Course guide
2500049 - GECHISPSB2 - Surface and Groundwater Hydrology II

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:** 4.5 **Languages:** Catalan

LECTURER

Coordinating lecturer: ERNEST BLADE CASTELLET

Others: ERNEST BLADE CASTELLET, ALBERT FOLCH SANCHO, GONZALO JAVIER OLIVARES CERPA, MAARTEN WILLEM SAALTINK

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)
14420. Knowledge of urban services projects related to water distribution and sanitation. (Specific technology module: Hydrology)
14421. Knowledge and understanding of the supply and sanitation systems, as well as their sizing, construction and conservation. (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.
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 3hours per week of classroom activity .

The teacher presents the basic concepts and topics of the subject, shows examples and solves exercises.

Some hours are 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.

There are 4 houres of practicalactivities in the computer classroms

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

Analysis of the precipitation and the rain-flow transformation. Statistic of extremes. Curves IDF. Design rains. Return period. Alternate blocks. Loss of precipitation. Clean shower. Rainfall - flow transformation. Unit Hidrogram and Synthetic unitary hydrogram. Hydrogram propagation. Hydrological methods: Muskingum. Propagation through reservoirs. Reservoirs design for flood protection. Tools and software for superficial hydrology: HEC-HMS model. Recharge and unsaturated area. Groundwater numerical Models.

1 Ability to apply different methods of infiltration in the land and know how to apply aquifer recharge models.
2 Ability to use tools for calculating rain transformation processes in runoff.

Development at the level of specialization of the basic concepts acquired from superficial and subterranean hydrology in the preceding courses on water technologies. Introduction. Analysis of precipitation and rainfall-runaoff transformation. Introduction to the HEC-HMS code. Urban hydrology (hydrology in urban environment. Raising of grids and sinks. Design criteria for sewers networks. Hydraulic calculations with commercial codes: SWMM5) recharging and unsaturated area (level and pressure, unsaturated Darcy law, infiltration according to Green Ampt and according to Horton. Radiation, Vapor, evaporation, Penman, evapotranspiration, stationary situation in basin, water balance Models in soil). Transport of Solutes (Advection, diffusion, dispersion, ADE, analytical solutions, matrix diffusion, types of tracers, types of tests, interpretation, definition and classification of pollution, adsorption and degradation processes, reactive ADE, vulnerability and protective perimeters). Numerical groundwater models.

STUDY LOAD

Type	Hours	Percentage
Guided activities	4,5	4.00
Hours medium group	22,5	20.00
Self study	63,0	56.00
Hours large group	22,5	20.00

Total learning time: 112.5 h

CONTENTS

Introduction

Description:
Description of the teaching methodology and assessment. Review of elementary concepts presented in previous courses.

Specific objectives:
Revision of needed previous knowledge.

Full-or-part-time: 2h 24m
Theory classes: 1h
Self study : 1h 24m

Recharge and unsaturated zone

Description:
Level and Pressure, Wettability and retention, Unsaturated Darcy's Law, Richards equation, Infiltration according to Horton and Green Ampt
Radiation (long and short wave, radiation balance, albedo, calculation of radiation), Vapor (saturated vapor, relative humidity), Evaporation, Penman evapotranspiration (reference and actual), Penman-Monteith, Thornthwaite, Hargreaves.
Steady state in a basin, water balance models in soil
A example for calculation of recharge

Specific objectives:
Knowing the basics of unsaturated flow. Knowing how to apply infiltration models
Knowing the basics of evapotranspiration. Knowing how to apply models of evapotranspiration.
Knowing how to apply aquifers recharge models

Full-or-part-time: 14h 23m
Theory classes: 5h
Practical classes: 1h
Self study : 8h 23m

Evaluation

Full-or-part-time: 9h 36m
Laboratory classes: 4h
Self study : 5h 36m

Analysis of precipitation and rainfoall--runaoff transformation

Description:
Use and characteristics of the different statistical distributions used in flood hydrology.
Obtaintion and use of Clark synthetic unit hydrographs
Exercises and homework previously supplied

Specific objectives:
Knowledge of the bases and application of the statistical distributions more commonly used in surface hydrology
Knowledge of a commonly used unit hydrograph
Resolution of doubts raised by students

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

Urban Hydrology

Description:
Description of the hydrological processes of urban drainage. Rational method when applied to urban areas ..
Inlet design.
Exercises grates and inlets
Models deposits and wave kinematics
Exercises in urban hydrology

Specific objectives:
Specifics of urban hydrology. Rational model in urban area.

