Fluid Mechanics* (Landau and Lifshitz: Course of Theoretical Physics, Volume 6), Elsevier Butterworth Heinemann (1987). http://www.sciencedirect.com/science/book/9780080339337
- Lautrup, B. *Physics of Continuous Matter*, Taylor & Francis (2011) e-book link
- Tritton, D.J. *Physical Fluid Dynamics*, Oxford University Press (1988)

Software

No específic software is required.