ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

43000606 - Materiales Para La Energía

DEGREE PROGRAMME

04AN - Master Universitario En Ingenieria De Materiales

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	43000606 - Materiales para la Energía
No of credits	3 ECTS
Type	Compulsory
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	04AN - Master Universitario en Ingenieria de Materiales
Centre	04 - Escuela Tecnica Superior De Ingenieros De Caminos, Canales Y Puertos
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Javier Martinez Rodrigo (Subject coordinator)	ETSIT C-232	javier.martinez@upm.es	M - 13:00 - 14:00 Th - 13:00 - 14:00 Also under students request by e-mail

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

2.3. External faculty

Name and surname	Email	Institution
Yu Kyoung Ryu Cho	y.ryu@upm.es	ETSIT

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Basic knowledge of Physics, electricity and instrumentation

- Undergraduate-level Materials Science course

4. Skills and learning outcomes *

4.1. Skills to be learned

CE1 - Capacidad para aplicar los fundamentos científicos del comportamiento físico y químico de los materiales para relacionar causalmente sus propiedades fundamentales físicas y químicas con su comportamiento macroscópico y el de los productos con ellos realizados / Ability to apply the scientific foundations of the physical and chemical behavior of materials to correlate their fundamental physical and chemical properties with their macroscopic behavior and that of the products made with them.

CE2 - Uso de equipos y técnicas experimentales de caracterización de materiales (micro y macroestructura, comportamientos mecánico, eléctrico, y óptico) para identificar y analizar los diversos tipos de materiales / Use of equipment and experimental techniques for the characterization of materials (micro and macrostructure, mechanical, electrical, and optical behavior) to identify and analyze the various types of materials.

CE5 - Capacidad para planificar, explotar y gestionar técnicamente la selección, fabricación, procesado, utilización, reciclado, reutilización y eliminación de materiales, de forma respetuosa con el medio ambiente, de conformidad con la legislación nacional e internacional, y promoviendo el desarrollo sostenible y el bienestar de la sociedad / Ability to technically plan, exploit and manage the selection, manufacturing, processing, use, recycling, reuse and disposal of materials, in an environmentally friendly manner, in accordance with national and international

legislation, and promoting sustainable development and well-being of the society

CG1 - Uso de la lengua inglesa: Los alumnos son capaces de transmitir conocimientos y expresar ideas y argumentos de manera clara, rigurosa y convincente, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia / Use of the English Language: Students are able to transmit knowledge and express ideas and arguments in a clear, rigorous and convincing manner, both orally and in writing, adapting to the characteristics of the situation and the audience .

CG3 - Trabajo en equipo: Los alumnos desarrollan la capacidad para trabajar en equipo, integrarse y colaborar de forma activa en la consecución de objetivos comunes / Teamwork: Students develop the ability to work as a team, integrate and actively collaborate in achieving common goals.

CG4 - Creatividad: Los alumnos son capaces de resolver de forma nueva, original y aportando valor, situaciones o problemas en el ámbito de la ingeniería de materiales / Creativity: Students are able to solve situations or problems in the field of materials engineering in a new, original way and adding value.

CG5 - Organización y planificación: Los estudiantes son capaces de fijar objetivos, con la planificación y programación de actividades (tiempo y fases) y con la organización y gestión de los recursos necesarios para alcanzarlos / Organization and Planning: Students are capable of setting objectives, with the planning and programming of activities (time and phases) and with the organization and management of the necessary resources to achieve them..

CG8 - Resolución de problemas: Los estudiantes son capaces de reconocer, describir, organizar y analizar los elementos constitutivos de un problema para idear estrategias que permitan obtener, de forma razonada, una solución contrastada y acorde a ciertos criterios preestablecidos / Problem solving: Students are able to recognize, describe, organize and analyze the constitutive elements of a problem to devise strategies that allow obtaining, in a reasoned way, a contrasting solution and according to certain pre-established criteria.

4.2. Learning outcomes

RA3 - Conocer, comprender y saber aplicar las bases de la ciencia y del método científico

RA8 - RA32 - Conocer, comprender y saber aplicar los fundamentos científicos del comportamiento de los materiales

RA10 - basic and advanced knowledge on electrochemical techniques, photo-electrochemistry and electrochemical energy storage devices

RA1 - Saber comunicar conocimientos, procedimientos, resultados o técnicas relacionadas con el comportamiento y el uso de materiales

* 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

The main objective is course is to gain knowledge of the basic fabrication methods, structure and properties of materials for energy management, with a particular emphasis on measuring techniques and performance indicators in electrochemical energy storage.

