250531 - MODSOLAQCO - Modelling of Soil and Groundwater Contamination

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
Academic year: 2018
Degree: MASTER'S DEGREE IN GEOLOGICAL AND MINING ENGINEERING (Syllabus 2013). (Teaching unit Compulsory)
MASTER'S DEGREE IN GEOTECHNICAL AND EARTHQUAKE ENGINEERING (Syllabus 2009). (Teaching unit Optional)
MASTER'S DEGREE IN GEOTECHNICAL ENGINEERING (Syllabus 2015). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Spanish, English

Teaching staff
Coordinator: DANIEL FERNANDEZ GARCIA
Others: DANIEL FERNANDEZ GARCIA, ALBERT FOLCH SANCHO, PAULA - FELICIDAD RODRIGUEZ ESCALES

Opening hours
Timetable: To be agreed with the teachers, office D2-004.

Degree competences to which the subject contributes

Specific:
8178. Ability to plan and execute transportation facilities, distribution and storage of solids, liquids and gases.
8211. The ability to address and solve advanced mathematical problems in engineering, from the scope and context of the problem to its statement and implementation in a computer program. In particular, the ability to formulate, program and apply advanced analytical and numerical calculation models to the design, planning and management of a project, as well as the ability to interpret the results obtained in the of mining engineering.
8219. Ability to plan and implement water treatment and waste management plants (municipal, industrial and hazardous waste).
8241. Adequate knowledge of modelling, assessment and management of geological resources, including groundwater, mineral and thermal resources.
8247. Ability to assess and manage environmentally projects, sites or facilities.
Teaching methodology

The course consists of 3 hours per week of classroom activity.

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

The 0,8 hours 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.

Learning objectives of the subject

Ability to plan and execute transportation facilities, distribution and storage of solids, liquids and gases.

Ability to plan and implement water treatment and waste management plants (municipal, industrial and hazardous).

Ability to assess and manage environmentally projects, plants and facilities.

Ability to address and solve advanced mathematical engineering problems, from problem statement to formulation development and its implementation in a computer program. In particular, the ability to formulate, plan and implement advanced analytical models and numerical calculation, project planning and management, and the ability to interpret the results in the context of mining engineering.

Specialized knowledge on environmental engineering to be able to apply advanced techniques and methodologies. The aim is to deepen the knowledge on the ability to model, assess and manage the impact of the civil works and exploitation of minerals and energy resources on the environment. An important aspect to consider will be sustainable development as related to water resources, waste, and contaminated sites.

Water Engineering. Interactions between groundwater, civil works and the environment, fluvial and marine sedimentary dynamics.

The aim of the course is to understand the behavior and transport mechanisms of non-aqueous phase organic liquids pollutants in the subsurface. Application to mathematical modeling, human health risk analysis and ecosystems.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 19h 30m</th>
<th>15.60%</th>
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</thead>
<tbody>
<tr>
<td>Hours medium group: 9h 45m</td>
<td>7.80%</td>
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</tr>
<tr>
<td>Hours small group: 9h 45m</td>
<td>7.80%</td>
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<tr>
<td>Guided activities: 6h</td>
<td>4.80%</td>
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<tr>
<td>Self study: 80h</td>
<td>64.00%</td>
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</tbody>
</table>
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## Content

### Introduction

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>2h 48m</td>
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</tbody>
</table>

**Description:**
Sources of contamination and types of contaminants
State waters and soils in Catalonia and Europe, description of the contamination problem

**Specific objectives:**
Understand the various sources and types of contamination of soil and groundwater
State waters and soils in Catalonia and Europe, conceptual models of contaminated sites

### Properties and characteristics of contaminants

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>12h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>5h</td>
</tr>
<tr>
<td>Self study:</td>
<td>7h</td>
</tr>
</tbody>
</table>

**Description:**
Description of the parameters that control the infiltration capacity such as the viscosity, density and relative mobility.
Description of the parameters that control the distribution of mass between phases: solubility, vapor pressure, and distribution coefficient and Henry's constant
Description of the parameters that control movement: saturation, moisture content, interfacial tension, contact angle, capillary pressure, residual saturation, hydraulic conductivity, relative permeability

