INSTITUTO POLITÉCNICO DE BRAGANÇA

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| Course Unit | Fluid Mechanics | | | Field of study | Fluid Mechanics and Hydraulics | | |
| Bachelor in | Mechanical Engineering | | | School | School of Technology and Management | | |
| Academic Year | 2022/2023 | Year of study | 2 | Level | 1-2 | ECTS credits | 6.0 |
| Type | Semestral | Semester | 2 | Code | 9123-759-2201-00-22 | | |

| Workload (hours) | 162 | Contact hours | T | - | TP | 60 | PL | - | TC | - | S | - | E | - | OT | - | O | - |
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T - Lectures; TP - Lectures and problem-solving; PL - Problem-solving, project or laboratory; TC - Fieldwork; S - Seminar; E - Placement; OT - Tutorial; O - Other

Name(s) of lecturer(s): Valdemar Raul Ramos Garcia, António Augusto Nogueira Prada, Maria Isabel Lopes Marcelino Dias de Abreu

## Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:
1. Read and understand literature and to work with tables, graphics, diagrams and physical quantities on fluid mechanics.
2. Know and understand basic physical processes and phenomena on fluid mechanics.
3. Know the fluid properties and to distinguish Newtonians and nonNewtonians fluids.
4. Solve fluid statics problems.
5. Know and understand the kinds of fluid flow regimes.
6. Solve problems of fluid mechanics by applying both theoretical and experimental techniques.
7. Solve problems of ideal and real fluid flow in pipes.

## Prerequisites

Not applicable

## Course contents

Fluid Properties. Fluid statics. Kinematics of fluid motion. Systems, Control volumes, conservation of mass. Bernoulli's equation. The impulse-momentum principle. Similitude and Dimensional analysis. Flow in pipes.

## Course contents (extended version)

1. Fluid properties.
   - Density.
   - Specific weight.
   - Specific volume.
   - Compressibility.
   - Surface tension.
   - Capillarity.
   - Vapor pressure.
   - Viscosity.
2. Fluid statics.
   - Pressure.
   - Pressure variation.
   - Absolute and gauge pressures.
   - Manometry.
   - Pressure forces on plane surfaces.
   - Pressure forces on curved surfaces.
   - Center of pressure.
   - Buoyancy.
   - Fluid masses subjected to acceleration.
3. Kinematics of fluid motion.
   - Steady and unsteady flow.
   - Streamlines.
   - One-dimensional flow.
   - Velocity and acceleration.
4. Systems, Control volumes and conservation of mass.
   - Systems and Control volumes.
   - Conservation of mass: the continuity equation.
5. Bernoulli's equation.
   - Flow of an incompressible ideal fluid.
   - Bernoulli's equation.
   - Equation of energy.
   - Hydraulic gradlines.
   - Aplplications of Bernoulli's equation: Venturi meter, Pitot tube, Torricelli's equation.
6. The impulse-momentum principle.
   - The linear impulse-momentum equation.
   - Pipe flow applications.
   - Open channel aplications.
   - Flow machines aplications.
7. Similitude and Dimensional analysis.
   - Dimensional analysis.
   - Buckingham's theorem.
   - Similitude and physical models.
   - Geometric, kinematic and dynamic similarity.
   - Dimensionless numbers: Reynolds, Froude, Cauchy, Weber, Euler.
8. Flow of a real fluid in pipes.
   - Fundamental equations.
   - Viscosity. Laminar flow. Reynolds number.
   - Poiseuille's law.
   - Turbulent flow (smooth pipes and rough pipes).
   - Friction factor.
   - Continuous head losses in pipelines.
   - Darcy- Weisbach equation.
   - Pipe friction in noncircular pipes-the hydraulic radius.
   - Pipe friction-empirical formulas.
   - Local losses in pipelines.

## Recommended reading

1. B. S. Massey. “Mecânica dos Fluidos”. Fundação Calouste Gulbenkian, 2002.
2. L. Adriano Oliveira, A. Gameiro Lopes. “Mecânica dos Fluidos”, 3ª ed. ETEP, 2010.
3. R. Street, G. Watters, J. Vennard. “Elementary Fluid Mechanics”, 7th ed, John Wiley & Sons, 1996.
4. R. Giles. “Fluid Mechanics and Hydraulics- Theory and Problems”. Schaum's, 1994.
5. Frank White. “Fluid Mechanics”, 7th ed, McGraw-Hill, 2011.

## Teaching and learning methods

In the lecture classes, the fundamental concepts are presented for understanding the course contents. The students, helped by the professor, will enhance their knowledge by solving practical exercises, that will be discussed and solved in the practice classes and experimental works (with reports) will be performed in teams of three in laboratory.

## Assessment methods

1. Alternative 1 - (Regular, Student Worker) (Final, Supplementary)
   - Laboratory Work - 20%
   - Laboratory Work - 20%
   - Final Written Exam - 60%
2. Alternative 2 - (Student Worker) (Final, Supplementary, Special)
   - Final Written Exam - 100%
3. Alternative 3 - (Regular, Student Worker) (Supplementary, Special)
   - Final Written Exam - 100%

## Language of instruction

Portuguese, with additional English support for foreign students.

## Electronic validation

| Valdemar Raul Ramos Garcia | Luís Manuel Ribeiro Mesquita | João da Rocha e Silva | José Carlos Rufino Amaro |
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| 22-02-2023 | 26-02-2023 | 27-02-2023 | 04-03-2023 |