Hydraulic Conduction (250220)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	9.0 ECTS
Programs	GRAU EN ENGINYERIA D'OBRES PÚBLIQUES (pla 2010)
Course	2022/23

Main teaching language at each group

- Group 10Q2 Catalan (Anual)

Faculty

Responsible Faculty: Ernest Blade Castellet
Faculty: Ernest Blade Castellet, Maria Soledad Estrella Toral, Eduardo Martínez Gomariz, Marti Sanchez Juny, Jackson David Tellez Alvarez

Objectives of Education

Students will acquire knowledge of concepts and technical aspects related to both pressurised and open channel flow systems. They will also learn to solve basic hydraulic engineering problems.

Upon completion of the course, students will have acquired the ability to: 1. Apply equations of fluid motion to engineering cases related to pressurised or open channel flow systems. 2. Solve problems related to pipe networks, including support elements such as fittings and valves. 3. Analyse open-channel water flow in basic geometries or conditions.

Characteristics of fluids: compressibility, viscosity, phase transitions and surface tension; Fluid statics; Equations of fluid motion and their application to ducted flow; Continuity, momentum and Bernoulli's trinomial; Turbulent motion and the Reynolds number; Permanent and variable flow in pipes, including the conservation of energy and pressure-drop analysis, as well as pumping systems; Permanent and variable flow in open channel flow systems and its application to the functioning of channels; Erodible channels; Dimensional analysis; Similarity law; Models; Basic concepts of surface hydrology

Competencies

Especific

Knowledge of the concepts and technical aspects of both pressure and free surface conduction systems
Knowledge of the basic concepts of surface and underground hydrology.
Knowledge of and ability to design and dimension hydraulic works and facilities, energy systems and the harnessing of hydroelectric energy, and plan and manage surface and underground hydraulic resources
Knowledge and understanding of supply and treatment systems, and of how to dimension, construct and conserve them

Transversal

EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.

EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 3. Planning and using the information necessary for an academic assignment (a final thesis, for example) based on a critical appraisal of the information resources used.
SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	45.0 h	45.45 %
	Medium group	30.0 h	30.30 %
	Laboratory classes	15.0 h	15.15 %
	Guided Activities	9.0 h	9.09 %
Self Study		126.0 h	

Contents

Item 1 Mechanical properties of fluids

Definition of fluid.Properties of fluids, (density, specific weight).Changes of state, vapor pressure, cavitation. Concepts of stress: normal and shear stresses. Normal stress in liquids, bulk modulus of compressibility. Shear stress in liquids, concept of viscosity.

Exercises

Item 2 Hydrostatics

General equation. Statics of liquids in gravitational field. Hydrostatic thrust on plane and curved walls. Force balance on a totally submerged solid. Uplift. Force balance on of a partially submerged solid. Relative force balance

Exercises

Item 3 Concepts and fundamental equations in movement of fluids

Real fluids and perfect fluids. Flow around boundaries. Boudary layer: separation.
Description of the movement. Variation of a property: local and material derivative. Continuity equation applied to a flow tube. Momentum equation: application to a flow tube. Bernoulli equation in average values: Variation along a flow tube. Experience and Reynolds number. Turbulent movement in ducts.
Exercises

Item 4 Flow in pipelines

Steady and non-steady flow. Basic concepts and equations of the steady flow in pipelines: equations of continuity and energy conservation. Energy line and piezometric line. Energy loses. Moody's diagram: discussion and analysis of the influence of turbulence intensity.
Schematic description of a turbopump. Characteristic curve. Pumps in series and in parallel. NPSH. Elements of a pumping system. Measures of pressure, velocity and flow rate.
Exercises
Introduction to unsteady flow in pipelines. Wtarehammer in pipelines due to instant valve closure. Periodic waves, pressure wave and depression wave.
Exercises

Item 5 Open channel flow

Introduction to the open channel flow. Classification of open channel flow in relation with time and space. Geometric parameters of the channels, main hydraulic variables of the flow, definition of Froude number. Steady uniform flow.

Calculation of the capacity for a cross section, coefficient of Manning. Canalization.
Specific energy. Critical regime. Control section. Hydraulic jump
Exercises
Back water curves: classification, boundary conditions and integration.
Exercises
Transitions. Weirs and spillways. Flow gauge stations. Channel design.
Exercises
Introduction to the main applications of the HECRAS open channel flow model
Hydrograph concept. Equations of Saint-Venant,

Topic 6 Introduction to physical models

Dimensions. Pi theorem. Dimensionless numbers in hydraulics. Meaning of Froude number and Reynolds number. Theory of similarity, Froude similarity. Scale effects

Item 7 Surface Hydrology

Water cycle. Water balance. Water vapor in the atmosphere. Rainfall processes. Rain data. Concept of periode of return. Temporary and spatial description of rain. IDF curve concept.
Physical description of a basin: hydrographic network. Surface runoff. Time of Concentration. Curve area / time. Analysis of a hydrograph. The rational method. Runnoff Coefficient.

