Course guide
2500218 - GEA0218 - Hydrogeology and Environmental Geochemistry

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 ENVIRONMENTAL ENGINEERING (Syllabus 2020). (Compulsory subject).

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

LECTURER

Coordinating lecturer: FRANCISCO JAVIER SANCHEZ VILA

Others: SANDRA MOLINERO GÓMEZ, MAARTEN WILLEM SAALTINK, FRANCISCO JAVIER SANCHEZ VILA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
14445. Recognize the biological bases and foundations of the plant and animal field in engineering: notions of genetics, biochemistry and metabolism, physiology, organisms and environment, population dynamics, flows of matter and energy and changes in ecosystems, biodiversity, principles of the kinetics of microbial growth and reactor theory.
14447. Obtain basic knowledge about the use and programming of computers, operating systems, databases and basic numerical calculation and applied to engineering.
14451. Apply the fundamental concepts of statistics and randomness of physical, social and economic phenomena, as well as uncertainty and decision-making techniques.
14452. Enhance the capacity of spatial vision and identify the techniques of graphic representation, topography, photogrammetry, cartography, remote sensing and Geographic Information systems.
14453. Describe and apply the techniques of analysis of physical, chemical and biological parameters; Integrate the experimental evidence found in field and / or laboratory data with the theoretical knowledge and interpret its results.
14454. Formulate the principles of fluid mechanics and the fundamentals of continuous medium mechanics.
14455. Identify the concepts and technical aspects linked to the conduit systems, both in pressure and in free sheet and apply them to the water supply transport networks; pumping systems; unit networks; separative networks; Avenues prevention systems in urban areas and analysis of tools for the recovery of altered river and coastal spaces.
14456. Describe the processes linked to the water cycle: atmospheric circulation and rain formation; rain transformation into runoff; and apply them to surface and underground hydrology associated with avenues risk, surface water pollution, aquifer management and groundwater pollution.

Generical:
14440. Identify, formulate and solve problems related to environmental engineering.
14441. Apply the functions of consulting, analysis, design, calculation, project, construction, maintenance, conservation and exploitation of any action in the territory in the field of environmental engineering.
14442. To use in any action in the territory proven methods and accredited technologies, in order to achieve the greatest efficiency respect for the environment and the protection of the safety and health of workers and users.

TEACHING METHODOLOGY

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

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

Groundwater, its origin, its movement on the ground, its physical-chemical interaction with soils and rocks as well as its social, economic and environmental value are studied. The flow of water in a porous medium, the mechanics of aquifers and the hydraulics of catchments are quantitatively studied. Piezometry, water balance and recharge. Chemical processes and reactions in soils and rocks. Interaction with surface waters (rivers, wetlands). Interaction with the sea and oceans. Interaction with the hydrosphere and the atmosphere. Effects of natural or anthropic chemical processes on the environment. Relationship between groundwater and the environment. Sustainable management of aquifers, corrective measures and artificial recharge.

1. To know the physical and hydraulic properties of the porous medium and the theory of Flow in a porous medium, to study the mechanics of aquifers, the piezometric networks and water balance, recharge and flow in the unsaturated zone and the dynamics of coastal aquifers.
2. Know the foundations of hydrogeochemistry, biological processes and chemical reactions in the porous medium. Artificial recharge concepts and sustainability, effective tensions and subsidence.

Hydrogeology and Environmental Geochemistry. The subsurface water cycle will be analyzed. From the physical and hydraulic properties of the porous medium, it will be possible raise the mechanics of aquifers and piezometric networks. Fundamentals of hydrogeochemistry, biological processes and chemical reactions in the porous medium.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

hydrogeological concepts

Description:
Movement of water in the hydrosphere. Water resources management. The Underground Reservoirs. Recharge, evaluation methods

Specific objectives:
Movement of water in the hydrosphere. The Hydrological Cycle focused on the underground cycle. Water resources and reserves. Joint use of surface and groundwater. Joint management. Artificial recharging. Underground reservoirs. Concepts. Aquifer and aquitard. Groundwater level and piezometric level. Water balance. Evapotranspiration evaluation methods. Calculation of a water balance

Full-or-part-time: 12h
Theory classes: 5h
Self study : 7h

coastal aquifers

Description:
Recharge, evaluation methods
Ghyen-Herzberg formulation, variable density, coastal aquifer management
intrusion wedge balance calculations

