Universitat Autònoma de Barcelona

2019/2020

Fluids and Superfluids

Code: 100179
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OT	4	1

Contact

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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

Daniel Campos Moreno

Prerequisites

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 flow.

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
- Develop critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others
- Develop independent learning strategies
- 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

- Generate innovative and competitive proposals for research and professional activities.
- Respect the diversity and plurality of ideas, people and situations
- 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 Eulers equation.
7. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
8. Develop independent learning strategies.
9. Generate innovative and competitive proposals for research and professional activities.
10. Justify Oseens equation for the movement of a sphere within a fluid of low Reynolds number.
11. Phenomenologically describe the behaviour of superfluid helium on the model of Tisza.
12. Reduce Navier-Stokes equation in the boundary Establisher of an analytically solvable expression.
13. Respect diversity in ideas, people and situations.
14. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
15. Use statistical procedures to describe turbulent flow.
16. Use the methods of solving partials differential equations to solve the equations of fluid and solid movement in fluids.
17. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
18. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.
19. 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, development of a project.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practical classes	16	0.64	3, 11, 4, 5, 6, 1, 9, 10, 14, 12, 13, 16, 15
Theory classes	33	1.32	2, 3, 11, 8, 7, 4, 5, 6, 1, 10, 14, 12, 13, 16, 15
Type: Autonomous			
Personal or group study	75	3	3, 11, 8, 7, 4, 5, 6, 1, 9, 10, 12, 18, 16, 15
Project delivery	17	0.68	2, 8, 19, 14, 17, 18

Assessment

- Two partial tests including theory and problems (80% of the final grade, each 40%); delivery of a written project (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
First term test	40 %	3	0.12	2, 3, 11, 7, 4, 5, 6, 1, 10, 14, 12, 16, 15
Recovery exam	80%	3	0.12	2, 3, 11, 8, 7, 4, 5, 6, 1, 10, 14, 12, 17, 16, 15
Second term test	40 %	3	0.12	2, 3, 11, 8, 7, 4, 5, 10, 14, 12, 17, 16, 15
Written project	20 %	0	0	2, 8, 19, 9, 14, 13, 17, 18

Bibliography

- Kundu, P.K. *Fluid Mechanics*, Academic Press (2012). http://www.sciencedirect.com/science/book/9780123821003
- 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
- Paterson, A.R. *A first Course in Fluid Dynamics*, Cambridge University Press (1983)
- Tritton, D.J. *Physical Fluid Dynamics*, Oxford University Press (1988)