Course guide
320072 - TRAR - Wastewater Treatment and Reuse

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering.
702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN TEXTILE TECHNOLOGY AND DESIGN ENGINEERING (Syllabus 2009). (Optional subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: Buscio Olivera, Valentina

Others: Barajas Lopez, Maria Guadalupe

PRIOR SKILLS

It is advisable to have passed the subject ENVIRONMENTAL TECHNOLOGIES AND SUSTAINABILITY.

TEACHING METHODOLOGY

- Presential sessions for exposing the contents.
- Presential sessions of practical work (laboratory).
- Presential sessions of individual work (problems).
- Self-directed study.
- Preparation and evaluation of assesable group activities.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, students should be able to:
- Evaluate the quality of wastewater depending on the characterization parameters, and make the conceptual design of the treatment process based on the quality of the wastewater, its destination (discharge, recycling, reuse), the regulations and other conditions.
- Carry out the engineering analysis and basic design of the main processes for the treatment of urban and industrial wastewater.
- Design a basic system of a wastewater treatment plant.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Self study	90,0	60.00
Hours medium group	15,0	10.00
Hours small group	15,0	10.00

Total learning time: 150 h

CONTENTS

Topic 1. Introduction to wastewater treatment

Description:
- The role of wastewater treatment in the water cycle.
- Sources and types of pollutants.
- Main purification processes: objectives and methods.
- Regulations.

Specific objectives:
At the end of the topic 1, the student should be able to:
- Identify and interpret the key parameters of wastewater pollution.
- Determine the main treatment methods and their role in the wastewater treatment.
- Perform calculations related to the Declaration of use and water pollution (DUCA) existing in Catalonia.

Related activities:
Problem 1. DUCA calculation

Full-or-part-time: 12h
Theory classes: 3h
Practical classes: 2h
Laboratory classes: 2h
Self study : 5h

Topic 2. Pretreatment and primary settlers

Description:
- Introduction.
- Screening.
- Sand removers and degreasers.
- Neutralization.
- Fundamental parameters in the design of primary settlers.
- Design of primary settlers.
- Criteria and calculation methods.
- Homogenization tanks.

Specific objectives:
At the end of the topic 2, the student should be able to:
- Specify the pollutants and relate them to each pretreatment and primary treatment.
- Perform basic calculations for analysis and design of primary processes.

Related activities:
Practice 1. Biological purification treatment by activated sludge.
Problem 3. Primary clarifier design.

Full-or-part-time: 25h
Theory classes: 5h
Practical classes: 3h
Laboratory classes: 2h
Self study : 15h

Topic 3. Physiochemical treatment

Description:
- Introduction.
- Double layer theory.
- Coagulation: main parameters.
- Flocculation: main parameters.
- Laboratory test: Jar-test.
- Treatment efficiency.

Specific objectives:
At the end of the topic 3, the student should be able to:
- Apply physicochemical mechanisms for understanding and defining processes.
- Identify and select coagulants and flocculants agents.
- Design and evaluate trials Jar Test.

Related activities:
Practice 2. Study of the coagulation-flocculation process.
Problema 4. Coagulation - flocculation.

Full-or-part-time: 16h
Theory classes: 2h
Practical classes: 2h
Laboratory classes: 2h
Self study : 10h

Topic 4. Fundamentals of biological treatment processes

Description:
- Fundamentals of biological processes: types of processes, basic mechanisms, microorganisms, bacterial growth kinetics, oxygen consumption rate, etc.
- Aerobic suspended biomass processes: continuous flow and discontinuous flow activated sludge.

Specific objectives:
At the end of topic 4, the student should be able to:
- Specify the different types of microorganisms involved in biological purification and their role in the process.
- List and define the different processes and kinetic and stoichiometric parameters of the purification processes.
- Formulate the kinetic equations of the purification processes and apply them to specific cases.
- List and classify the different biological purification processes.
- Define a pilot plant study.

Related activities:
Practice 3. Microscopic observation of activated sludge in biological purification treatments.
Practice 4. Determination of the respiration rate (OUR).
Problem 2. BOD kinetics.

Full-or-part-time: 27h
Theory classes: 4h
Practical classes: 4h
Laboratory classes: 4h
Self study : 15h

Topic 5. Fundamentals of nutrient removal

Description:
- Introduction.
- Biological removal of nitrogen.
- Biological removal of phosphorus.

Specific objectives:
At the end of topic 5, the student should be able to:
- Indicate typical concentrations of the different species of N and P in wastewater.
- Explain the fundamentals of nitrogen removal methods
- Explain the mechanisms and conditions of biological nitrification and denitrification
- Diagram and explanation of the main biological processes for the elimination of N and P, making basic calculations of substrate / nutrient ratios.

Full-or-part-time: 14h
Theory classes: 4h
Self study : 10h

Topic 6. Design of processes in suspended-biomass processes

Description:
- Introduction.
- Activated sludge process.
- Material balances and design of an activated sludge process.

