

## Course guide

# 295555 - 295EQ031 - Waste Recovery Technologies

**Last modified:** 02/10/2025

**Unit in charge:** Barcelona East School of Engineering  
**Teaching unit:** 713 - EQ - Department of Chemical Engineering.

**Degree:** MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Compulsory subject).

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

### LECTURER

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**Coordinating lecturer:** VICENÇ MARTI GREGORIO

**Others:** Primer quadrimestre:  
JOSE LUIS CORTINA PALLAS - Grup: T1  
FRANCISCO JAVIER GIMENEZ IZQUIERDO - Grup: T1  
VICENÇ MARTI GREGORIO - Grup: T1

### PRIOR SKILLS

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Language of instruction is English.

### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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#### Specific:

CEMUEQ-06. Design, build and implement methods, processes and facilities for the integral management of supplies and residues, solid, liquid and gaseous, in industries, with the capacity to assess their impacts and risks

CEMUEQ-02. To design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as a technological base the various areas of chemical engineering, including processes and transport phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions

CEMUEQ-05. To manage and supervise all types of facilities, processes, systems and services of the different industrial areas related to chemical engineering

#### Generical:

CGMUEQ-02. To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environment conservation

CGMUEQ-03. To lead and to manage technically and economically projects, facilities, plants, companies and technology centers in the field of chemical engineering and related industrial sectors

#### Transversal:

02 SCS. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.

03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

## TEACHING METHODOLOGY

The following activities will be carried out, either in or outside the classroom, in the development of the course:

1. Lectures, participative sessions and problem solving sessions, visits (VIS)
2. Homework and assignments (HOM)
3. Project base learning (PRO)
4. Mid-term exam (MEX) and final Exam (FEX)

Detailed project information regarding the scope, content, format, deadlines, etc., will be presented in an attached document.

## LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student will be able to:

- Identify each typology of waste, its hazard and understand the kind of resources that will be obtained
- Identify and apply the proper kind of management (reduction, reusing, recycling, recovery, treatment, disposal) to optimize resources
- Preliminary design of equipment and installations for the conversion of waste in resource

## STUDY LOAD

Type	Hours	Percentage
Self study	96,0	64.00
Hours small group	13,5	9.00
Hours large group	40,5	27.00

**Total learning time:** 150 h

## CONTENTS

### 1-Waste concepts, scientific basis

#### Description:

Hazardous and non-hazardous wastes. From linear model to circular economy. Waste Framework Directive. Hierarchy of waste management (reducing, reusing, recycling, recovery, treatment, disposal). Type of wastes linked to its origin (urban, industrial, agricultural, forestal and farm wastes, construction, mining, sanitary and specific) and impact on environment. European List of Wastes. Scientific basis for waste to resource calculation.

#### Specific objectives:

Fundamentals of knowledge about wastes.

#### Full-or-part-time: 11h

Theory classes: 4h

Practical classes: 1h

Self study : 6h



## 2-Waste Characterization

**Description:**

Characterization linked to determination of resource materials, hazard classification and management of waste. Analytical methods for wastes.

**Specific objectives:**

Knowledge of the waste characterization for its identification, classification and its management.

**Full-or-part-time:** 11h

Theory classes: 3h

Practical classes: 2h

Self study : 6h

## 3-Reducing, reusing and recycling strategies

**Description:**

Initiatives for reducing, reusing and recycling. Urban waste generation and collection systems. Contaminant waste. Circular economy cycles and indicators for wastes and collection fraction.

**Specific objectives:**

Highlight the application of these strategies vs other following the management hierarchy.

**Full-or-part-time:** 13h

Theory classes: 3h

Practical classes: 2h

Self study : 8h

## 4-Treatment for recovery

**Description:**

Fundamentals of biological processes. Description and design of composting plants for biowaste. Chemical products from biowaste. Mechanical-biological treatment

**Specific objectives:**

To know the basis of treatment methods for the recovery of material that imply design of equipment and installations for the conversion of waste in resource

**Related activities:**

Visit/Seminar (VIS)

**Full-or-part-time:** 28h

Theory classes: 8h

Practical classes: 2h

Self study : 18h



## 5-Treatment of hazardous wastes

### Description:

Fundamentals of mechanical separation, stripping, vapour extraction, adsorption, chemical and advanced oxidation, supercritical fluid extraction, membrane processes, stabilisation, thermal desorption, vitrification, thermic, plasma, and other techniques for the elimination of hazardous components of a waste. Air pollution control systems.

### Specific objectives:

To know the basis of treatment methods for the elimination of hazardous components (design of equipment and installations)

### Related activities:

Mid-term Exam (MEX) of cumulative topics 1-4.

