

Course Unit	Applied Hydraulics I		Field of study	Hydraulics and Hydric Resources	
Bachelor in	Civil Engineering		School	School of Technology and Management	
Academic Year	2023/2024	Year of study	3	Level	1-3
Type	Semestral	Semester	1	ECTS credits	6.0
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. Design.
 - 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. Minuturbines.
 - Conditions of installing pumps. Specific speed. Diagrams of operation 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, mixed sections, 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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