Activities

Project Hec-Ras

Project into groups 3 people.
Part 1: Design a channel and calculation of flow parameters.

Part 2: Verification using the program Hec-Ras.

Dedication

9h

Teaching Methodology

The subject consists of 3 hours a week of attend classes, the professor exposes some concepts and basic materials, he presents examples and he realizes some exercises.
1 hour a week is used to solve practical exercises. A good interaction between students and the professor is expected. The students can consult notes, discuss the exercises with the class mates, etc. The teacher follows the work of the students; he answers questions about the resolution. The teacher collects the exercises to correct and evaluate them. After evaluation terms of reference are delivered to the students by the result across Atenea

Although most of the sessions will be given in the language indicated, sessions supported by other occasional guest experts may be held in other languages.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The grade of the subject is obtained from the grades of continuous assessment. The continuous assessment consists of doing different activities, both individual and group, of an additive and formative nature, carried out during the course (inside the classroom and outside it).

Assessment tests consist of questions about concepts associated with the learning objectives of the subject in terms of knowledge or understanding, and a set of application exercises.

The final grade (NF) is obtained from the application of the following expression:

NF = 0.3 · NA + 0.3 · NG + 0.4 · NC

Where

-NA: arithmetic mean of ordinary assessment tests
-NG: geometric mean of ordinary assessment tests
-NC: arithmetic mean of the activities proposed by the teachers throughout the course

The student can give up the process of continuous assessment or by communicating it in writing to the teacher responsible at the beginning of the course or by not attendance at 20% of NC activities. In such case the NF of the subject will calculate doing:

NF = NG

Criteria of qualification and of admission to the re-evaluation: The students suspended to the ordinary evaluation that have presented regularly in the proofs of evaluation of the suspended subject will have the option to take a re-assessment test in the period set in the academic calendar. Students who have already passed it or students qualified as not presented will not be able to take the re-assessment test for a subject. The maximum grade in the case of taking the re-assessment exam will be five (5.0). The non-attendance of a student summoned to the test of re-evaluation, celebrated in the fixed period will not be able to give rise to the realization of another test with later date. Extraordinary assessments will be carried out for those students who, due to force majeure, have not been able to take any of the continuous assessment tests. These tests must be authorized by the corresponding head of studies, at the request of the teacher responsible for the subject, and will be carried out within the corresponding teaching period.

Test Rules

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.

Office Hours

From Thursday to Thursday from 12 a.m. to 1:30 p.m.

Bibliography

Basic

- Chadwick A. J.; Morfett, J.C. Hydraulics in civil engineering. London: Allen and Unwin, 1986. ISBN 0046270035.
- Mataix, C. Mecánica de fluidos y máquinas hidráulicas. 2a ed., ampl. y p al día, rev. y red. en el SI. Madrid: Ediciones del Castillo, 1982. ISBN 8421901753.
- Carvalho, A. Hidráulica. 3a ed. Lisboa: Fundaçao Calouste Gulbenkian, 1991.
- López Andrés, L. Manual de hidráulica. Alicante: Universidad de Alicante, 1997. ISBN 8479083204.
- Sanchez,M.; Bladé,E.; Puertas,G. Hidráulica. Barcelona: Edicions UPC, 2005. ISBN 8483018217.

Complementary

- Lencastre, A. Manual de ingenieria hidráulica. Pamplona: Universidad Pública de Navarra, 1998. ISBN 8495075164.
- López, L. Problemas de hidráulica. Alicante: Universidad de Alicante, 1999. ISBN 8479086475.
- Giles. R. V. Mecánica de los fluidos e hidráulica. 2a ed. Madrid: McGrawHill, 1994. ISBN 8448118987.
- Chown, V.T. Hidráulica de los canales abiertos. Santafé de Bogotá: MGrawHill, 1994. ISBN 9586002284.

- Puertas, J.; Sánchez, M. Hidráulica. Madrid: Colegio de ingenieros de caminos, canales y puertos, 2001.
- Blade, E ... [et al.]. Modelación numérica en ríos en régimen permanente y variable : una visión a partir del modelo HEC-RAS. Edicions UPC. Barcelona: Edicions UPC, 2009. ISBN 9788498803891.