VNIVERSITAT DE VALÈNCIA

COURSE DATA

DATA SUBJECT

Code: 46567
Name: Applied Electrochemical Technology
Cycle: Master's Degree
ECTS Credits: 3
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2261 - Master's Degree in Chemical Engineering	Escola Tècnica Superior d'Enginyeria	1	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2261 - Master's Degree in Chemical Engineering	Optatividad	ELECTIVES

COORDINATION

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SUMMARY

Elective course of 3 ECTS from the second semester of the Master's Degree in Chemical Engineering taught in Spanish

Electrochemistry is the branch of chemistry that studies the relationship between chemical reactions and electricity, whose processes are mediated by the transfer of electrons. Electrochemistry has a strong presence in many of the products that are used or consumed on a daily basis: metals such as aluminum, sodium, magnesium or calcium are obtained from electrochemical methods, as well as chlorine and caustic soda. . Electrochemical reactions are also behind cells and batteries (both rechargeable and non-rechargeable), essential in modern societies, and the coating of objects with metals or metal oxides from electrodeposition is crucial in surface engineering to avoid another electrochemical phenomenon: corrosion. Electrochemical processes have been known for a long time, but today this discipline is gaining a lot of importance again due to its modern and future applications, such as energy generation and storage, environmental treatments, materials science and engineering and nanotechnology. Thus, in this subject, of an especially practical and highly applied nature, students will learn the elementary principles of electrochemistry, to later be able to use them in the study of the numerous industrial applications of this discipline, placing special emphasis on energy and environmental aspects. The contents will be worked through practical cases, which will be very useful for the training of students with a view to their

professional future and their day-to-day life in general.

LEARNING OUTCOMES (RD 1393/2007): Calculate the potential of an electrochemical cell and interpret its value in terms of the spontaneity of the reaction. Determine the speed of an electrochemical reaction. Identify the main industrial electrochemical processes. Calculate the capacity of a battery and compare different batteries based on their behavior. Identify the different electrochemical methods of surface treatment and their usefulness. Apply the fundamentals of electrochemistry to solve energy and environmental problems. Recognize the different types of corrosion and understand its mechanisms. Design equipment and devices to prevent corrosion.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

COMPETENCES / LEARNING OUTCOMES

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Adapt to changes and be able to apply new and advanced technologies and other relevant developments with initiative and entrepreneurship.

Apply critical reasoning to their knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience and practice, in order to establish economically viable solutions to technical problems.

Be able to access information tools in different areas of knowledge and use them properly.

Be able to apply the scientific method and the principles of engineering and economics to formulate and solve complex problems in processes, equipment, facilities and services in which matter changes its composition, state or energy content, these changes being characteristic of the chemical industry and of other related sectors such as pharmacology, biotechnology, materials science, energy, food or the environment.

Be able to assess the need to complete their technical, scientific, language, computer, literary, ethical, social and human education, and to organise their own learning with a high degree of autonomy.

Be able to defend criteria with rigor and arguments and to present them properly and accurately.

Be able to solve unfamiliar and ill-defined problems that have specifications in competition by considering all possible methods of solution, including the most innovative ones, and selecting the most appropriate, and correct implementation by evaluating the different design solutions.

Be able to take responsibility for their own professional development and specialisation in one or more fields of study.

Communicate and discuss proposals and conclusions in specialised and non-specialised multilingual forums, in a clear and unambiguous manner.

Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.

Students should be able to integrate knowledge and address the complexity of making informed judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities associated with the application of their knowledge and judgments.

Students should demonstrate self-directed learning skills for continued academic growth.

DESCRIPTION OF CONTENTS

1. Introduction to electrochemical processes

Electrochemistry and society.
Cells and electrochemical reactions.
Ionic conductivity and mobility

2. Thermodynamics of electrochemical processes

Potential differences and electrode potentials.
Gibbs free energy and cell potential. Spontaneity.
Nernst equation.

3. Electrochemical kinetics

Velocity of electrode and polarization reactions.
Butler-Volmer equation. Evans diagrams.
Voltammetry and other electrochemical techniques

4. Synthesis of chemical products by electrochemical processes

Industrial electrochemical synthesis processes

5. Fuel cells and batteries

Energy storage.
Primary and secondary (rechargeable) batteries.
Fuel cells.

6. Electrochemical surface treatment

Anodization.
Electrodeposition.
Electrochemical machining.
Nanotechnology and electrochemistry. Manufacture of nanomaterials.

