UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

## Waste, Wastewater and Contaminated Sites Management

**2627-2-F5402Q035**

### Aims

Knowledge of the system cycle of integrated management of municipal and industrial waste, urban and industrial wastewater treatment, remediation of contaminated sites.

*Knowledge and understanding*
At the end of the course the student knows:

- The physico-chemical processes of neutralization, precipitation and sedimentation;
- The municipal wastewater treatment processes;
- The fundamentals and technologies of thermal treatment;
- The processes for the treatment of incinerator flue gas;
- The methods of characterization of a contaminated site;
- The physico-chemical processes for the remediation of contaminated sites.

*Applying knowledge and understanding*
At the end of the course the student is able to:

- Calculate mass and energy balances in the waste management cycle.
- Calculate mass flows and balances in the wastewater management cycle.
- Develop a conceptual model of a contaminated site.
- Apply knowledge to real-world cases of contaminated site remediation, highlighting the advantages and disadvantages of proposed alternatives.

*Making judgements*
At the end of the course the student is able to:

- Analyze the environmental problem;
- Critically evaluate the different available options of processes and plants;
- Identify the most suitable treatment technology;

*Communication skills*
Scientific communication skills in English at B2 level, both oral and written, in technical-scientific contexts.

*Learning skills*
Being able to apply the acquired knowledge to contexts different from those presented during the course, and to understand the topics covered in the scientific literature concerning the characterization and treatment of wastes and contaminated sites.

## Contents

Chemical and physico-chemical treatments. Wastewater treatment systems. Fundamentals of the combustion process: physico-chemical and chemical bases and mechanisms. Thermal treatments. Municipal solid waste management. Methodologies for investigation, characterization and analyses of contaminated sites. Processes and physico-chemical technologies.

## Detailed program

Treatment of urban and industrial wastewater: Physico-chemical processes and technologies: sedimentation, flotation, process of acid-base neutralization, precipitation, reduction and dehalogenation. Urban wastewater treatment plants: Qualitative and quantitative parameters which characterize urban vs. industrial waste water; pretreatment, pumping, grilling, EQ, suspended solid removal, chemical and chemico-physical processes, activated sludge and lined sludge processes; nitrification / denitrification; phosphate removal; tertiary treatment; sludge cycle management. Treatment of solid waste. Thermal destruction: chemical and physical fundamentals of combustion, gasification and pyrolysis. Indicators of combustion. Products of incomplete combustion. Processes and technologies for thermal treatment: grate furnace, rotary kiln, fluid bed furnace. MSW incineration: parts of the incinerator plant. Mass and energy balances. Residues of the treatment. Fume processing: dust precipitation, acid and micropollutant scavenging. Prevention of NOx formation, NOx scavenging. Treatment of solid residues. Monitoring the emission quality. Recycling and recovery processes. The remediation of contaminated sites: The characterization plan: collection and processing of records and existing data, classification, definition of intervention priority; inspection and preliminary investigation, sampling and analysis. The sampling plan and its implementation. Contaminated site remediation by physico-chemical technologies and processes: in situ (Soil Flushing) vs. ex-situ (Soil Washing); thermal desorption, solvent extraction, extraction of vapours from soil.

Practical classes: Mass and energy balances in waste management cycles. Flow and mass balances in wastewater cycle. Case Studies.

## Prerequisites

Fundamentals of Physical Chemistry (kinetics and thermodynamics), Inorganic Chemistry (precipitation and redox reactions), Organic Chemistry, Physics.

## Teaching form

The course includes: 16 two-hour lectures of delivered didactics in presence (4 CFU), 5 two-hour practical classes of interactive teaching in presence (1 CFU), 10 hours of educational visit in interactive mode (1 CFU campus abroad).
In the practical classes, students are given a problem to solve using the methods presented in the theoretical lessons. The development of the problem is guided by the teacher and tends to develop and strengthen the student's ability to identify the most suitable techniques for the application. During the campus abroad one or more waste treatment plants are visited.
The course is taught in English.

## Textbook and teaching resource

Teaching material will be available on the e-learning platform.

Textbooks:

Colin Baird and Michael Cann “Environmental Chemistry”

George Tchobanoglous, Hilary Theisen and S. A. Vigil “Integrated solid waste management: engineering principles and management issues”, McGraw-Hill

Renato Vismara “Depurazione biologica”, Hoepli

## Semester

second semester

## Assessment method

oral examination

the examination foresees the resolution of one or more exercises based on the exercise sessions (contributes 25% of the final grade) and an interview aimed at verifying the knowledge of the topics covered in the lectures and the autonomy of analysis and judgment (contributes 75% of the final grade)

exam grade in the range 18-30/30

it is possible to take the exam in Italian

## Office hours

By appointment to be made by e-mail (elena.collina@unimib.it)

## Sustainable Development Goals

QUALITY EDUCATION | CLEAN WATER AND SANITATION | RESPONSIBLE CONSUMPTION AND PRODUCTION