ANX-PR/CL/001-01
LEARNING GUIDE

SUBJECT

45000128 - Recycling Of Materials

DEGREE PROGRAMME

04MI - Grado En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2022/23 - Semester 2

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1. Description

1.1. Subject details

Name of the subject	45000128 - Recycling Of Materials
No of credits	6 ECTS
Type	Compulsory
Academic year ot the programme	Third year
Semester of tuition	Semester 6
Tuition period	February-June
Tuition languages	English
Degree programme	04MI - Grado en Ingenieria de Materiales
Centre	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2022-23

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Jesus Ruiz Hervias (Subject coordinator)	Lab. Fisica	jesus.ruiz@upm.es	Tu - 10:00 - 12:00 W - 10:00 - 12:00

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

2.2. Research assistants

Name and surname	Email	Faculty member in charge
Perez Gallego, Daniel	d.perez@upm.es	Ruiz Hervias, Jesus
Orellana Barrasa, Jaime	jaime.orellana@upm.es	Ruiz Hervias, Jesus
Cristobal Beneyto, Miguel	miguel.cristobal@upm.es	Ruiz Hervias, Jesus

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

- Fundamentos QuÍmicos

3.2. Other recommended learning outcomes

The subject - other recommended learning outcomes, are not defined.

4. Skills and learning outcomes *

4.1. Skills to be learned

CE 3. - Saber planificar la resoluciÃ³n de problemas relacionados con la selecciÃ³n, fabricaciÃ³n, procesado, utilizaciÃ³n y reciclado de todo tipo de materiales en funciÃ³n de las herramientas de que se disponga y de las restricciones de tiempo y recursos

CE 8. - Saber diseÃ±ar y gestionar la utilizaciÃ³n y durabilidad de componentes y dispositivos con materiales, con especial cuidado en el deterioro de materiales y siendo respetuosos con el medio ambiente

CE 9. - Saber diseÃ±ar, implementar y controlar los procesos de reutilizaciÃ³n y/o almacenamiento de materiales, con especial atenciÃ³n al cuidado del entorno

CG 1 - Uso de la lengua inglesa

CG 10 - Adaptación a nuevas situaciones

CG 11 - Responsabilidad y ética profesional

CG 2 - Capacidad de trabajo en equipo

CG 3 - Comunicación oral y escrita

CG 8 - Respeto del Medio Ambiente

CG 9 - Capacidad de trabajo interdisciplinar

4.2. Learning outcomes

RA5 - Saber aplicar las Tecnologías de la Información y de la Comunicación

RA48 - Conocer y saber aplicar tecnologías limpias de reciclado, reutilización y recuperación de materiales,

RA47 - Entender, asimilar y manejar los conceptos básicos para administrar los materiales en la fase final de su ciclo vital; bien reutilizándolos o almacenándolos, siempre de forma respetuosa con el medio ambiente.

RA3 - Ser capaz de trabajar en equipo en entornos interdisciplinares.

RA16 - Ejecutar el trabajo con responsabilidad y respeto a los demás y al medioambiente

RA17 - Utilizar con soltura la comunicación oral y escrita en lengua inglesa.

RA49 - Conocer y saber aplicar técnicas y medidas de ahorro energético

RA4 - Saber adaptarse a nuevas situaciones.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

This course deals with the main issues associated to Recycling and Sustainability in our present world. This is a very complex issue that can be approached in many different ways. Here we will try to focus on the aspects that are more related to materials engineering. The course contents include lectures on the main recycling techniques for different kinds of materials and a seminar on the different energy sources that can be used to achieve long-term sustainability. In addition, invited speakers will give conferences on several topics relevant to the course.

The students will have to present two team projects during the term, one about recycling and the other one about Energy and Sustainability. The objective is to critically analyse an articulation of sustainable development in each case. The method developed by Prof. Michael Ashby to deal with complex problems in sustainability will be used. The projects should focus on a particular aspect and include the opinions of all stakeholders. The most important point is critical thinking and creativity, not ideology. In order to give you some ideas, guidance will be provided in practical classes for such kind of analysis. Some practical classes will also be devoted to the installation and use of CES Edupack software. This software will be used for life-cycle analysis and sustainability data.

At the end of this course, the student should be able to:

- explain the main concepts of the recycling of materials and sustainability disciplines, and discuss the importance of a rational use of natural resources,
- appropriately use life-cycle analysis to estimate the costs and implications of recycling activities in our lives, and
- apply these skills and knowledge to critically analyze articulation of sustainable development related to recycling, energy and sustainability.

In addition to that, the student should improve his transferable skills including oral and written communication, team work and decision making, time and project management, and work ethics.

5.2. Syllabus

1. Introduction to Recycling and UN Sustainable Development Goals (SDG)
    1.1. Life-cycle analysis
2. Polymer recycling
3. Waste separation techniques
4. Metal recycling
    4.1. Hydrometallurgical processes
    4.2. Pyrometallurgical processes
    4.3. Quality controlling in Recycling
5. Seminar on Energy and Sustainability
    5.1. Introduction
    5.2. Solar energy
        5.2.1. Solar direct
        5.2.2. Solar indirect
    5.3. Wind energy
    5.4. Water energy
    5.5. Geothermal energy
    5.6. Fracking
    5.7. Nuclear energy: fission and fusion

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Introduction to Recycling and UN Sustainable Development Goals (SDG)** Duration: 01:00 Lecture **Life-cycle analysis** Duration: 03:00 Lecture			
2	**Installation of CES Edupack software** Duration: 01:00 Lecture	**Use of CES Edupack for life-cycle analysis** Duration: 03:00 Laboratory assignments		**Friday task: review of course lectures** Online test Continuous assessment Not Presential Duration: 00:30
3	**Polymer recycling** Duration: 04:00 Lecture			
4	**Polymer recycling** Duration: 04:00 Lecture			**Friday task: review of course lectures** Online test Continuous assessment Not Presential Duration: 00:30
5	**Introduction to Ashby method for analysing an articulation of sustainable development** Duration: 02:00 Laboratory assignments			**Mini-project on life-cycle analysis using CES Edupack** Group presentation Continuous assessment Presential Duration: 02:00
6	**Waste separation techniques** Duration: 02:00 Lecture **Team work meeting** Duration: 02:00 Cooperative activities			
7	**Recycling of metals: hydrometallurgical processes** Duration: 02:00 Lecture **Recycling of metals: pyrometallurgical processes** Duration: 01:00 Lecture	**Laboratory of waste separation and materials recovery** Duration: 02:00 Laboratory assignments	**Visit to Valdemingomez waste management plant** Duration: 05:00 Additional activities	**Friday task: review of course lectures** Online test Continuous assessment Not Presential Duration: 00:30

8	**Recycling of metals: quality control** Duration: 01:00 Lecture **Exercises about recycling and quality control** Duration: 01:00 Problem-solving class **Team work meeting** Duration: 02:00 Cooperative activities			
9	**Seminar on Energy and Sustainability: introduction** Duration: 01:00 Lecture **Seminar on Energy and Sustainability: direct solar energy** Duration: 01:00 Lecture **Team work meeting** Duration: 02:00 Cooperative activities			
10				
11	**Seminar on Energy and Sustainability: indirect solar energy** Duration: 01:00 Lecture **Seminar on Energy and Sustainability: wind energy** Duration: 01:00 Lecture **Team work meeting** Duration: 02:00 Cooperative activities			**Friday task: review of course lectures** Online test Continuous assessment Not Presential Duration: 00:30
12	**Seminar on Energy and Sustainability: water energy** Duration: 01:00 Lecture **Seminar on Energy and Sustainability: geothermal energy** Duration: 01:00 Lecture **Team work meeting** Duration: 02:00 Cooperative activities			
13	**Seminar on Energy and Sustainability: fracking** Duration: 01:00 Lecture **Seminar on Energy and Sustainability: nuclear fission and fusion** Duration: 01:00 Lecture			**Friday task: review of course lectures** Online test Continuous assessment Not Presential Duration: 00:30

