



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Groundwater Pollution and Remediation

2122-2-F7501Q086

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#### Aims

- achieve the knowledge of chemical and physical characteristics of the contaminants, such as of miscible and non-miscible contaminants, to comprehend contaminants behavior in groundwater;
- ability to distinguish between anthropogenic pollution and natural contamination;
- capability in solving simple problems related to the transport of contaminants, including advection, dispersion, delay and degradation;
- achieve the knowledge of the main investigations techniques to acquire hydrogeological and hydrochemical parameters;
- agility in reading a conceptual model from the collected data
- achieve the knowledge of the main groundwater remediation techniques and of their implementation in different situations.

#### Contents

Contaminants and their propagation in groundwater;

Survey methods to define the polluted area characterization;

Techniques to cleaning up aquifers and to evaluate the results of the remediation,  
Resolution of groundwater pollution cases.

## **Detailed program**

Anthropogenic pollution and natural contamination;

Pollutants and sources of pollution: characteristics, frequency, and distribution;

Chemical physical characteristics of contaminants;

Transport phenomena: advection, dispersion, adsorption, delay, degradation;

Mass conservation principle and transport equation;

Analytical transport solution of the transport equation, simple case of a continuous source;

Movement of NAPL (non-aqueous liquid phase), light and heavy (LNAPL and DNAPL); basic concepts of capillarity and wettability, permeability and relative permeability

Site characterization, investigations, and construction of a conceptual model;

Legislation: theoretical outline related with groundwater remediation and risk analysis;

Main remediation techniques, influencing physicochemical factors, feasibility, remediation time prediction, monitoring, data interpretation, achievement of the remediation objectives (hydraulic barrier, air sparging and soil venting, permeable reactive barrier, LNAPL and DNAPL removal, short references to other techniques).

## **Prerequisites**

Basic knowledge of hydrogeology

## **Teaching form**

Lessons

## **Textbook and teaching resource**

The teaching (slides, exercises, schematics), which will be published on the e-learning site:

Suggested texts for detailed study :

<https://elearning.unimib.it/enrol/index.php?id=37830>

**Francani V., 2014. Idrogeologia. C.E.A. Casa Editrice Ambrosiana**

Di Moffetta, Sethi, 2012. Ingegneria degli Acquiferi. Springer.

Fetter C.W., 1993. Contaminant Hydrogeology, New York, Macmillan.

## **Semester**

First Semester

## **Assessment method**

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The written examination consists of: 1) a question, in order to evaluate the comprehension of the principle theoretical concepts. 2) a problem to solve through an ordered sequence of exercises and to discuss, in order to evaluate the skill in solving a contamination problem.

The oral exam consists of: - a discussion on topics concerning site characterization and remediation techniques, in order to evaluate personal knowledge and application of the methods of investigation and remediation.

The written test provides a total score of 25/30.

The oral exam gives the possibility to increase the score of the writing test up to 7/30.

## **Office hours**

On informatic platform by appointment with the teacher by email

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