Course guide
2500040 - GECOBHIDRA - Hydraulic Constructions

Last modified: 01/10/2023

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.

Degree: BACHELOR'S DEGREE IN CIVIL ENGINEERING (Syllabus 2020). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: ALLEN BATEMAN PINZON

Others: ALLEN BATEMAN PINZON, JOSE MIGUEL DIEGUEZ GARCIA, JUAN PEDRO MARTÍN VIDE, ARNAU PRATS PUNTÍ

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14418. Knowledge and ability to project and size hydraulic works and installations, energy systems, hydroelectric uses and planning and management of surface and underground hydraulic resources. (Specific technology module: Hydrology)

Generical:
14380. Scientific-technical training for the exercise of the profession of Technical Engineer of Public Works and knowledge of the functions of advice, analysis, design, calculation, project, construction, maintenance, conservation and exploitation.
14383. Ability to project, inspect and direct works, in their field.
14384. Capacity for the maintenance and conservation of hydraulic and energy resources, in its field.
14386. Capacity for maintenance, conservation and exploitation of infrastructure, in its field.
14389. Knowledge of the history of civil engineering and training to analyze and assess public works in particular and construction in general.
14390. Identify, formulate and solve engineering problems. Pose and solve construction engineering problems with initiative, decision-making skills and creativity. Develop a systematic and creative method of analysis and problem solving. (Additional school competition).

TEACHING METHODOLOGY

The course consists of 2 hours per week of classroom activity (large size group) and 1.6 hours weekly with half the students (medium size group).

The 2 hours in the large size groups are devoted to theoretical lectures, in which the teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

The 1.6 hours in the medium size groups is devoted to solving practical problems with greater interaction with the students. The objective of these practical exercises is to consolidate the general and specific learning objectives.

The rest of weekly hours devoted to laboratory practice.

Support material in the form of a detailed teaching plan is provided using the virtual campus ATENEA: content, program of learning and assessment activities conducted and literature.

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.

LEARNING OBJECTIVES OF THE SUBJECT

Students will acquire the knowledge and skills to plan and design hydraulic works and facilities, energy systems and hydroelectric power plants, and to plan and manage surface and groundwater resources.

1 Ability to project and dimension hydraulic works and installations, energy systems, hydroelectric uses and planning and management of surface and underground hydraulic resources.

Knowledge of channel flow systems such as irrigation canals and sanitary sewers. Knowledge of River Engineering including river morphology and transport of solids, study of floodinga and flood-protection meadures, and riverbank protection. Environmental aspects of river areas and river restoration. Erosion and scour. Bridge hydraulics. Hydroelectric powerplants, hydrological, hydraulic and production-related analysis of a river elevation drop. Reversible turbines and mini-hydroelectric plants. Water hammer and mass oscillation. Classification of dams. Stability analysis.
Selecting a type of dam considering the geological determining factors. Spillways, floodgates and valves. Gravity dams, earth-fill dams, rock-fill dams, arch dams and buttress dams.

STUDY LOAD

Type	Hours	Percentage
Self study	84,0	56.00
Hours large group	30,0	20.00
Hours medium group	24,0	16.00
Hours small group	6,0	4.00
Guided activities	6,0	4.00

Total learning time: 150 h

CONTENTS

Hidroelectric and irrigation Channels

Description:
Operation and transport in free sheet: irrigation and hydroelectric channels, evacuation channels, drainage channels and tunnels. Design flows. Geometric characteristics. Flow type. Design criteria according to the type of flow: Normal, varied, variable. Design criteria according to the type of terrain. Special elements in a channel. Inverted siphon, lateral weirs, control weirs, lateral gates, on-demand control gates, mixed gates. Gate calculation. Water intakes. Flow meters. Evacuation channels: fast regime, cross waves. Tunnel design. Cavitation assessment. Ventilated flows.
Sizing of irrigation channels and sizing of an inverted siphon.

Full-or-part-time: 15h 36m
Theory classes: 2h
Practical classes: 2h
Laboratory classes: 2h 30m
Self study : 9h 06m

Hydroelectric Power Plants

Description:
1) Type of waterfall. Energy and power dissipated. Jump on foot. Jump in derivation. Jump in derivation with dam dam. Jump with pressure leads. The download channel (fast). Underground power plants. Complementary drives. Pumping plants, reversible groups and reversible plants. 2) Power and energy. Gross jump. Useful jump. Salt net. Power of a jump. Productivity of a jump. Coefficient of efficiency. Power and energy units. Load factor and hours of use. The electricity market. Types of power plants. Function of power plants, fluent, reversible, peak power plants. Combined power plant management, energy optimization. Basic postulates of the design of a turnbina. Type of turbine. Characteristics: Pelton, Francis and Kaplan. Parts of a hydroelectric production equipment.
Perform a calculation of power, losses in pipes and other details of the flow in hydroelectric systems

