Course guide
250658 - CARGESTCAS - Characterization, Management and Treatment of Soil and Groundwater Contamination

Unit in charge: Barcelona School of Civil Engineering
Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering.
Degree: MASTER'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2014). (Compulsory subject).
Academic year: 2022  ECTS Credits: 5.0  Languages: Spanish

LECTURER

Coordinating lecturer: FRANCISCO JAVIER SANCHEZ VILA
Others: MARCOS CARNICERO DEL RIO, DANIEL FERNANDEZ GARCIA, PAULA FELICIDAD RODRIGUEZ ESCALES, FRANCISCO JAVIER SANCHEZ VILA

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
13340. Apply scientific concepts to environmental problems and their correlation with technological concepts.
13343. Identify, define and propose technological management and appropriate solution to an environmental problem.
13344. Dimension conventional treatment systems and raise their mass balance and energy.

Transversal:
8562. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

8563. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

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.

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

CE01 - Apply scientific concepts to environmental problems and their correlation with technological concepts.
CE04 - Identify, define and propose technological management and appropriate solution to an environmental problem.
CE05 - Dimension conventional treatment systems and raise their mass balance and energy.

Explore scientific concepts and technical principles of quality management of the receiving environments, atmosphere, water and soil.
Explore scientific concepts and technical principles of management and treatment of gaseous emissions, water supply, sewage and waste and remediation techniques for groundwater and contaminated soils.
Sized systems for the treatment of major pollutants vectors.
Interprets rules, identifies goals, evaluates alternative techniques, proposes appropriate solutions and prioritize actions.

Definitions and porous medium soil and geological processes leading to soil.
Transport and reaction of contaminants in saturated porous media: principles; transport processes: advection, molecular diffusion, hydrodynamic dispersion, sorption homogeneous and heterogeneous reactions; transport and reaction equations continuity equation, applications and examples .
Techniques thermal soil remediation: thermal desorption; incineration; vitrification; pyrolysis.
Techniques physicochemical soil remediation: soil flushing; solidification / stabilization; soil steam extraction (SVE); soil washing; electrokinetic.
Soil bioremediation techniques: phytoremediation; biodegradation; transformation with reduced toxicity; bioaccumulation bioaugmentation; inoculation; biological dehalogenation.
Physicochemical techniques groundwater remediation: containment; chemical dehalogenation; pumping and treatment of dissolved contaminants; bombeode hydrocarbons DNAPLs Treatment.
In situ techniques: natural attenuation; permeable reactive barriers; reactive areas, air sparging.

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>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>15,0</td>
<td>12.00</td>
</tr>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>10,0</td>
<td>8.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>10,0</td>
<td>8.00</td>
</tr>
<tr>
<td>Guided activities</td>
<td>10,0</td>
<td>8.00</td>
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Total learning time: 125 h
## CONTENTS

### Introduction

**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

**Full-or-part-time:** 4h 48m
Theory classes: 2h
Self study: 2h 48m

### Subsurface flow

**Description:**
Theory of subsurface flow
Continuity equation. Solutions in 1D and 2D
Basic concepts on well hydraulics

**Specific objectives:**
Well hydraulics: steady-state and transient regimes

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study: 4h 11m

### Properties and characteristics of contaminants

**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

**Full-or-part-time:** 9h 36m
Theory classes: 4h
Self study: 5h 36m
**Contaminant transport**

**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

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

**Characterization of contaminated sites**

**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

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study : 4h 11m

**Assessment of water contamination and soil**

**Description:**
Presentation of the legislative framework for contaminated soil and water protection of the environment and human health
Anàlisis 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

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study : 4h 11m
Remediation engineering

**Description:**
Description of techniques 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.

**Full-or-part-time:** 7h 11m
Theory classes: 3h
Self study: 4h 11m

Problem

**Description:**
Solving exercises in the classroom

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

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

Models of contaminated soils and aquifers

**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

**Full-or-part-time:** 7h 11m
Laboratory classes: 3h
Self study: 4h 11m

Guided activities

**Full-or-part-time:** 4h 48m
Laboratory classes: 2h
Self study: 2h 48m

**GRADING 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 * PR + 0.3 * TD + 0.4 * EX
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:

Complementary: