Universidad Zaragoza

Academic Year/course: 2023/24

26935 - Fluid Physics

Syllabus Information

Academic year: 2023/24
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

Physical and phenomenological introduction to Fluid Physics. The acquisition of the learning results of the subject provides training and competence to contribute to some extent to their achievement:

- Goal 7: Affordable and Clean Energy
- Goal 9: Industry, Innovation and Infrastructure.
- Goal 13: Climate Action
- Goal 15: Life of terrestrial ecosystems.

Previous knowledge of Physics and Mathematics is recommended. In particular, it is necessary to have knowledge of: the origin and meaning of forces and moments; properties of and operations with vectors and matrices, calculation of derivatives (total and partial) and integrals (definite and indefinite); of differential operators such as the vector operator nabla in its different forms and familiarity with the physical meaning and manipulation of differential and integral equations.

2. Learning results

Generic competencies:

- To know the physical and mathematical fundamentals of Fluid Mechanics and the equations that determine it
- To know the fundamental models of fluid flow: ideal, viscous, turbulent, compressible, and with free surface.
- To manage the main problem-solving techniques.
- To become familiar with numerical problem solving techniques in the study of Fluid Physics.
- To become familiar with the fundamental techniques of experimentation in Fluid Mechanics.
- To know and use the techniques and instruments used in the technological treatment of fluids.

Specific competencies:

- Knowledge of the basic principles of Fluid Physics
- Application to problem solving in this field.

3. Syllabus

1. Physical properties of fluids. Intermolecular forces. The continuum hypothesis. Concept of fluid element.

Local thermodynamic equilibrium. Forces acting on a fluid. The stress tensor. Shape of the stress tensor for a fluid at rest. Fluidostatics. Surface tension.

2: Description of the Lagrangian and Eulerian fluid field. Substantial derivative. Trajectories, current lines and traces.

Movement around a point. The strain rate tensor. Rotation and deformation. Vorticity, circulation.

Fluid and control volumes. Reynolds transport theorem

3: Fundamental equations. Conservation of mass, quantity of motion and energy. Transport phenomena. Flows of energy and quantity of motion. Vorticity transport equation. Equation of the internal energy and of the entropy. Dissipation of mechanical energy.

4: Dimensional analysis. Interest of dimensional analysis in fluid physics. Vaschy-Buckingham Pi Theorem.

Non-dimensionalization of the general equations. Dimensionless parameters. Physical interpretation. Complete and partial

physical similarity. Similarity solutions.

5: Ideal flow. Ideal fluid condition. Euler equations. Bernoulli's equation for gases and liquids. Irrotational motion. Two-dimensional and axisymmetric movements. Current function. Elementary solutions. Principle of superposition. Complex potential. Lift and circulation. Motion of an ideal fluid with vorticity.

6: Viscous flow. Stationary two-dimensional movements. Couette and Hagen-Poiseuille flow. Input effects.

Non-stationary two-dimensional movements: Stokes current and Rayleigh problem. Two-dimensional motion of thin liquid films. Movements at low Reynolds numbers. Flow around a sphere.

7: Viscous boundary layer. Motion at high Reynolds numbers. Boundary layer concept. Analysis of orders of magnitude and approximations. Two-dimensional boundary layer equations and boundary conditions. Similarity solutions. Influence of the pressure gradient. Detachment.

8: Flow of gases in compressible regime. Normal discontinuities: Shock waves and contact discontinuities.

Mach waves. Flow of gases in ducts of slowly variable cross-section. Sonic blocking.

4. Academic activities

The learning process that has been designed for this subject is based on the following:

- Lectures, given to the whole group, in which the teacher will explain the basic principles of the subject and will solve some selected problems of application to the Degree.

- Laboratory practices. The laboratory practices are face-to-face activities, necessary for the student to pass the subject. The timetable will be planned by the center and communicated at the beginning of the term.

- Autonomous work, studying the subject and applying it to the resolution of exercises.

- Tutoring.

5. Assessment system

The student must demonstrate that they have achieved the intended learning results by means of the following assessment activities

1. Laboratory practice reports will be valued. This constitutes 25% of the final grade.
2. The completion of exercises proposed in class will be valued. This constitutes 20% of the final grade.
3. An assignment will be presented. This constitutes 25% of the final grade.

At the end of the semester on the date established by the Faculty of Sciences, a written exam consisting of short questions will be taken. This constitutes 30% of the final grade. On the same day, students who have not completed assignments 1, 2 and 3, will complete an exercise that will constitute 45% of the final grade and a lab exam that will constitute 25% of the final grade.