Full-or-part-time: 12h
Theory classes: 3h
Practical classes: 2h
Self study : 7h

Fluvial morphodynamics and riverbed works

Description:
The river system. Composition and relationship with the environment. Sediment characteristics. Particle size curve and grain characteristics. Type of transport, bottom, suspension and washing. Beginning of movement, Shields abacus, background shapes. Flow resistance in beds. Karman Prandt's theory. Grain resistance, background shapes and vegetation.
Flow Resistance Exercises. Exercises In The beginning of the movement.
Assessment of bed erosion: Long-term erosion, erosion by bottom forms. The power of the flow. Examples of bed stability.
River morphology, Regime Theory. Bed stability: bottom and slope stability. Natural bed design criteria. Dynamic stability in beds. Transport formulas. The balance of Lane. Exner equation (Morphodynamic equation)
Simple exercise in fluvial morphology, explanation of Exner's equation in a practical example.
General characteristics of local erosion: Bridge piles, stirrups, sleepers, prominent elements in beds, falls, walls. Maximum erosion and the temporal evolution of erosion. The mechanics of local erosion in piles and bridge stirrups, formulas of maxima, equations of temporal evolution. Almost permanent calculations of the evolution of erosion in piles and stirrups. On elevation in bridges. Characteristics, formulations.
The local erosion calculation will be carried out in a bridge pile and in a abutment. Additionally, they will go to the laboratory to see in an experiment the local erosion process.
Piping, protection materials, design of a longitudinal protection. Protection for bridge batteries and bridge stirrups. Sedimentation in reservoirs, calculation of production and progress of the delta. Sediment management.
Several examples of bed protection design in beds.

Full-or-part-time: 36h
Theory classes: 9h
Practical classes: 4h
Laboratory classes: 2h
Self study : 21h

Dams

Description:
Characteristics of a reservoir: Levels, flooded area, height, useful volume. Types of dams, acting forces. Concept of underpressure. Stability. Drains. Taking loose materials, design. Drainage and siphoning.
Development of a didactic exercise on dam stability

Full-or-part-time: 19h 12m
Theory classes: 8h
Self study : 11h 12m

Dispersion and mixing in river systems

Description:
Saline wedge in mouths, description of the phenomenon, its impact on sedimentation in rivers, wedge dynamics. Dispersion of pollutants and suspended sediment in channels. Longitudinal, vertical and transversal dispersion. Examples of dredging, mining, and others.
Diffusion coefficient assessment. Calculation of the diffusion in dredging processes. Salt wedge dynamics calculations. Demonstration laboratory of the salt wedge.

Full-or-part-time: 9h 36m
Theory classes: 3h
Practical classes: 1h
Self study : 5h 36m

DebrisFlows

Description:
Description of the phenomenon. Triggering phenomena (rain, earthquakes, volcanoes). Initiation (stability of the terrain), Rheology (relationship depth-speed). Propagation (Random Method). Mitigation works.
In this session we will visit the river morphodynamics laboratory to carry out a detrital flow experiment, previously we will show examples in videos of experiments with detrital flows.

Full-or-part-time: 14h 23m
Theory classes: 4h
Laboratory classes: 2h
Self study : 8h 23m

Flood and Risk Assessment

Description:
What are fast flows. Trigger mechanisms. Flooding concepts (water and debris), simple assessment mechanisms. Definition of irrigation, danger, vulnerability, exposure. Determination of risk and resilience. Construction of risk maps, design rules for a risk map. Practical application to generate a risk map.
Practical flooding exercise with simple 2D models.

Full-or-part-time: 16h 48m
Theory classes: 5h
Practical classes: 2h
Self study : 9h 48m

Visit to a hydroelectric system

Description:
The visit to Susqueda waterfall is interesting since its water supplies the city of Barcelona. Furthermore, the dam is of great architectural value for the beauty of its design. This trip will only be scheduled if conditions are right.

Full-or-part-time: 14h 23m
Laboratory classes: 6h
Self study : 8h 23m

evaluation

Full-or-part-time: 6h
Laboratory classes: 2h 30m
Self study : 3h 30m

GRADING SYSTEM

The mark of the course is obtained from the ratings of continuous assessment and their corresponding laboratories and/or classroom computers.

Continuous assessment consist in several activities, both individually and in group, of additive and training characteristics, carried out during the year (both in and out of the classroom).

The teachings of the laboratory grade is the average in such activities.

The evaluation tests consist of a part with questions about concepts associated with the learning objectives of the course with regard to knowledge or understanding, and a part with a set of application exercises.

25% Assessment 1 at mid-semester (individual)
25% Assessment 2 at the end of the semester (individual)
25% practical exercises at home (group and individual)
25% Laboratory by submitting a document. (Group)

Criteria for re-evaluation qualification and eligibility: students that failed the ordinary evaluation and have regularly attended all evaluation tests will have the opportunity of carrying out a re-evaluation test during the period specified in the academic calendar. Students who have already passed the test or were qualified as non-attending will not be admitted to the re-evaluation test. The maximum mark for the re-evaluation exam will be five over ten (5.0). The non-attendance of a student to the re-evaluation test, in the date specified will not grant access to further re-evaluation tests. Students unable to attend any of the continuous assessment tests due to certifiable force majeure will be ensured extraordinary evaluation periods.

These tests must be authorized by the corresponding Head of Studies, at the request of the professor responsible for the course, and will be carried out within the corresponding academic period.

BIBLIOGRAPHY

Basic:
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- Baban, R. Design of diversion weirs: small scale irrigation in hot climates. Chichester: John Wiley & Sons, 1995. ISBN 0-471-95211-7.
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- Vischer, D.L.; Hager, W.H. Dam hydraulics. Chichester: John Wiley & Sons, 1998. ISBN 0-471-97289-4.
- Leliavsky, S. Irrigation engineering: canals and barrages. London: Chapman and Hall, 1965. ISBN 0-412-07320-X.
- Leliavsky, S. Hydro-electric engineering for civil engineers. London: Chapman and Hall, 1982. ISBN 0-412-2530-1.
- Leliavsky, S. Irrigation engineering: syphons, weirs and locks. London: Chapman and Hall, 1965. ISBN 0-412-07330-7.

Complementary:
- Chown, V.T. Hidráulica de los canales abiertos. Santafé de Bogotá: MGrawHill, 1994. ISBN 9586002284.