Specific objectives:
Water balance. Evapotranspiration evaluation methods. Calculation of a water balance
Understand the fundamental concepts of variable density, the movement of fluids at the land-sea interface, and the management of freshwater resources in coastal aquifers.
intrusion wedge balance calculations

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 3h
Self study : 8h 23m

groundwater flow

Description:
Water flow in porous media The Equation of Continuity Flow solutions in porous media 1D
Tracing of piezometric surfaces and flow networks

Specific objectives:
Water flow in porous media. Porosity, hydraulic conductivity. Darcy's Law. Heterogeneity and anisotropy. Transmissibility. Continuity Equation. Storage coefficient. Permanent regime and transitional regime. Some particular 1D and 2D solutions. River-aquifer interaction.
Equivalent permeability calculation in stratified medium. Flow Networks. Definition. Layout. Qualitative and quantitative interpretation. . Tracing of piezometric surfaces and flow networks

Full-or-part-time: 31h 12m
Theory classes: 3h
Practical classes: 6h
Laboratory classes: 4h
Self study : 18h 12m

well hydraulics

Description:
Basic concepts on catchment hydraulics Catch hydraulics in transient regime: confined, semi-confined and free aquifers. Interpretation of pumping tests. Graphic methods.

Specific objectives:
Basic concepts on catchment hydraulics. Starting hypothesis. Pumping tests: concept and preparation. Dupuit-Forcheimer hypothesis. Analytical formulas. Catch hydraulics in transient regime: confined, semi-confined and free aquifers. Principle of superposition. Image theory.
Interpretation of pumping tests. Graphic methods.

Full-or-part-time: 14h 23m
Theory classes: 3h
Practical classes: 3h
Self study : 8h 23m

concepts of hydrochemistry

Description:
Chemical components of groundwater. Parameters that determine the physical, chemical and physico-chemical characteristics of groundwater. Rock-water relationship. Origin. Modifying processes. Piper and Stiff diagrams
Chemical analysis. Chemical diagrams

Specific objectives:
Study and management of a chemical analysis. Representation of chemical data. Aquifer pollution. Aquifer pollution. Sources of pollution: landfills, agriculture, toxic waste, others. Accidental spills.
Chemical analysis. Chemical diagrams

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

solute transport

Description:
Advection, diffusion and dispersion. Formulation of the transport equation as a partial derivative equation (EDP) and its solution using analytical solutions.
basic transport calculations

Specific objectives:
Know how to formulate a mass balance of an integrated system and solve it. Know the processes that transport pollutants to groundwater Know how to formulate an EDP for the transport of a pollutant and solve it using analytical methods.
understand the basic concepts of advection and dispersion

Full-or-part-time: 24h
Theory classes: 2h
Practical classes: 4h
Laboratory classes: 4h
Self study : 14h

reactive transport

Description:
Chemical equilibrium, thermodynamic definitions; activity, law of action of masses, mixtures in liquids. Equations and variables of speciation. Operation of speciation codes. Reaction rate, elementary and global reactions, Kinetic laws, mineral kinetics, experimental determination.
multicomponent transport calculations

Specific objectives:
Revise the thermodynamic concepts needed to understand other topics of the subject. Know when to use a kinetic or equilibrium approach and know how to work with kinetic laws.
Know how to make chemical calculations assuming chemical equilibrium. .

Full-or-part-time: 26h 24m
Theory classes: 4h
Practical classes: 7h
Self study : 15h 24m

unsaturated zone

Description:
concepts of biphasic flow
unsaturated zone experiments

Specific objectives:
Understand the concepts of air-water flow

Full-or-part-time: 9h 36m
Theory classes: 2h
Laboratory classes: 2h
Self study : 5h 36m

GRADING SYSTEM

The qualification of the subject will be made from two exams, partial (hydrogeology part) and final (geochemical part). The final mark will be obtained by the arithmetic mean of these two exams. The reevaluation will consist of a single exam. In case of passing it, a final grade of 5 will be given in the subject. In case of not passing, the final grade will be the highest between this reassessment exam and the midterm and final average.

EXAMINATION RULES.

All students who have taken partial and final exams will be allowed to attend the re-evaluation exam.

BIBLIOGRAPHY

Basic:
- Custodio, E.; Llamas, M.R. (eds.). Hidrología subterránea. 2a ed. corr. Barcelona: Omega, 2001. ISBN 8428204462.