Specific objectives:
At the end of topic 6, the student should be able to:
- Define and explain the diagram of the activated sludge process.
- Specify the nomenclature and symbols used in the study of these processes
- Formulate the material balances in the activated sludge process and the additional relationships used in the design.
- Solve the equations mentioned to define the basic design of the process.
- Make a basic calculation of the process based on data from a pilot plant.
- Identify and define the influence of process parameters on the operation.

Related activities:
Practice 1. Biological purification treatment by activated sludge.
Problem 5. Basic design of activated sludge processes.

Full-or-part-time: 25h
Theory classes: 4h
Practical classes: 4h
Laboratory classes: 2h
Self study : 15h

Topic 7. Wastewater treatment plant control systems

Description:
- Introduction.
- Basic sampling in a WWTP.
- Parameter monitoring.
- Calculation and control of the different parameters (mass load, sludge age, purge...).
- Internal and external causes that can alter the operation of a WWTP.
- Prevention methods.

Specific objectives:
At the end of Topic 7, the student should be able to:
- Plan the sampling and control of a WWTP.
- Know the causes of malfunctioning of a WWTP and act to solve it.
- Prevent the malfunction of a WWTP.

Related activities:
Practice 1. Biological purification treatment by activated sludge

Full-or-part-time: 9h
Theory classes: 2h
Laboratory classes: 2h
Self study : 5h

Topic 8. Sludge management

Description:
- Introduction.
- Sludge line diagram.
- Generation and characteristics of the sludge generated.
- Sludge separation.
- Sludge treatment: thickening, stabilization, dehydration, anaerobic digestion.

Specific objectives:
At the end of the topic 8, the student should be able to:
- Explain the composition and properties of sludge from wastewater treatment plants.
- Explain the fundamentals and applications of the sludge management processes.

Related activities:
Practice 1. Biological purification treatment by activated sludge

Full-or-part-time: 8h
Theory classes: 2h
Laboratory classes: 1h
Self study : 5h

Topic 9. Advanced treatment processes

Description:
- Need for advanced processes.
- Moving bed bioreactor.
- Membrane technologies.
- Membrane bioreactors.
- Advanced oxidation processes.

Specific objectives:
At the end of Topic 9, the student should be able to:
- Explain the basic characteristics of each type of treatment.
- Determine the appropriate treatment based on the pollutants, the regulations and the desired quality.

Full-or-part-time: 7h
Theory classes: 2h
Self study : 5h

Topic 10. Wastewater reuse and recycling

Description:
- Reuse and recycling of wastewater
- Aspects related to health: Normative.
- Technologies used in water recovery
- Examples.

Specific objectives:
At the end of the topic 10, the student should be able to:
- Distinguish between reuse and recycling.
- Explain the basic legal and health conditions
- Describe the correct types and combinations of technologies used in the recovery of water.

Full-or-part-time: 7h
Theory classes: 2h
Self study : 5h

GRADING SYSTEM

- Written tests 70%: 1st exam (35%), final exam (35%).
- Laboratory 20%: reports (10%), laboratory notebook (3%), individual work in the laboratory (7%).
- Other activities (exercises delivered) 10%.

The unsatisfactory results of the first exam can be redirected by means of a written test that will be carried out on the same day as the second one. This test can be accessed by all students with a grade lower than 5 in the first exam. The qualification (punctuation 0 - 10) obtained will replace the grade of the first exam, as long as it is higher.

EXAMINATION RULES.

Attendance to laboratory and problems sessions is mandatory.

BIBLIOGRAPHY

Basic:
- Tchobanoglous, George; Metcalf & Eddy. Wastewater engineering: treatment and resource recovery [on line]. 5th ed. New York [etc.]: McGraw-Hill, cop. 2014 [Consultation: 18/01/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5662641. ISBN 9781259010798.
- Trapote Jaume, Arturo. Depuración y regeneración de aguas residuales urbanas. 3a ed. Alacant: Publicaciones Universidad Alicante, 2020. ISBN 9788497177290.
- Ramalho, Rubens Sette. Tratamiento de aguas residuales [on line]. Barcelona: Reverté, 1991 [Consultation: 14/11/2022]. Available on: https://web-p-ebscohost-com.recursos.biblioteca.upc.edu/ehost/ebookviewer/ebook?sid=30a9a476-fa6f-421e-a5ea-272a204ef860%40redis&vid=0&format=EB. ISBN 9788429179750.

Complementary:
- Ferrer Polo, J.; Seco Torrecillas, A.; Robles Martínez, A. Tratamientos biológicos de aguas residuales [on line]. 3a ed. València: Universitat Politècnica de València, 2022 [Consultation: 14/11/2022]. Available on: https://gdocu.upv.es/alfresco/service/api/node/content/workspace/SpacesStore/935a8d7c-2081-4d74-9f7c-bf3ad9e69bb4/TOC_0358_03_03.pdf?guest=true. ISBN 9788413960159.

RESOURCES

Other resources:
- Ministerio de Medio Ambiente y Medio Rural Marino. Manual para la implantación de sistemas de depuración en pequeñas poblaciones: https://www.aragon.es/documents/20127/24009052/Manual+CEDEX2.pdf/32188fba-b20f-ecac-fb01-49a15e0e3cd9?t=1578648844927