



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Idrogeologia Applicata

2425-1-F7401Q075-F7401Q079M

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#### Aims

To provide skills about: the characteristics of soils and rocks that control subsurface water storage and circulation; estimation of groundwater reserves and renewable water resource; surface and deep water relationships; hydrochemistry of groundwater and principles of the evolution of water chemistry; classification of springs and their hydraulic regime; construction of intake and catchment works; characterization of aquifers with flow tests to determine hydraulic parameters of aquifers. The use of analytical and numerical solutions for problem solving and interpretation of tests. Notes on methods and regulations for resource and catchment point defense.

The second part of the course "Contaminant Hydrogeology" is aimed at the hydrogeology of contaminants, the types of substances involved, the physics of transport in groundwater, tracer tests, transport equations with terms for reaction and adsorption, solutions for the determination of hydrodispersive parameters, active and passive water and contaminant measurement and sampling techniques, and techniques for securing, remediation and de-pollution for both saturated and unsaturated conditions. Mention will be made for the heat transport part, which will be integrated in detail in the GEOENERGY course

#### Contents

Students will learn basic knowledge on hydrogeology, applied and contaminant hydrogeology, treatment of contaminated sites

Contaminant Transport Processes:

- Advection, dispersion, and diffusion
- Contaminant sorption and retardation
- Source characterization and release mechanisms
- Contaminant fate and transport modeling
- Reactive transport and biodegradation processes

Contaminant Site Investigation:

Site characterization techniques  
Sampling methods and analysis  
Contaminant plume delineation  
Groundwater monitoring networks  
Risk assessment and management strategies  
Groundwater Remediation:

Pump-and-treat systems  
In-situ remediation techniques (e.g., bioremediation, chemical oxidation)  
Permeable reactive barriers  
Enhanced natural attenuation  
Remediation performance assessment  
Groundwater Modeling:

Numerical modeling principles  
Development and calibration of groundwater models  
Modeling of flow and contaminant transport  
Uncertainty analysis in groundwater modeling  
Model validation and sensitivity analysis  
Emerging Topics:

Managed aquifer recharge and groundwater banking  
Groundwater and climate change  
Groundwater governance and policy  
Impacts of urbanization and land-use change on groundwater  
Groundwater sustainability and resource management

## **Detailed program**

### Fundamentals of hydrogeology

Hydrologic cycle and water circulation in different geological systems. Hydrogeological balance: rainfall, temperature, real and potential evapotranspiration. Porosity definitions and use. Fluid flow in saturated and unsaturated soil, porous rocks or jointed rocks. Reconstruction and interpretation of piezometric surfaces and flow nets. Classification and analysis of springs, spring discharge regime, evaluation of spring discharge dynamics using recession curves, Hydrochemistry: physical chemical properties of groundwaters, TDS, dissolved elements their origin and their effects, data representation, plotting and analysis. . Well design and installation, drilling and construction techniques, purging, maintenance, materials. Monitoring and interpretation of well hydraulic testing and pumping tests under steady state and transient conditions. Well sampling techniques and problems, methods and materials, sampling campaigns. Applying site characterization to model development.

### Applied hydrogeology

Solute transport and contaminant migration in saturated and unsaturated soils. Tracer tests and characterization of dispersivity. Multi-fluid processes. NAPLs, physical chemical characteristics and transport in the vadose and saturated zones. Primary or direct and secondary contamination processes. Interaction between soil matrix and solutes. Transformation, attenuation and decay processes of solutes. Biodegradation: theory, in situ estimation, and modelling. Organic and inorganic compounds in subsurface water. Treatments at contaminated sites and groundwater remediation methods and techniques.

Risk analysis for soil and water contamination. Reference legislation: regional, national and european laws for superficial and subsurface water.

Lab exercises: Flow net construction, simple solution of water flow in porous media, interpretation of well tests.

Design of a reclamation scheme for different contaminated sites.

## **Prerequisites**

A base-level knowledge in engineering geology, site investigation, physics and mathematics is required. IT is mandatory the acquisition of the credits in the course of Hydrogeology

## **Teaching form**

- Lessons

- Laboratory experiences and problem solving

## **Textbook and teaching resource**

All the lectures are downloadable from the elearning website

## **Semester**

1st and second semester

## **Assessment method**

Oral

## **Office hours**

## **Sustainable Development Goals**

CLEAN WATER AND SANITATION

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