Water Quality and Treatment (250MAG004)

General Information

School	ETSECCPB
Departments	Departament d'Enginyeria Civil i Ambiental (DECA)
Credits	5.0 ECTS
Programs	MÀSTER UNIVERSITARI EN ENGINYERIA DE L'AIGUA (pla 2025)
Course	2025/26

Main teaching language at each group

- Group 10Q1 English (Q1)

Faculty

Responsible Faculty: Enrica Uggetti
Faculty: Cigdem Eskicioglu, Jaume Puigagut Juarez, Enrica Uggetti

Objectives of Education

This course will address various aspects of different types of water treatment processes, including both biological treatment processes and nature-based solutions. Emphasis will be placed on both water characterization, covering the main quality parameters, and the technical aspects of the design and operation of different water treatment technologies.
Advanced treatment methods for water reclamation and reuse will also be covered.
Part of the course will be dedicated to bioindication and biosensing techniques for monitoring microbial activity and organic matter content in water. Real case studies will be presented, and mathematical models will be used to assess water quality.
Specific Objectives:
- To understand the main water quality parameters.
- To comprehend the technical aspects of design and operation of biological wastewater treatment systems and nature-based solutions for water resource management.
- To understand advanced treatment technologies for water regeneration and reuse.
- To become familiar with microbiological quality analysis techniques, including bioindication and biosensing.

The course aims to provide students with a comprehensive view of water treatment approaches focused on regeneration and reuse, promoting water sustainability. Active student participation is encouraged, and through guided assignments on real-world case studies and mathematical modelling, students will learn to explore, analyse, and evaluate various water and wastewater treatment technologies.

Total hours of student work

		Hours	Percentage
Supervised Learning	Large group	45.0 h	100.00 %
	Medium group	0.0 h	0.00 %
	Laboratory classes	0.0 h	0.00 %
	Guided Activities	0.0 h	0.00 %
Self Study		80.0 h	

Contents

Water classification, quality and characterization (COD, BOD, Temperature, etc.), microbial kinetics.

General concepts regarding the classification and quality of wastewater will be introduced. The main water quality parameters (e.g., COD, BOD, nutrient content, etc.) will be described, along with the analytical techniques used to measure them. Basic concepts of microbial kinetics will also be introduced and further developed throughout the course.

Biological wastewater treatments processes (concepts, sizing, design and operation)

The theory and practice of biological wastewater treatment processes will be presented, incorporating concepts from microbiology, stoichiometry, and energetics. Various bioreactor design concepts, including aerobic and anaerobic processes in suspended and attached growth reactors for domestic and industrial wastewater treatment, as well as sludge digestion, will also be introduced.

Constructed wetlands and other NBS for water management (concepts, sizing, design and operation)

The different types of nature-based solutions for water treatment and management (e.g., aquifer recharge, constructed wetlands, environmental restoration) will be presented, with a focus on the technical aspects of each. The principles of design and sizing for some of these solutions will be introduced. Real-world case studies of the application of these systems will be analyzed.

Advanced treatment and water reuse (including case studies and regulation)

Advanced treatment processes for wastewater reclamation will be explained, with a focus on subsequent water reuse. Water reuse in accordance with current regulations will be discussed, and case studies of wastewater reclamation will be presented.

Microbial water quality and disinfection.

Molecular and conventional techniques to determine sanitary conditions in water samples. Real-time PCR; Flux cytometry; MPN statistical assessment coupled to the multiple fermentation test; plate counting. Disinfection with chlorine dosing. Chlorine speciation during disinfection. Chl Chick-Watson disinfection model kinetics.

Bioindication and biosensoring.

General parameters on microbial ecology. Use of Sludge Biotic Index (SBI) as a numerical tool for the assessment of water quality in wastewater treatment systems. General characteristics of (bio)sensors. The use of bioelectric-based sensoring for the assessment of microbial activity, biomass and organic matter. Numerical assessment of case studies.

Lab sessions

LAB SESSION 1. Lab session on the numerical assessment of water quality and microbial activity and biomass using bioelectric-based sensors.
LAB SESSION 2. Quantitative evaluation of of phosphorus recovery from wastewater using two strategies: Natural clay-based ponds and iron slag industrial by-products. 1-hour theoretical session: phosphorus adsorption models + ecological engineering concepts. 2-hour numerical-based activity.

Teaching Methodology

The course consists of 4 hours per week of in-person classroom instruction.
The following activities are carried out:

- Theoretical classes, in which the instructor presents the basic concepts and materials of the subject, provides examples, and works through exercises.
- Problem-solving and/or individual or group exercises, either involving calculations or discussion of topics covered in the theoretical part, aimed at helping students assimilate the theoretical knowledge and reinforce both general and specific learning objectives.

On the ATENEA virtual campus, students will have access to the theoretical presentations, as well as the necessary supporting documentation and materials for discussion of the practical part.

Grading Rules

(*) The evaluation calendar and grading rules will be approved before the start of the course.

The course grade is assessed as follows:

Exams: 40%

Course project: 60%

Test Rules

EXAMS: Individual assessments.
COURSE PROJECT: Conducted in groups of 2–3 students.

Bibliography

Basic

- Metcalf & Eddy. https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5662641. 5th ed. New York: McGraw-Hill, 2014. ISBN 9781259010798.
- Droste, Ronald L.; Gehr, Ronakd R. Theory and Practice of Water and Wastewater Treatment. 2nd ed. Hoboken, NJ: John Wiley & Sons, 2019. ISBN 9781119312376.
- Water treatment handbook. 7ht ed. Malmaison Cedex: Degrémont, 2007. ISBN 9782743009700.

Complementary

- Standard methods for the examination of water and wastewater. 23th. Hoboken, NJ: Lipps, W.C.; Braun-Howland, E.B.; Baxter, T.E, 2017. ISBN 9780875532875.