### Full-or-part-time: 25h

Theory classes: 8h

Practical classes: 2h

Self study : 15h

## 6-Waste to fuel and waste to energy

### Description:

Biogas (anaerobic digestion plants from biowaste), pyrolysis, gasification, plasma arc. Refuse derived fuel. Description of techniques and installations of combustion/ incineration/cogeneration. Fuel cells based on wastes.

### Specific objectives:

To know the basis of treatment methods for the recovery of energy and energetic products from wastes

### Related activities:

Homework and Assignments (HOM)

### Full-or-part-time: 23h

Theory classes: 6h

Practical classes: 2h

Self study : 15h

## 7-Waste Disposal

### Description:

Type of landfills used for different wastes (construction, inert, non-inert, special), design of landfill. Biogas and lixiviates and its management. Incineration for the elimination of hazardous wastes. Urban mining.

### Specific objectives:

Knowledge about the management of waste to landfilling and destined to incineration to eliminate hazardous compounds.

### Related activities:

Homework and Assignments (HOM)

### Full-or-part-time: 13h

Theory classes: 4h

Practical classes: 1h

Self study : 8h



### 8-Special waste topics

**Description:**

Fundamentals on radiation, wastes of low, medium and high activity, nuclear power plant impact, type of storage (ATC, AGP, low activity). Reprocessing of nuclear fuel. Basis of Human Health Risk Assessment. Examples of specific management of case study wastes from the Project (PRO) activity.

**Specific objectives:**

To have the basis of radioactive waste management and processing as well as Human Health Risk Assessment. To know case studies of waste management based in the technologies learned in (PRO) activity.

**Related activities:**

Project based learning (PRO)

**Full-or-part-time:** 26h

Theory classes: 6h

Self study : 20h

## ACTIVITIES

### Visit to waste manager/attendance to seminar (VIS)

**Description:**

The activity will supply direct information from companies/professionals linked with the treatment of wastes to recovery. The visit/attendance to the seminar will be evaluated with a questionnaire.

**Full-or-part-time:** 4h

Guided activities: 2h

Self study: 2h

### Mid-term exam (MEX)

**Description:**

Mid-term exam will be an exam of the first part of the subject and capacity of the student to assimilate initial concepts.

**Full-or-part-time:** 50h

Guided activities: 2h

Self study: 48h

### Project base learning (PRO)

**Description:**

The teachers will suggest a list of waste management topics to develop as a project in groups of 3-5 students. The students have to look for case studies that match with the demand and elaborate a report detailing this info and perform a presentation in the "Special topics" session to the audience

**Full-or-part-time:** 12h

Guided activities: 2h

Self study: 10h



### Homework and assignments (HOM)

**Description:**

Individual activity based in solving some exercises or perform simulations using soft at home.

**Full-or-part-time:** 4h

Self study: 4h

### GRADING SYSTEM

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The final grade is determined according to the following equation:

$$\text{Final grade} = 0.20 \cdot \text{MEX} + 0.50 \cdot \text{FEX} + 0.1 \cdot (\text{HOM} + \text{VIS} + \text{PRO})$$

### EXAMINATION RULES.

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Mid-term exam and final exam performed with the use of class notes and ATENEA material.

### BIBLIOGRAPHY

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**Basic:**

- Tchobanoglous, George; Kreith, Frank. Handbook of solid waste management [on line]. 2nd ed. New York [etc.]: McGraw-Hill, cop. 2002 [Consultation: 13/05/2020]. Available on: <https://sanitarac.pro/wp-content/uploads/2017/07/Solid-Waste-Management.pdf>. ISBN 0071356231.
- LaGrega, Michael D; Buckingham, Phillip L; Evans, Jeffrey C. Hazardous waste management. 2n ed. Boston, MA: McGraw-Hill, cop. 2001. ISBN 0070393656.
- Christensen, Thomas H. (ed.). Solid waste technology & management. Chichester: John Wiley and Sons, 2011. ISBN 9781405175173.
- Pérez Dueñas, Lara [et al.]. Guía de caracterización de residuos peligrosos. Bilbao: Ategrus, cop. 2008. ISBN 9788461229628.

**Complementary:**

- Rittmann, Bruce E.; McCarty, Perry L. Environmental biotechnology : principles and applications. Boston [etc.]: McGraw-Hill, cop. 2001. ISBN 0071181849.
- Lee, C.C; Lin, Shundar (eds.). Handbook of environmental engineering calculations. 2nd ed. New York [etc.]: McGraw-Hill, cop. 2007. ISBN 9780071475839.

### RESOURCES

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**Other resources:**

- Guidance documents from USEPA (<https://www.epa.gov/>) and other EPA.
- Guidance documents from Catalan Waste Agency (<http://residus.gencat.cat/en/inici/index> )
- Guidance documents from Ellen McArthur Foundation (<https://www.ellenmacarthurfoundation.org/>) />Legislation for EC (<http://ec.europa.eu/environment/waste/index.htm>) />Other web-based information.