Masterclasses combined with Laboratory practices are scheduled in order to expand the knowledge of the students in materials for energy .

5.2. Syllabus

1. Introduction to the course: Common materials and trends in energy management

2. Basic thermodynamics of electrochemical processes in solid-solid, solid-liquid, and liquid-liquid interfaces.

3. Type of electrodes and electrolytes: Requirements, type, and fabrication

4. Fabrication of raw materials and integration in electrodes

5. Electric double layer features: capacitors

6. Practical on supercapacitors devices

7. Electrochemical energy storage systems I: pseudocapacitive reactions and battery-type materials.

8. Electrochemical energy storage systems II: Battery electrodes, fabrication, cyclability, safety and future trends.

9. Mechanical energy harvesting materials: piezoelectric, tribologic, actuators

10. Heterogenous reactions and electrocatalysis

11. Application of heterogenous electrocatalysis in energy storage: Fuel cells, principles, materials, applications

12. Heterogeneous electrocatalysis in air batteries: Air cathodes, materials, design and fabrication

13. Materials for solar cells and photovoltaics

14. Practical on batteries and solar cells

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Introduction to the course: Common materials and trends in energy management** Duration: 02:00 Lecture			
2	**Basic thermodynamics of electrochemical processes in solid-solid, solid-liquid, and liquid-liquid interfaces.** Duration: 02:00 Lecture			
3	**Type of electrodes and electrolytes: Requirements, type, and fabrication** Duration: 02:00 Lecture			
4	**Fabrication of raw materials and integration in electrodes** Duration: 02:00 Lecture			
5	**Electric double layer features: capacitors** Duration: 02:00 Lecture			
6		**Practical on supercapacitors devices** Duration: 02:00 Laboratory assignments		
7				**Partial examination 1** Written test Continuous assessment Presential Duration: 02:00
8	**Electrochemical energy storage systems I: pseudocapacitive reactions and battery-type materials.** Duration: 02:00 Lecture			
9	**Electrochemical energy storage systems II: Battery electrodes, fabrication, cyclability, safety and future trends** Duration: 02:00 Lecture			
10	**Mechanical energy harvesting materials: piezoelectric, tribologic, actuators** Duration: 02:00 Lecture			

11	**Heterogenous reactions and electrocatalysis** Duration: 02:00 Lecture			
12	**Application of heterogenous electrocatalysis in energy storage: Fuel cells, principles, materials, applications** Duration: 02:00 Lecture			
13	**Heterogeneous electrocatalysis in air batteries: Air cathodes, materials, design and fabrication** Duration: 02:00 Lecture			
14	**Materials for solar cells and photovoltaics** Duration: 02:00 Lecture			
15		**Practice on bateries and solar cells** Duration: 02:00 Laboratory assignments		
16				**Partial examination 2** Written test Continuous assessment Presential Duration: 02:00
17				**Final regular examination** Written test Final examination Presential Duration: 03:00

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
7	Partial examination 1	Written test	Face-to-face	02:00	40%	5 / 10	CG8 CG1 CE5 CE1
16	Partial examination 2	Written test	Face-to-face	02:00	60%	5 / 10	CE5 CE1 CG8 CG1

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final regular examination	Written test	Face-to-face	03:00	100%	5 / 10	CE5 CE1 CG8 CG1

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Final extraordinary examination	Individual presentation	Face-to-face	03:00	100%	5 / 10	CE5 CE1 CG8 CG1

7.2. Assessment criteria

Continuum assessment

Only if the whole class attendance > 60% of the days

Final mark = PE1 (40%) + PE2 (60%)

PE1: partial examination 1

PE2: partial examination 2

Pass mark: (PE1 + PE2)/2 > 5

Final Exam

Final exam with a total weight of 100%

Pass mark: Final Exam > 5

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Walfried Plieth Electrochemistry for Materials Science. Elsevier Science (2008)	Bibliography	Book
Handbook of batteries. Mc Graw Hill Professional (2001)	Bibliography	Book
B.E. Conway Electrochemical Supercapacitors: Scientific Fundamentals and Technological Applications. Springer (1999)	Bibliography	Book
Electroceramics by A.J. Moulson and J.M. Herbert, Chapman and Hall, 1990	Bibliography	Book
Allen J. Bard Electrochemical Methods: Fundamentals and Application. Z-lib.org	Bibliography	Book

9. Other information

9.1. Other information about the subject

This course is related to: ODS7, ODS9, ODS13