Being able to correctly dimensions the inlet works in urban areas

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

Tools and software for surface hydrology

Description:
Spatial data for hydrological studies
HEC-HMS
Geo-HMS

Full-or-part-time: 21h 36m
Theory classes: 2h
Laboratory classes: 7h
Self study : 12h 36m

Solute transport

Description:
Advection, diffusion, dispersion, ADE, analytical solutions, matrix diffusion
Types of tracer, types of tests, interpretation
Definition and classification of contamination, adsorption and degradation processes, reactive ADE, vulnerability and protective perimeters
Example for a calculation of contamination

Specific objectives:
Knowing the solute transport processes in groundwater. Knowing how to formulate an PDE a for solute transport and how to solve it by analytical methods.
Knowing how to interpret a tracer test.
Knowing the relevant processes of aquifer contamination.

Full-or-part-time: 19h 12m
Theory classes: 7h
Practical classes: 1h
Self study : 11h 12m

Numerical groundwater models

Description:
Types of models, numerical methods, using models
Example of a numerical model
Modflow workshop

Specific objectives:
Understanding what does a numerical model and know its capabilities and limitations.
Evaluation
Become familiar with the code Modflow

Full-or-part-time: 16h 48m
Theory classes: 2h
Practical classes: 1h
Laboratory classes: 4h
Self study : 9h 48m

GRADING SYSTEM

The continuous assessment will take into account the following factors:

- Exams (NA)
- Exercises performed at home (NP1)

50% of the grade will be the surface hydrology and the other 50% of the groundwater hydrology.

The rating of both parts is the weighted average: NF = 0.7 *NA 0.3 · NP where NA is the average obtained in the exams, NP is the average mark obtained in the practical exercises.

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.

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:
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- Gómez Valentín, M. Curso de hidrología urbana. Barcelona: Escola Tècnica Superior d'Enginyers de Camins, Canals i Ports. Universitat Politècnica de Catalunya (UPC), 2008. ISBN 978-84-612-1514-0.
- Comisión Docente. Curso Internacional de Hidrología Subterránea. Hidrogeología : conceptos básicos de hidrología subterránea. Artes Gráficas Torres, S. L.. Fundación Centro Internacional de Hidrología Subterránea, 2009. ISBN 9788492146918.
- Custodio, E.; Llamas, M.R. (eds.). Hidrología subterránea. 2a edición corregida. Barcelona: Omega, 1983. ISBN 8428204462.

Complementary:

- Chow, V.T.; Maidment, D.R.; Mays, L.W. Hidrología aplicada. Santa Fé de Bogotá, Colombia: McGraw-Hill Interamericana, ISBN 958-600-171-7.
- Scharffenberg, W.A.; Flemming, M.J. Hydologic Modelling System HEC-HMS User's Manual. Davis, CA, Estats Units d'Amèrica: Hydrologic Engineerieng Center, 2010.
- Freeze, R.A. ; Cherry, J.A. Groundwater. Englewood Cliffs, NJ: Prentice Hall, 1979. ISBN 0133653129.
- Domenico, P.A. y F.W. Schwartz. Physical and Chemical Hydrogeology. 2nd ed. New York: John Wiley and Sons, 1998. ISBN 0471597627.
- Allen, R.G.; Pereira, L.S.; Raes, D.; Smith, M. Crop evapotranspiration: guidelines for computing crop water requirements: FAO Irrigation and drainage paper 56 [on line]. Rome: Food and Agriculture Organization of the United Nations, 1998 [Consultation: 02/02/2021]. Available on: http://www.fao.org/docrep/X0490E/X0490E00.htm. ISBN 9251042195.
- Bear, J., Cheng, A.H.D. Modeling groundwater flow and contaminant transport. Dordrecht [etc.]: Springer, 2010. ISBN 9781402066818.
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- Processing Modflow: an integrated modeling environment for the simulation of groundwater flow, transport and reactive processes [on line]. Version 8. Irvine, California: Simcore Software, 2012 [Consultation: 18/01/2021]. Available on: https://www.simcore.com/files/pm/v8/pm8.pdf.