Last update: 06-02-2018

295905 - RREC - Resources Recovery and Circular Economy

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering

Teaching unit: 713 - EQ - Department of Chemical Engineering

Academic year: 2017

Degree: BACHELOR'S DEGREE IN MATERIALS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: English

Teaching staff

Others: Oriol Gibert
José Luis Cortina
César Valderrama

Opening hours

Timetable: At any time if the professors' agendas permit. The offices are in building I, 3rd floor.

Degree competences to which the subject contributes

Specific:

CEQUI-19. Understand mass and energy balances, biotechnology, mass transfer, separation operations, chemical reaction engineering, the design of reactors, and the recovery and processing of raw materials and energy resources.
CEQUI-27. Understand spatial vision and graphic representation techniques, whether using traditional metric and descriptive geometry methods or computer assisted design applications.
CEQUI-26. Study the feasibility of a proposed project.

Generical:

CG-03. (ENG) Conocimiento en materias básicas y tecnológicas, que les capacite para el aprendizaje de nuevos métodos y teorías y les dote de versatilidad para adaptarse a nuevas situaciones.
CG-04. (ENG) Capacidad de resolver problemas con iniciativa, toma de decisiones, creatividad, razonamiento crítico y de comunicar y transmitir conocimientos, habilidades y destrezas en el campo de la Ingeniería Industrial.
CG-07. (ENG) Capacidad de analizar y valorar el impacto social y medioambiental de las soluciones técnicas.

Transversal:

04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
05 TEQ N1. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
07 AAT N2. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
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.

Last update: 06-02-2018

295905 - RREC - Resources Recovery and Circular Economy

Teaching methodology

The following activities will be carried out, either in or outside the classroom, in the development of the course:
1. Lectures by professors and optionally by guest speakers
2. Autonomous learning
3. Cooperative learning
4. Problem solving and case studies
5. Project assignments to be carried out in groups
6. Project based learning (PBL)

Learning objectives of the subject

After completion of this subject the student should be able to:
• demonstrate basic understanding of the key concepts and principles, benefits, challenges and underlying philosophy associated with resource efficiency under the paradigm of circular economy
• critically evaluate the technical and environmental impact of implementing aspects of the circular economy across industrial sectors, particularly with regard to the valorisation of wastes for the production of materials and energy and to the regeneration of water for its further reuse.
• to evaluate sustainability challenges, identify and formulate hypotheses or innovative ideas and apply the scientific method to solve practical problems.

Study load

Total learning time: 150h	Theory classes:	60h	40.00%
	Practical classes:	0h	0.00%
	Laboratory classes:	0h	0.00%
	Guided activities:	90h	60.00%

Last update: 06-02-2018

295905 - RREC - Resources Recovery and Circular Economy

Content

1. Introduction to Circular Economy

Learning time: 8h
Theory classes: 8h

Description:
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 chemical industry context. Revalorisation of solid waste and wastewater to energy, products and regenerated water. Challenges.

Related activities:
Activity 1: Critical reading of an article and filling out a questionnaire provided by the teacher
Activity 3: Oral exposition of a case study using power-point
Activity 2: Exercises on mass and energy balances

Specific objectives:
The student will develop a basic understanding of the concept of circular economy and its potential in the chemical industry context.

title english

Learning time: 1h
Theory classes: 1h

Description:
content english

Related activities:

2. Material and energetic characterization of wastes

Learning time: 8h
Theory classes: 8h

Description:
Description of the main routes of characterization of wastes/raw materials to quantify their energetic or material valorization. Main chemical and biochemical properties and quantification protocols. Determination of Heating values and estimation models and equations from chemical composition.

Related activities:
Activity: In the case study development a section of the work should include the energy/material characterization.

Specific objectives:
The student will learn how to characterize wastes and how they can be revalorized according to its properties in a circular economy context.

295905 - RREC - Resources Recovery and Circular Economy

3. Methodologies of economic and environmental evaluation (LCA/LCC)

Learning time: 8h

Theory classes: 8h

Description:

LCA target audience and applications. LCA framework, goal and scope. Inventory analysis, allocation Impact assessment. Carbon footprint methodology. LCC as complement of LCA. LCC methodology. Key concepts of LCC. Working flow for a LCC.

Related activities:

Homework assignment: Short exercises

Project: LCA and carbon footprint analysis through the CCalC, a general life cycle methodology and decision-support tool.

Specific objectives:

The student will be able to identify the different stages of a life cycle analysis and how to align the economic issues associated through the LCC.

The student will be able to develop a basic inventory from a system/industrial process and to perform a carbon footprint analysis.

4. Waste processing technologies for the production of energy

Learning time: 8h

Theory classes: 8h

Description:

Introduction to waste to energy (WtE) conversion. WtE conversion plants in the framework of Circular Economy Policy. WtE technology options: co-processing, anaerobic digestion, landfill gas collection, thermal treatment of municipal solid waste (MSW), pyrolysis / gasification, incineration. Types of feedstock for WtE systems and their characteristics. WtE systems, engineering and technology: Pre- processing and treatment of municipal solid waste (MSW) prior to incineration, Municipal solid waste (MSW) combustion plants, Waste firing in large combustion plants, WtE systems for district heating. Environmental impacts of WtE conversion plants. Pollution control systems for waste to energy technologies.

Related activities:

Homework assignment: Short exercises

Project: Conversion of Municipal Solid Waste (MSW) to produce Electricity through the Solid and Gaseous Biomass Carbon Calculator software.

Specific objectives:

The student will be able to analyse and estimate the potential energy recovery from feedstock and the significant benefits that represent their valorisation in waste-to-energy systems. The student will be able to evaluate a waste-to-energy conversion plant from a sustainable perspective.

Last update: 06-02-2018

295905 - RREC - Resources Recovery and Circular Economy

5. Solid waste processing technologies for the production of products	Learning time: 8h Theory classes: 8h

Description:
Solids wastes are generated in large extension in the industrial and urban cycles and processing routes to recover added values or by-products will be developed. Definition of treatment flow-sheets identification of treatment or processing technologies, development of associated mass and energy balance will be defined. Routes of valorization for different industrial applications will be selected and requirements of quality will be provided.

Specific objectives:
The student will be able to analyse and estimate the potential material recovery from solid wastes and the significant benefits that represent their valorisation in waste-to-products systems.

6. Water regeneration and recycling technologies	Learning time: 8h Theory classes: 8h

Description:
Water in the context of circular economy. Current water resources and uses. Alternative hydric resources. Water regeneration and recycling. Water treatment technologies. Membrane-based technologies. Innovative hybrid systems. Industrial wastewater valorisation and reuse. Potential circularity in water sector. Industrial symbiosis. Examples.

Related activities:
Activity 1: Solving problems related to the unit content.
Activity 2: Critical reading of an article and filling out a questionnaire provided by the teacher.

Specific objectives:
The student will learn which routes and technologies are available today for the regeneration and reuse of wastewater in a circular economy context.

Qualification system

Final test: 30%
Questions, tests, problems, shortl reports during the course: 30%
Preparation of a report on a case study (in groups) and oral exposition: 40%

Last update: 06-02-2018

295905 - RREC - Resources Recovery and Circular Economy

Bibliography

Basic:

Ibrahim Dincer and Marc A. Rosen. Exergy: Energy, Environment and Sustainable Development. . Elsevier Linacre House, Jordan Hill, Oxford OX2 8DP, UK, 2007.

David Hunkeler, Kerstin Lichtenvort, Gerald Rebitzer. Environmental Life Cycle Costing. CRC press Taylor and Francis group, 2008.

Naomi B. Klinghoffer and Marco J. Castaldi. Waste to energy conversion technology. Woodhead Publishing Limited, 80 High Street, Sawston, Cambridge CB22 3HJ, UK, 2013.

Others resources:

Spire Circula Economy Road-Map: https://www.spire2030.eu/intro
EU Circular economy Road Map: https://ec.europa.eu/growth/industry/sustainability/circular-economy_en
Scientific papers from different databases: Science Direct, Scopus
Use the remote access to the UPC library: http://bibliotecnica.upc.edu/colleccions/ebib-eng
Energy Ebook Package Springer Link: http://link.springer.com/search?facet-contenttype=%22Book%22&package=40367&showAll=false