Guia docent [295920] – [ASIE] – [Applied Sustainability in Engineering] Document provisional

Unitat responsable:	Escola d'Enginyeria de Barcelona Est			
Unitat que imparteix:	713 - EQ – Chemical Engineering Department			
Curs	2025-2026	**Crèdits**	6	
Idiomes	English			

PROFESSORAT	
Professorat responsable:	Sergi Vinardell Cruañas
Altres:	César Alberto Valderrama Angel

CAPACITATS PRÈVIES

Not applicable.

METODOLOGIES DOCENTS

The course will combine theoretical lectures with practical exercises to be completed individually, as well as specific case studies to be analysed and solved in groups. Specifically, 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
2. Case studies and assignments
3. Project task
4. Final Exam

OBJECTIUS D'APRENENTATGE DE L'ASSIGNATURA

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

- Demonstrate a good knowledge and understanding of the tools used for sustainability analysis with emphasis on life cycle assessment, carbon footprint and life cycle costing.
- Evaluate the technological, environmental and economic feasibility of a system through the life cycle perspective.
- Identify sustainable energy technologies, efficient energy storage systems and critical raw materials needed for the energy transition.
- Distinguish between different waste-to-resource and waste-to-energy solutions to promote circular and sustainable waste management solutions.
- Apply low-carbon and defossilized technologies into industrial processes.

HORES TOTALS DE DEDICACIÓ DE L'ESTUDIANTAT

Tipus	Hores	Percentatge
Hores activitats dirigides	24	16.00 %
Hores grup gran	36	24.00 %
Hores aprenentatge autònom	90	60.00 %
Dedicació total: 150 h		

CONTINGUTS

Temari 1: General Framework

Descripció:

1. Definition and principles of sustainability. Key characteristics and evolution of climate concern and policy-related instruments. European Green Deal and primary EU climate policies. Environmental pressures and the IPAT equation. Description of sustainability solutions in line with EU climate policies.

Activitats vinculades:

Solving problems related to the topic content.
Project.

Dedicació: hores totals

Grup gran/Teoria: 3 h

Activitats dirigides: 1 h Aprenentatge autònom: 18 h

Temari 2:	Sustainability Assessment
Descripció: 2.1. Life cycle assessment (LCA): Framework and applications. LCA stages. Goal and scope definition. Attributional and consequential LCA. Inventory analysis. Multifunctionality: allocation and system expansion. Impact assessment. LCA software and databases. Carbon footprint methodology. 2.2. Life cycle costing (LCC): Key concepts. Time value and cost-benefit analysis. LCC methodology. Working flow for a LCC. 2.3. Social life cycle assessment (S-LCA): General framework. S-LCA methodology. Stakeholder categories. Impact subcategories. Social life cycle impact assessment. PSILCA database.	
Activitats vinculades: Solving problems related to the topic content. Case Study 1.	
Dedicació: hores totals Grup gran/Teoria: 10 h Activitats dirigides: 10 h Aprenentatge autònom: 26 h	

Temari 3:	Sustainable Energy Systems
Descripció: 3.1. Renewable Energy Systems: General context. Solar photovoltaic. Solar Thermal. Wind Power; onshore and offshore systems. Hydropower. Geothermal. 3.2. Energy Storage and Hydrogen: Regulatory framework. Energy storage to accomplish national and EU renewable energy targets. Battery Energy Storage System and Li-ion batteries. Pumped Storage Hydropower. Power-to-X. Renewable hydrogen production. Hydrogen-to-X pathways. 3.3. Critical raw materials and their supply chain: General EU context. Critical raw materials; characteristics and global supply. EU list of CRMs. Criticality assessment methodologies. CRMs for Li-ion batteries, solar photovoltaic, wind turbines. Supply chain resilience.	
Activitats vinculades: Solving problems related to the topic content. Case Study 2.	
Dedicació: hores totals Grup gran/Teoria: 8 h Activitats dirigides: 4 h Aprenentatge autònom: 18 h	