	Team work meeting Duration: 02:00 Cooperative activities			
14	**Exercises about Energy and Sustainability** Duration: 01:00 Problem-solving class			**Project about an articulation of sustainable development** Group presentation Continuous assessment Presential Duration: 03:00
15	**Review of exercises about the course contents** Duration: 02:00 Problem-solving class			**Final test** Written test Continuous assessment Presential Duration: 02:00
16				
17				**Final ordinary exam** Written test Final examination Presential Duration: 02:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Friday task: review of course lectures	Online test	No Presential	00:30	2%	5 / 10	CE 3. CG 1 CG 3 CG 8 CE 8. CE 9. CG 10 CG 11
4	Friday task: review of course lectures	Online test	No Presential	00:30	2%	5 / 10	CE 3. CG 1 CG 3 CG 8 CE 8. CE 9. CG 10 CG 11
5	Mini-project on life-cycle analysis using CES Edupack	Group presentation	Face-to-face	02:00	0%	5 / 10	CE 3. CE 9. CG 8 CG 9 CG 10 CG 11 CG 2 CG 1 CG 3
7	Friday task: review of course lectures	Online test	No Presential	00:30	2%	5 / 10	CE 3. CG 1 CG 3 CG 8 CE 8. CE 9. CG 10 CG 11

11	Friday task: review of course lectures	Online test	No Presential	00:30	2%	5 / 10	CE 3. CG 1 CG 3 CG 8 CE 8. CE 9. CG 10 CG 11
13	Friday task: review of course lectures	Online test	No Presential	00:30	2%	5 / 10	CE 3. CG 1 CG 3 CG 8 CE 8. CE 9. CG 10 CG 11
14	Project about an articulation of sustainable development	Group presentation	Face-to-face	03:00	60%	5 / 10	CE 3. CE 9. CG 8 CG 9 CG 1 CG 3 CG 10 CG 11 CE 8. CG 2
15	Final test	Written test	Face-to-face	02:00	30%	4 / 10	CG 1 CG 3 CG 8 CE 3.

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final ordinary exam	Written test	Face-to-face	02:00	100%	5 / 10	CE 8. CE 9. CE 3. CG 1 CG 3 CG 8 CG 9 CG 10 CG 11

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final extraordinary exam	Online test	Face-to-face	02:00	100%	5 / 10	CE 8. CE 9. CE 3. CG 1 CG 3 CG 8 CG 9 CG 10 CG 11

7.2. Assessment criteria

A) Continuous assessment (pass mark: 50/100 points)

This is the recommended way to follow the course. There will be two term projects and one final test for all students.

- Term project: maximum 60 points (compulsory for continuous assessment)
- Final test: (*) maximum 30 points (same structure as final exam)
- Friday tasks: maximum 10 points

(*) In order to pass the course in the continuous assessment mode, the students should get at least 4/10 in the final test.

Notes about term projects:

- It is compulsory to do the term projects in order to access the continuous assessment mode.
- If the term projects are plagiarized by any team, the corresponding team members will have to take the final exam, and the term project mark will not be considered for the final exam.
- The term projects will be presented by each team member in front of the class.
- Each team will have to upload the presentation files through moodle at least two days before the presentation date.
- The highest mark will only be awarded to excellent projects. Marks will be individual, based on the presentation.

B) Final exam (passmark: 50/100 points): for those who did not pass the continuous assessment. If a student has not done the term project or it was found that it was plagiarized, he will also have to analyse an articulation of sustainable development using the method explained in the course.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Ashby, M.F. "Materials and Sustainable Development" Elsevier, 2016	Bibliography	
Ashby, M.F. "Materials and the Environment. Eco-informed Material Choice". Butterworth Heinemann, 2012	Bibliography	
Classroom presentations	Web resource	
CES Edupack software	Others	Software for materials selection and life-cycle analysis, with an emphasis on Recycling and Sustainability

9. Other information

9.1. Other information about the subject

The course is related to the following Sustainable Development Goals:

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy

Goal 11: Make cities inclusive, safe, resilient and sustainable

Goal 12: Ensure sustainable consumption and production patterns

Goal 13: Take urgent action to combat climate change and its impacts