**Specific objectives:**
Knowing the parameters that control the infiltration capacity such as the viscosity, density and relative mobility.
Knowing the parameters that control the distribution of mass between phases: solubility, vapor pressure, distribution coefficient and Henry's constant
Knowing the parameters that control movement: saturation, moisture content, interfacial tension, contact angle, capillary pressure, residual saturation, hydraulic conductivity, relative permeability

### Multiphase flow

<table>
<thead>
<tr>
<th>Learning time:</th>
<th>9h 36m</th>
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</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>4h</td>
</tr>
<tr>
<td>Self study:</td>
<td>5h 36m</td>
</tr>
</tbody>
</table>

**Description:**
Theoretical basis of multiphase flow
Description of methods to design and evaluate the operation of an oil reservoir

**Specific objectives:**
Generalized Darcy's law, the law limits Darcy relative permeability curves and retention of mass conservation in multiphase flow, phase continuity, flow Buckingham, analytical solutions (Buckley-Leverett, McWhorter and Sunada)
Learn methods to design and evaluate the operation of a reservoir of oil
### Contaminant transport

**Learning time:** 12h  
Theory classes: 5h  
Self study: 7h

**Description:**  
Description of the dissolution of non-aqueous liquids such as chlorinated solvents are, gasoline, ...  
Description of transport processes in the saturated zone and presentation of basic equations of transport  
Description of transport processes in the vadose zone and the basic equations of transport of gases and vapors

**Specific objectives:**  
Learn to evaluate the time of dissolution and the dissolution of a cup of liquid non-aqueous  
Knowing the transport processes in the saturated zone  
Knowing the transport processes in the vadose zone and the basic equations of transport of gases and vapors

### Characterization of contaminated sites

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

**Description:**  
Characterization of groundwater  
Characterization of soils  
Characterization of gases  
Characterization of NAPLs  
Description of how to interpret the results of analysis of water, soil and gases in the subsurface

**Specific objectives:**  
Learn the characterization of groundwater, soil, gas and NAPLs in contaminated sites  
Learn how to interpret the results of analysis of water, soil and gases in the subsurface

### Assessment of water contamination and soil

**Learning time:** 7h 11m  
Theory classes: 3h  
Self study: 4h 11m

**Description:**  
Presentation of the legislative framework for contaminated soil and water protection of the environment and human health  
Análisis risk to the environment and human health risk, toxicity and dose

**Specific objectives:**  
Learn the legislative framework for contaminated soil and water protection of the environment and human health  
Learn how to estimate the risk to the environment and human health problems associated with contamination of soil and groundwater
### Remediation engineering

**Learning time:** 9h 36m  
Theory classes: 4h  
Self study: 5h 36m

**Description:**  
Description of tècniques decontamination of groundwater  
Description of the decontamination of polluted soils

**Specific objectives:**  
Learn different techniques of decontamination of groundwater. Design and evaluation.  
Learn techniques for decontamination of polluted soils. Design, implementation and evaluation.

### Problem

**Learning time:** 19h 12m  
Practical classes: 8h  
Self study: 11h 12m

**Description:**  
Solving exercises in the classroom

**Specific objectives:**  
Learn to evaluate, calculate, and project design.

### Models of contaminated soils and aquifers

**Learning time:** 7h 11m  
Laboratory classes: 3h  
Self study: 4h 11m

**Description:**  
Presentation of models for risk analysis problems in contaminated soils and aquifers

**Specific objectives:**  
Learn tools to assess the risk associated with a pollution problem

### Guided activities

**Learning time:** 4h 48m  
Laboratory classes: 2h  
Self study: 2h 48m
Qualification system

The rating will be obtained from continuous assessment of qualifications. Continuous assessment consists of doing various activities, both individual and group character and additive training, conducted during the year (in the classroom and outside of it). The rating is the average of the activities of this type, obtained through exercises (PR), a directed work (TD) and an examination (EX). The final mark is estimated as: $0.3 \times 0.4 \times PR \times 0.3 \times TD \times EX$

Regulations for carrying out activities

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:


Complementary:
