Course guide
250807 - 250807 - Numerical Modelling Tool in Geoengineering

Last modified: 25/01/2024

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

Degree: MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: SEBASTIAN OLIVELLA PASTALLE

Others: SEBASTIAN OLIVELLA PASTALLE, ALFONSO RODRIGUEZ DONO, JEAN VAUNAT

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13308. To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
13310. To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory testing programmes.
13311. To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.

Generical:
13300. To apply advanced knowledge in sciences and technology to the profesional or research practice.
13302. To identify and design solutions for geo-engineering problems within ethical, social and legislative frameworks.
13303. To evaluate the impact of Geo-engineering on environment, sustainable social development and the significance of working within reliable and consciensous profesional environment.
13304. To incorporate new techncologies and advanced tools in Geo-engineering into profesional and research activities.
13305. To conceive Geo-engineering as a multi-disciplinary field that includes relevant aspects from geology, sismology, hydrogeology, geotechnical and earthquake engineering, geomechanics, physics of porous media, geophysics, geomatics, natural hazard, energy and climate interactions.
13306. To promote innovation for the development of methodology, analyses and solutions in Geo-engineering

TEACHING METHODOLOGY

Curso que combina una parte semanal con un curso concentrado

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

To conceive soils and rocks as porous media governed by Solid and Fluid Mechanics.
To interpret laboratory tests and field observations so as to identify the mechanisms responsible for soil response. To propose laboratory research programmes.
To formulate and implement Finite Element and Finite Differences numerical models with the objective to analyze the processes that govern ground response, to interpret field information and to predict soil response.

* To apply oral presentation techniques.
* To use advanced calculation tools to analyze Civil Engineering problems, design big-scale models and suggest design solutions for prototypes.
* To know and be able to use advanced techniques to geo-referentially represent data.
* To have powerful tools for the geospatial analysis of geo-referentiated data.

- Introduction.
- Formulation of thermo-hydraulic coupled problems in soils and rocks.
- Presentation of the numerical tool.
- Tutorials.
- Application to real cases.

This subject focuses primarily on the study of the physical processes that take place in unsaturated porous media. These processes can be summarized as: water flow, both liquid and in the form of steam in an unsaturated medium; flow of other fluids, for example, moist air in the multifase medium; heat flow both by driving and by advection, the latter caused by the movement of the fluids; deformation of the porous matrix either by changes of voltage as by interstitial pressure changes. These processes are important in several fields of field engineering, among them, the hydrogeology of the unsaturated zone (above the phreatic level), the hydro mechanical behavior of unsaturated soils, the water and heat flow in aquifers and the behavior of porous media under temperature variations. Once the processes have been studied separately, the existing couplings will be analyzed. The global formulation to which it will be arrived, allows to analyze the thermal hydro mechanical behavior coupled with geological means. Finally, some aspects related to the numerical resolution of problems will be presented using said formulation and its applications to real cases.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	63.95
Hours small group	9,8	7.83
Hours large group	25,5	20.38
Hours medium group	9,8	7.83

Total learning time: 125.1 h

CONTENTS

Theory

Description:
* Properties of liquid water. Density, compressibility, viscosity and surface tension * Properties of water vapor and gaseous phase (humid air). Density, compressibility and viscosity. Dissolved air, Henry's law. * Influence of temperature, pressure and presence of solutes in the properties of water and gas. * Influence of capillary pressure or suction on vapor concentration. Psychrometric law. Effect of solutes. Capillary suction and osmotic suction. * Internal energy and enthalpy. First principle of thermodynamics. * Boiling. Vapor pressure. Diagram of phases of water. * General equation of balance in continuous medium.
*
Fundamentals. Basic laws and THM balance equations

Mechanical constitutive laws I. Behaviour of unsaturated soils

General structure of Code_Bright and capabilities

Code_Bright and GiD installation and guidance. GiD interface basics

Mechanical constitutive laws II. Behaviour of expansive soils, hard soils and soft rocks

Boundary conditions. Constant flow, constant pressure. Excavation-construction. Atmospheric

Full-or-part-time: 43h 12m
Theory classes: 18h
Self study : 25h 12m

Tutorials

Description:
Tutorials: Linear problems (foundation, heat flow, drainage around a trench, gas flow and injection, conservative contaminant migration)

Mock-up tutorial example. Pre and post-processing (GiD)

Tutorials: Advanced problems (DAM, mock-up test, Sequential Excavation Method -SEM-, shear hydraulic test, consolidation joint element, CO2 injection, BExM, atmospheric)

Full-or-part-time: 16h 48m
Practical classes: 1h
Laboratory classes: 6h
Self study : 9h 48m

Real cases

Description:
Applications I. Dam construction and long-term response

Applications II. Soil-vegetation atmosphere interactions

Applications III. Analyses of expansive clay sealing systems in deep geological disposal of radioactive waste

Applications IV. Sequential excavation in unsaturated soils

Troubleshooting proposed by teachers or students

Full-or-part-time: 33h 36m
Practical classes: 8h
Laboratory classes: 6h
Self study : 19h 36m

GRADING SYSTEM

The subject is evaluated by assignments.

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:
- Code_Bright Team. Manual Code_Bright.