Temari 4:	Waste-to-Resource and Circular Economy
Descripció: 4.1. Introduction to circular economy: Definition and principles. Key characteristics and enabling factors of a circular economy. Resource, environmental, economic and social benefits of circular economy. Circular economy in the European and global context. EU Circular Economy Action Plan. 4.2. Waste-to-Resources: General context. Biowaste and biorefinery concepts. Urban mining. Characteristics of urban wastes and potential for resource recovery. Critical raw materials contained in urban wastes. Challenges of urban mining. 4.3. Waste-to-Energy: Introduction to waste to energy (WtE) conversion. WtE conversion in the framework of Circular Economy Policy and EU perspective. WtE technology options. Thermal treatment of municipal solid waste (MSW) by pyrolysis and gasification. Waste-to-Bioenergy. Anaerobic digestion. Incineration of municipal solid waste. Environmental impacts of WtE conversion plants.	
Activitats vinculades: Solving problems related to the topic content. Case Study 3.	
Dedicació: hores totals Grup gran/Teoria: 8 h Activitats dirigides: 4 h Aprenentatge autònom: 18 h	

Temari 5:	Sustainable Industrial Processes
Descripció: 5. Introduction to industrial sustainability. Regulatory framework. European Union Emission Trading System (EU ETS). Enabling factors to decarbonize industrial processes: renewable energy, electrification, carbon capture, circular economy options. Examples of industrial relevance.	
Activitats vinculades: Solving problems related to the topic content.	
Dedicació: hores totals Grup gran/Teoria: 3 h Activitats dirigides: 2 h Aprenentatge autònom: 5 h	

Temari 6:	Sustainability in a Global Scope and Perspective
Descripció:	

General framework and mainstream economic thinking. Planetary boundaries. Economic growth and green growth. Decoupling growth and environmental impact. Introduction to heterodox and post-growth economic models.

Activitats vinculades:
Solving problems related to the topic content.

Dedicació: hores totals
Grup gran/Teoria: 4 h
Activitats dirigides: 2 h
Aprenentatge autònom: 5 h

SISTEMA DE QUALIFICACIÓ

The final grade is determined according to the following equation:

Final grade = FEX*0.45+CS*0.35+PRO*0.20

Final Exam (FEX)
Case Studies and assignments (CS)
Project (PRO)

Especificació

1. The evaluation will include three case studies and one project task to be completed in groups. For each case study, students will be required to submit a written report. The project will be presented orally.
2. There will be a final exam aimed at assessing the learning objectives achieved by the student, which will consist of questions and problems.

The course does not have revaluation exam.

BIBLIOGRAFIA

Bàsica:

Reddy K.R, Cameselle C, Jeffrey A.A. Sustainable Engineering: Drivers, Metrics, Tools, and Applications. Wiley, 2019.
Hunkeler D, Lichtenvort K, Rebitzer G. Environmental Life Cycle Costing. CRC press Taylor and Francis group, 2008.
ISO 14040. Environmental Management - Life Cycle Assessment - Principles and Framework: International Standard 14040. International Standards Organization, 2006a.
ISO 14044. Environmental Management - Life Cycle Assessment - Requirements and Guidelines: International Standard 14044. International Standards Organization, 2006b.
Jackson, T. Prosperity without Growth: Economics for a Finite Planet. Earthscan, Dunstan House, 14a St Cross Street, London, UK, 2009.
Klinghoffer, N.B and Castaldi, M.J. Waste to energy conversion technology. Woodhead Publishing Limited, 80 High Street, Sawston, Cambridge CB22 3HJ, UK, 2013.
UNEP. Arcese G, Benoit-Norris C, Berger M, Ekener E, Finkbeiner M, Russo Garrido S, Lehmann A, Neugebauer S, Schaubroeck T, Traverso M, Valdiva S. Guidelines for social life cycle assessment, United Nations Environment Life Cycle Initiative, 2020.
Yang P. Renewable Energy: Challenges and Solutions. Springer Nature, 2024.

Complementaria:

RECURSOS

Altres recursos:

Other resources will be provided by the professors during the development of the course through ATENEA platform.