Course guide
390437 - GIAR - Integrated Wastewater Management

Last modified: 22/12/2025

Unit in charge: Barcelona School of Agri-Food and Biosystems Engineering
Teaching unit: 745 - DEAB - Department of Agri-Food Engineering and Biotechnology.

Degree: BACHELOR'S DEGREE IN BIOSYSTEMS ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2025 **ECTS Credits:** 6.0 **Languages:** English

LECTURER

Coordinating lecturer: Ramos Quiroz, Carlos Antonio

Others: Ramos Quiroz, Carlos Antonio
Cerrillo Moreno, Míriam

PRIOR SKILLS

English level: higher intermediate (B2) or advanced (C1)

TEACHING METHODOLOGY

Theory classes: Development of concepts and fundamental principles in wastewater treatment and valorization within the framework of the circular economy and sustainability. Analysis of practical examples and problem-solving exercises to achieve the defined learning objectives. Provision of tools for the basic design of industrial facilities.
Problem-solving and laboratory practices: Execution of laboratory and problem-solving work aimed at deepening the understanding of topics addressed in theory classes.
Group project: Implementation of a project (written report and oral presentation as poster presentation) related to the subjects studied, fostering collaborative learning and the application of theoretical knowledge.

LEARNING OBJECTIVES OF THE SUBJECT

Upon completion of the course, students will be able to understand: (i) the current challenges related to wastewater generation, (ii) the technical and legislative frameworks governing wastewater management, and (iii) the principal treatment technologies (physical, chemical, and biological) as well as strategies for contaminant reduction and resource recovery.
The competencies associated with the course are as follows: (i) students will have developed the learning skills necessary to pursue further studies with a high degree of autonomy (CB5); (ii) students will be able to apply the knowledge acquired and their problem-solving abilities in new or unfamiliar contexts within broader or multidisciplinary settings related to their field of study (CB7); and (iii) students will foster innovation in new food materials and bioproduct processes, designing processes aimed at enhancing safety, efficiency, and environmental performance (CE03).

STUDY LOAD

Type	Hours	Percentage
Self study	90,0	60.00
Laboratory classes	20,0	13.33
Theory classes	40,0	26.67

Total learning time: 150 h

CONTENTS

Topic 1 - Introduction to Sustainability

Description:
Wastewater as a resource – water, energy, nutrients
From sanitation to circular economy
Sustainability pillars: environmental, economic, social Life Cycle Assessment (LCA), footprints (carbon, water, energy)
Water–Energy–Food–Ecosystem Nexus
Biorefinery concept and barriers to implementation

Specific objectives:
To understand the problems associated with the generation of wastewater.
To understand and apply the fundamental principles of sustainability in the minimization, treatment, and valorization of wastewater.

Related activities:
- Activity 1
- Activity 2

Full-or-part-time: 15h
Theory classes: 6h
Self study : 9h

Topic 2 - Wastewater Characterization

Description:
Sources: domestic, industrial, agricultural
Physical parameters
Chemical parameters
Biological aspects
Emerging pollutants
Sampling and analytical methods

Specific objectives:
To identify physicochemical and biological parameters that characterize and compose wastewaters, according to its origin.
Interpretation of analytical results.

Related activities:
Activity 1
Activity 2
Activity 3

Full-or-part-time: 25h
Theory classes: 6h
Laboratory classes: 4h
Self study : 15h

Topic 3 - Wastewater treatment

Description:
- Treatment train: preliminary, primary, secondary, tertiary
- Key parameters: HRT, SRT, OLR
- Standards and effluent quality
- Integration with sludge management
- Screening, grit, grease removal Sedimentation (primary clarification)
- Coagulation–flocculation
- precipitation
- neutralization
- Disinfection: chlorination, UV, ozone
- AOPs
- Microbial degradation of organics
- Activated sludge system
- Nutrient removal (N, P)
- Biofilm systems
- Membranes
- MBR

Specific objectives:
To describe and understand the fundamental principles of the main wastewater treatment technologies currently available on the market.
To acquire technical knowledge for the proper management of wastewater.

Related activities:
Activity 1
Activity 2
Activity 3

Full-or-part-time: 45h
Theory classes: 12h
Laboratory classes: 6h
Self study : 27h

Topic 4 - Wastewater valorization

Description:
- Anaerobic digestion
- Digestate valorization
- Bioelectrochemical systems
- Nitrogen recovery
- Phosphorus recovery
- Water reuse
- Nanofiltration and Reverse Osmosis
- Microalgae
- Nature-based solutions: wetlands, green roofs
- Integrated biorefineries
- Emerging trends: AnMBR, bioplastics, direct reuse

Specific objectives:
To describe and understand the fundamental principles of the main wastewater treatment technologies currently available on the market.
To acquire technical knowledge for the proper management of wastewater.

Related activities:
Activity 1
Activity 2
Activity 3
Activity 4

Full-or-part-time: 67h 30m
Theory classes: 15h
Laboratory classes: 12h
Self study : 40h 30m

GRADING SYSTEM

The final grade for the course shall be determined on the basis of the weighted assessment of the following components:
N1: Individual written examination conducted midway through the semester, assessing the learning outcomes corresponding to the first part of the course.
N2: Individual written examination conducted at the end of the semester, assessing the learning outcomes corresponding to the second part of the course.
N3: Group-based assessment of a practical case study, to be defined during the course. Guidance and clarification will be provided through scheduled meetings with students.

The final grade shall be calculated as follows:
Final grade = $0.35 \times N1 + 0.35 \times N2 + 0.30 \times N3$

EXAMINATION RULES.

Participation in small-group sessions is compulsory

BIBLIOGRAPHY

Basic:
- Tchobanoglous, George; Burton, Franklin L; Stensel, H. David. Wastewater engineering : treatment and reuse. 4th ed.; International ed. New York [etc.]: McGraw-Hill, cop. 2003. ISBN 0070418780.
- Chen, G.-H. (Guanghao); Loosdrecht, M. C. M. van; Ekama, G. A.; Brdjanovic, Damir. Biological wastewater treatment : principles, modelling and design [on line]. 2nd edition. London: IWA Publishing, 2020 [Consultation: 22/12/2025]. Available on: https://iwaponline.com/ebooks/book/791/Biological-Wastewater-TreatmentPrinciples. ISBN 9781789060362.
- Reddy, Krishna R; Cameselle, Claudio; Adams, Jeffrey A. Sustainable and resilient engineering : drivers, metrics, tools, and applications. Second edition. New Jersey: Wiley, 2025. ISBN 9781394267682.
- O'Callaghan, Paul; Adapa, Lakshmi M.; Buisman, Cees. The Dynamics of water innovation : a guide to water technology commercialization. USA: Water Environmental Federation, 2024. ISBN 9781572784529.