7. Electrochemical corrosion

Corrosion phenomenon. Importance of the study of corrosion in engineering. Typology.
Thermodynamics and kinetics of corrosion.
Passivity and localized corrosion.
Protection techniques.
Design strategies against corrosion.

8. Environmental and energy applications of electrochemical technology

Electrodialysis.
Electrocoagulation and electroflotation.
Electrolysis and electrocatalysis.
Photoelectrocatalysis

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	20,00
Classroom practices	10,00
Total hours	**30,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	6,00
Independent study and work	12,00
Preparation of lessons	14,00
Preparation for assessment activities	8,00
Resolution of case studies	5,00
Total hours	**45,00**

TEACHING METHODOLOGY

The methodology to be used in the subject will be, fundamentally, the active methodology of Problem-Based Learning (ABP), complemented with expositive classes of more theoretical content. The PBL will be implemented in most of the contents of the subject, proposing in each of the sessions in which a real problem or situation is used that the students, working in pairs, must solve. It will be necessary for the students to have some electronic device and Internet access in the classroom to be able to access the information they need when solving these problems. Two types of classroom sessions will be considered:

Theoretical sessions: the teaching staff will present the theoretical foundations of the topic to be dealt with, focusing on the key aspects that must be developed in the practical cases. The use of the PBL methodology in these sessions will have a more conceptual nature and the aspects that are worked on in the problems raised will be directly related to the theoretical content presented by the teaching staff.

Practical sessions: in all these sessions applied practical cases will be considered. In them, the students must solve the proposed problems, using for this the theoretical concepts acquired in the previous sessions (starting point), as well as all the information they consider necessary and that they will have to look for cooperatively.

EVALUATION

Objective test (40% of the grade): there will be one or several written exams that will consist of both theoretical and practical questions and problems.

2. Practical activities (55% of the mark): they will be evaluated based on the documentation delivered (reports and practical cases delivered), tests carried out and/or oral presentations.

3. Continuous evaluation (5% of the grade): based on the participation and degree of involvement of the students in the teaching-learning process, taking into account regular attendance at the planned face-to-

face activities.

The course will be considered passed when the weighted average grade is equal to or greater than 5 (out of 10), as long as a grade equal to or greater than 4.5 (out of 10) is obtained in the objective test (exam). In the event that the objective test mark is less than 4.5, the weighted average will not be carried out with continuous evaluation and practical activities. In this case, the objective test will compute 100% of the evaluation of the subject. In any case, student can decide if they want the exam to count 100% of the evaluation of the subject.

REFERENCES

- Basic:

R.M. Fernández Domene, G. Roselló Márquez, P. Batista Grau, R. Sánchez Tovar, J. García Antón (2020). Fundamentos de teoría electroquímica. València: Editorial Universitat Politècnica de València (UPV).

V.S. Bagotsky (2006). Fundamentals of Electrochemistry. Hoboken: John Wiley & Sons.

A.J. Bard, L.R. Faulkner (2001). Electrochemical Methods: Fundamentals and Applications. New York: John Wiley & Sons.

J.O.M. Bockris, A.K.N. Reddy, M. Gamboa-Aldeco (2002). Modern Electrochemistry 2A: Fundamentals of Electrodics. Second Edition. New York: Kluwer Academic/Plenum Publishers

C. Lefrou, P. Fabry, J.C. Poignet (2012). Electrochemistry: the basics with examples. Berlin, Heidelberg: Springer

- Additional:

K.W. Beard (2019). Linden's Handbook of Batteries. Fifth Edition. New York: McGraw-Hill.

V.S. Bagotsky, A.M. Skundin, Y.M. Volfkovich (2015). Electrochemical Power Sources : Batteries, Fuel Cells and Supercapacitors. Somerset: John Wiley & Sons.

J.O¿M. Bockris, A.K.N. Reddy (2004). Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology, and Environmental Science. Second Edition. New York: Kluwer Academic/Plenum Publishers

P.R. Roberge (2008). Corrosion Engineering. Principles and Practice. New York: McGraw-Hill.

R.M. Fernández Domene, R. Sánchez Tovar, B. Lucas Granados, J. García Antón (2018). Principios de fotoelectroquímica. València: Editorial Universitat Politècnica de València (UPV).

R. van de Krol, M. Grätzel, (Eds.) (2012). Photoelectrochemical Hydrogen Production. New York: Springer.