Universidad Zaragoza

Academic Year/course: 2022/23

26935 - Fluid Physics

Syllabus Information

Academic Year: 2022/23
Subject: 26935 - Fluid Physics
Faculty / School: 100 - Facultad de Ciencias
Degree: 447 - Degree in Physics
ECTS: 5.0
Year:
Semester: First semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

The module Physics of Fluids is part of the optional block grade curriculum. It is a subject of 5 ECTS.

The aims of the course are aligned with the following Sustainable Development Goals (SDGs):

- Goal 7: Affordable and Clean Energy
- Goal 9: Industry, Innovation and Infrastructure
- Goal 13: Climate Action
- Goal 15: Life On Land

1.2. Context and importance of this course in the degree

The course presents the conceptual foundations of Physics of Fluids and its contents are necessary to complement and consolidate the various compulsory and optional subjects of the degree.

1.3. Recommendations to take this course

Schedule sessions and presentation of works. Distribution, depending on the credit of the various activities scheduled as follows:

Theoretical and practical classes: lectures and case-based learning classes (3.5 ECTS), and problem solving in small group (0.5 ECTS). The days, hours and classroom will be assigned by the Faculty of Science.

Laboratory Practice: 1 ECTS. The dates will be set at the beginning of the semester according to the number of enrolled students and availability of laboratory and instrumentation.

Practical work: Workload: 20 hours, with a classroom presentation included.

Exams: The written exam will last for 4 hours. It will be held at the end of the term, on the date assigned by the Faculty of Science. For the practical laboratory exam, 1 hour, the call will be published in due time for students who must do it.

2. Learning goals

2.1. Competences

Generic competences:

1. Understand the physical and mathematical foundations of fluid mechanics and the equations that determine the dynamics of fluids.

2. Be familiar with fundamental models of fluid flow: ideal, viscous, turbulent, compressible and free surface.

3. Manage the main techniques for solving practical questions and problems in the study of the physics of fluids.

5. Familiarize with the basic experimental techniques in fluid mechanics.

6. Know and use the techniques and instruments used in fluid handling technology.

Specific skills:

1. Knowledge of the basic principles of fluid physics

2. Application to solving problems in this field.

2.2. Learning goals

On completion of this module, students should be able to

1. Manage the differential and integral formulation of the laws governing the dynamic and thermal processes of fluids.

2. Understand the description of the flow field and its properties.

3. Formulate and interpret the forces acting on the fluid and its consequences in situations of steady flow both static and dynamic.

4. Use together the fundamentals of theoretical, experimental and computational fluid dynamics.

2.3. Importance of learning goals

Learning outcomes of the course are essential because they provide the student with a basic knowledge and skills needed to interpret and solve problems involving fluid mechanics plays a role methodological tools. In turn, they are the starting point for other subjects of the degree.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate the achievement of learning outcomes through:

1. Reports of laboratory practical lessons. This constitutes 25% of the final grade.
2. Conducting exercises in class. This constitutes 20% of the final grade.
3. Individual work. This constitutes 25% of the final grade.

At the end of the semester, according to the examination timetable center, there will be a comprehensive written test of the subject. It will consist of short questions and will constitute 30% of the final grade. On the same day, for those students who do not complete the tasks proposed in paragraphs 1, 2 and 3, another exercise that will constitute 45% of the note will be proposed and other laboratory examination will constitute 25% of the final grade.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, practice sessions, autonomous work, study and assessment tasks.

Students are expected to participate actively in class throughout the semester.

Further information regarding the course will be provided on the first day of class.

4.2. Learning tasks

The course include the following learning tasks:

- Lectures. They will be given to the entire group, in which the teacher will explain the basic principles of the subject and solve some problems selected application subject to the degree. These problems are mainly drawn from the collection that the teacher provides the student at the beginning of the semester. the participation of students in this activity by planning sorts of problems will be strengthened. That is, be indicated prior the problems that are to be discussed in the classroom so that the student can reflect on them and intervene in their resolution. They will be developed throughout the semester by 3 hours of weekly classes on schedule assigned by the center. It is, therefore, a classroom activity, and highly recommended assistance to good use.
- Laboratory practice sessions. They will be distributed throughout the semester and whose assessment will be part of the final grade for the course. Groups of three students will work on each laboratory setup, using a script previously delivered by teachers and a questionnaire that collects data and analysis. 6 two-hour sessions will be conducted at the laboratory.
- Autonomous work and study. Studying the matter and applying that knowledge to solve exercises. This activity is essential in the process of student learning and to complete the evaluation activities.
- Tutorials, related to any part of the module. The teacher will publish a schedule of tutorial times to students so they can attend in an orderly manner throughout the semester

4.3. Syllabus

The course will address the following topics:

- Topic 1. Physical properties of fluids. The continuum hypothesis. Concept of fluid element. Local thermodynamic equilibrium. Forces acting on a fluid. The stress tensor. Form of stress tensor for a fluid at rest. Surface tension.
- Topic 2: Description of Lagrangian and Eulerian flow field. Material derivative. Paths, streamlines and streaklines. Movement around a point. The strain rate tensor. Rotation and deformation. Vorticity circulation. fluids and control volumes. Reynolds Transport Theorem
- Topic 3: Basic equations. Conservation of mass, momentum and energy. Transport phenomena. Flows of energy and momentum. Transport equation of vorticity. Equation of internal energy and entropy. Dissipation of mechanical energy.
- Topic 4: Dimensional Analysis. Interest of dimensional analysis in fluid physics. Vaschy theorem Pi-Buckingham. Adimensionalización of the general equations. dimensionless parameters. physical interpretation. Full and partial physical likeness. Similarity solutions.
- Topic 5: Ideal flow. Ideal fluid condition. Euler equations. Bernoulli equation for gases and liquids. irrotational movement. Two-dimensional and axisymmetric movements. Current function. elementary solutions. Superposition principle. complex potential. Lift and drag . Motion of an ideal fluid with vorticity.
- Topic 6: Viscous flow. Steady two-dimensional movements. Couette flow and Hagen-Poiseuille. Unsteady two-dimensional movements: Stokes flow and Rayleigh problem. Motion of thin liquid films. Movements at low Reynolds numbers. Flow around a sphere.
- Topic 7: Viscous boundary layer moving at high Reynolds numbers. Concept of boundary layer. Analysis of orders of magnitude and approximations. Equations of two-dimensional boundary layer and boundary conditions. Similarity solutions. Influence of the pressure gradient. Detachment.
- Topic 8: Compressible gas flow regime. Normal discontinuities: shock waves and contact discontinuities. Mach waves. Gas flow ducts slowly variable section.

4.4. Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Facultad de Ciencias web https://ciencias.unizar.es/grado-en-fisica-0.

On the other hand, the students can find a detailed calendar in moodle2.unizar.es:

- Personal work deadline
- Laboratory final examination
- Theory and problems examination

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=26935