

Course Unit	Applied Hydraulics I		Field of study	Hydraulics and Hydric Resources	
Bachelor in	Civil Engineering		School	School of Technology and Management	
Academic Year	2022/2023	Year of study	3	Level	1-3
Type	Semestral	Semester	1	ECTS credits	6.0
Code	9089-322-3104-00-22				
Workload (hours)	162	Contact hours	T -	TP 58	PL -
			TC -	S -	E -
			OT -	O 2	

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) Carlos Liberal Moreno Afonso

### Learning outcomes and competences

At the end of the course unit the learner is expected to be able to:

1. Distinguish the various types of flows and analyses the different hydraulic scenarios;
2. Recognize the influence of the layout of conduits in the proper functioning of flow and understand the phenomenon of cavitation and trapping air;
3. Determine the discharge in conduits with standard consumption route;
4. Distinguish the types of unsteady flows in pipes and know the various protection methods of prejudicial phenomena;
5. Know the laws that govern the flow in open channels, classify the different types of flows and formulate solutions to the more usual hydraulic scenarios;
6. Extend the fundamental equations of the fluid mechanics to flow by orifices and weirs and know the methods of measuring flowing water;
7. Know the different types of turbines and pumps, explain its principles of operation, recognize the different types of facilities and formulate solutions to practical cases;
8. Know the laws that govern the ground-water flow and its applications.

### Prerequisites

Before the course unit the learner is expected to be able to:

1. Make numerical calculation, differential, integral, vector, linear algebra and analytic geometry;
2. Apply the knowledge of physics;
3. Make good use of the scientific calculator;
4. Apply the concepts of General Hydraulic.

### Course contents

Steady Flows in Pipes; Unsteady Flows in Pipes; Hydraulic Machinery; Open Channels Flow; Flows by Orifices, Gates and Weirs. Hydraulic Measurements; Groundwater.

### Course contents (extended version)

1. Steady flows in pipes
  - Permanent types of flows. Continuity equation. Energy and the Bernoulli equation.
  - Output pipes into the atmosphere. Influence of the routing of pipes.
  - Conduit Systems. Branching Pipes. Parallel Pipes.
  - Loss of energy due to friction and due to transitions and fittings. Hydraulic and energy grade lines
  - Pipes with consumption of uniform route. Trapping air. Cavitation.
2. Unsteady flows in pipes
  - General considerations. Surge tank water-level oscillation. Description of phenomenon. Dimensioning.
  - Water hammer. Description of the phenomenon. Transients caused by pumps. Dimensioning.
  - Liquid-column separation. Control devices.
3. Hydraulic machinery
  - Specific speed. Operation of turbines on a permanent basis.
  - General considerations. Types of turbines and pumps.
  - General descriptions and conditions of installing turbines.
  - Theory of elementary turbomachines. Similarity relations for turbomachines.
  - Suction lift of reaction turbines. Type, speed of rotation and main dimensions. Miniturbines.
  - Conditions of installing pumps. Specific speed. Diagrams of operating of pumps.
  - Characteristic curves. Startup and pumps priming. Suction lift of pumps. Choice of pumps.
4. Open channel flow
  - Uniform flow. Simple sections, closed sections, sections mixed, composite sections.
  - Steady-Nonuniform flow. Bernoulli's theorem. Specific energy.
  - Critical flow. Subcritical flow. Supercritical flow. Function  $h = h(Q)$  for  $E = E_0$ . Flow Control.
  - Types of water-surface profiles. Channel transitions.
  - Quantitative evaluation of surface profiles. The hydraulic jump. Derivation of Depth relationships.
5. Flows by orifices, gates and weirs. Hydraulic measurements
  - General considerations. Orifices. Gates. Weirs. Hydraulic measurements. Level measurements.
  - Pressure measurements. Velocity measurements. Flow rate measurements.
6. Groundwater
  - General considerations. Darcy's law. Permeability. One-dimensional steady groundwater flow.
  - Unconfined Steady flow. Confined steady flow.

### Recommended reading

1. Apontamentos das Aulas Teóricas;
2. Quintela, A. C. – Hidráulica. 13ª edição, 2014, Fundação Calouste Gulbenkian, Lisboa.
3. Lencastre, A. – Hidráulica Geral. Edição do Autor, Lisboa.
4. Manzanares, A. – Hidráulica Geral I e II. Técnica - AEIST, Lisboa.
5. Marriott, M. J. , Featherstone, R. E. e Nalluri, C. – Civil Engineering Hydraulics. 5th ed. , Wiley-Blackwell, 2009

### Teaching and learning methods

The unit curriculum will be taught using expository lessons and practical classes for resolution of exercises.

### Assessment methods

- All - (Regular, Student Worker) (Final, Supplementary, Special)

**Assessment methods**

- Final Written Exam - 100%

**Language of instruction**

Portuguese

**Electronic validation**

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15-10-2022	17-10-2022	24-10-2022	24-10-2022