Course guide
295705 - RMP - Recycling and Raw Materials

Last modified: 04/06/2026

Unit in charge: Barcelona East School of Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Compulsory subject).

Academic year: 2026 **ECTS Credits:** 6.0 **Languages:** Spanish

LECTURER

Coordinating lecturer: FRANCESCO TAMPIERI

Others: Tampieri, Francesco
León Albiter, Noel
Abt, Tobias Martin
Candau, Nicolas
Benito Paramo, Jose Antonio
Cinca I Luis, Núria
Morales Comas, Miguel

PRIOR SKILLS

Basic knowledge of chemistry, formulation and thermodynamics of chemical reactions are required, as well as the main characteristics of the different families of materials.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEI-16. Understand the basic applications of environmental technologies and sustainability principles.
CEMT-22. Knowledge and application of materials technology in the production, transformation, processing, selection, control, maintenance, recycling and storage of all types of materials.

Transversal:
02 SCS N2. SUSTAINABILITY AND SOCIAL COMMITMENT - Level 2. Applying sustainability criteria and professional codes of conduct in the design and assessment of technological solutions.

TEACHING METHODOLOGY

· The face-to-face activities consist of:
- Theoretical classes in which the contents related to the different blocks of the syllabus are presented
- Laboratory sessions in which practices related to the theoretical contents are carried out
- Visits to companies: in order to know in more detail some of the theoretical concepts explained in class
- Exhibition in the classroom of supervised works.

· Non-contact activity: Students work in a group on a monographic work on the extraction of metals, recycling of materials or waste treatment.

LEARNING OBJECTIVES OF THE SUBJECT

The main objective of the subject is that the student has the ability to assess the environmental impact associated with the extraction of materials from natural resources and the advantages of recycling in order to achieve a sustainable ecosystem with a rational use of Non-renewable natural resources.
At the end of the course the student must:
- Adequately know the life cycle analysis as an environmental management tool to assess the environmental impact associated with a product during its entire life cycle.
- Keep in mind the optimization and innovation in the processes of extraction and recycling of materials in order to reduce the environmental impact
- Be aware of the importance of optimal waste management and the recovery of non-recoverable waste in the environmental impact.

STUDY LOAD

Type	Hours	Percentage
Hours large group	50,0	33.33
Self study	90,0	60.00
Hours small group	10,0	6.67

Total learning time: 150 h

CONTENTS

Unit 1. Introduction to recycling

Description:
1. The materials throughout history. Annual production in the world.
2. Life cycle of a material.
3. History of recycling. The 3 R: reduce, reuse and recycle.
4. Types and waste management
5. Circular economy

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Unit 2. Life Cycle Analysis (LCA)

Description:
Life

Full-or-part-time: 5h 30m
Theory classes: 3h
Self study : 2h 30m

Unit 3. Polymers: Raw materials and recycling

Description:
Polímeros

Full-or-part-time: 6h 30m
Theory classes: 1h 30m
Practical classes: 2h
Self study : 3h

Unit 4.

Description:
content english

Full-or-part-time: 14h
Theory classes: 5h
Laboratory classes: 4h
Self study : 5h

Unit 5.

Description:
content english

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

title english

Description:
content english

Full-or-part-time: 5h 30m
Theory classes: 4h 30m
Self study : 1h

Unit 7. Recycling of urban solid waste. Technology and processes..

Description:
- Classification of waste
- Technology of waste treatment and recycling.

Related activities:
Visit to the public company TERSA dedicated to managing environmental services related to the circular economy, the valuation of municipal waste, the generation and commercialization of renewable energies.

Full-or-part-time: 6h 30m
Theory classes: 1h 30m
Practical classes: 2h
Self study : 3h

Unit 8. Introduction to extractive metallurgy: pyrometallurgy

Description:
- Extractive metallurgy: Pyrometallurgy and hydrometallurgy
- Pyrometallurgy calcination, roasting of sufuros and reduction of oxides. Ellingham diagrams
- Pyrometallurgy: metallothermy and igneous electrolysis

Related activities:
- Exercises related to Ellingham Diagrams
- Practice 3. Recovery of noble metals: copellation

Full-or-part-time: 15h 30m
Theory classes: 4h 30m
Practical classes: 2h
Self study : 9h

Unit 9. Extraction and recycling of steel. Example of pyrometallurgical process.

Description:
- Primary metallurgy: extraction of steel from ore. Environmental impact analysis.
- Secondary metallurgy: recovery of steel from scrap. Environmental impact analysis.
- Continuous casting

Full-or-part-time: 11h
Theory classes: 3h
Practical classes: 2h
Self study : 6h

Unit 10. Introduction to extractive metallurgy: hydrometallurgy

Description:
- Leaching processes: static and dynamic
- Extraction processes:
· Precipitation of a compound
· Extraction with organic solvents
· Ionic exchange
· Adsorption with activated carbon

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

Unit 11. Extraction and recycling of aluminum

Description:
- Extraction of aluminum from bauxite:
· Bayer Process: Obtaining alumina from bauxite
· Hall-Heroult process: igneous electrolysis of alumina
- Recycling of aluminum
- Environmental impact

Related activities:
Analysis of research articles on alternative processes to the extraction of aluminum to reduce the environmental impact

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

Unit 12: Extraction of other metals: titanium, magnesium and copper

Description:
- Obtaining titanium: Kroll process and alternative methods
- Obtaining magnesium:
· By electrolysis: Dow method and SOM process
· By thermal reduction: Pidgeon process
- Obtaining copper: pyrometallurgical and hydrometallurgical processes
- Environmental impact

Related activities:
Analysis of research articles about alternative processes to the extraction of titanium and magnesium.

Full-or-part-time: 18h
Theory classes: 6h
Self study : 12h

Unit 13. Recycling of ceramic materials and glass

Description:
Unit 10. Recycling of ceramic materials and glass

Full-or-part-time: 4h 30m
Theory classes: 1h 30m
Self study : 3h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

First partial: 20%
Segon partial: 20%
Third parcial: 20%
Practices + reports visits: 20%
Monographic work: 20%

BIBLIOGRAPHY

Basic:
- Ashby, M. F. Materials and the environment : eco-informed material choice. 2a ed. Amsterdam: Elsevier/Butterworth-Heinemann, 2013. ISBN 9780123859716.
- Ballester, Antonio; Verdeja, Luis Felipe; Sancho José. Metalurgia extractiva. Vol. 1. Madrid: Síntesis, DL, 2003. ISBN 8477388024.
- Ballester, Antonio; Verdeja, Luis Felipe; Sancho José. Metalurgia extractiva. Vol. 2. Madrid: Síntesis, DL, 2003. ISBN 8477388032.

Complementary:
- Worrell, Ernst; Reuter, Markus. Handbook of Recycling : State-of-the-art for Practitioners, Analysts, and Scientists [on line]. U.K.: Elsevier, 2014 [Consultation: 10/06/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1683293. ISBN 9780123965066.

RESOURCES

Other resources:
Software CES Edupack 2018