UAB
Universitat Autònoma de Barcelona

Electrochemistry and Corrosion

Code: 102499
ECTS Credits: 6

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Degree	Type	Year
2502444 Chemistry	OT	4

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

It is recommended to have studied and approved the courses that make up the matter of Physical Chemistry (Quantum Chemistry, Chemical Thermodynamics and Kinetics and Surface, Transport Fenomena) and the course of the correspondant laboratory (in the matter of Methodology and Chemical Experimentation)

Objectives and Contextualisation

Provide the necessary knowledge to recognize Electrochemistry as a useful tool in both basic and applied research, with special emphasis on the essential processes of Applied Electrochemistry: Electrosynthesis, Batteries, Electrodialysis and Corrosion Protection.

Competences

- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Be ethically committed.
- Communicate orally and in writing in one's own language.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.

- Handle standard instruments and material in analytic and synthetic chemical laboratories.
- Have numerical calculation skills.
- Lead and coordinate work groups.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Analyse problems with batteries and corrosion processes.
3. Analyse the aspects that control an electro-synthesis process and resolve specific problems in this field.
4. Apply the fundamental concepts of thermodynamics and kinetics to the use of batteries, and to the phenomenon of corrosion.
5. Be ethically committed.
6. Communicate orally and in writing in one's own language.
7. Describe the most important electrolysis based synthetic processes in industry.
8. Differentiate the different processes for electroplating metals.
9. Differentiate the most important methods of electrochemical separation and the most relevant electrochemical processes in the treatment of waste.
10. Distinguish the factors that govern a direct and indirect electrolytic process.
11. Evaluate electrochemical effluent filtering methods and compare them with other methods.
12. Evaluate electrochemical synthesis procedures in terms of their environmental impact and compare them with conventional synthetic methods.
13. Handle electrochemical instrumentation and specific instrumentation for analysing the corrosion of metals.
14. Have numerical calculation skills.
15. Interpret experimental data obtained by electrochemical techniques, evaluate the meaning and relate it with the appropriate theories.
16. Lead and coordinate work groups.
17. Learn autonomously.
18. Manage the organisation and planning of tasks.
19. Manage, analyse and synthesise information.
20. Obtain information, including by digital means.
21. Propose creative ideas and solutions.
22. Reason in a critical manner
23. Resolve numerical problems in relation to electro-synthetic processes and batteries.
24. Resolve problems and make decisions.
25. Resolve questions relative to the electroplating of metals, electrochemical separation processes and the electrochemical treatment of effluents.
26. Show sensitivity for environmental issues.
27. Summarise an article written in English in a reasonable time.
28. Use IT to treat and present information.
29. Use common English terminology for industrial chemistry, electrochemistry and corrosion, environmental chemistry, green chemistry, quality management, monitoring systems, and financial and business management.
30. Work in a team and show concern for interpersonal relations at work.

Content

1. Heterogeneous electron transfer reactions (ETs).

Oxidation-Reduction. Homogeneous ET vs heterogeneous ET. Electrochemical systems: electrodes. Fundamental thermodynamic and kinetic aspects: Nernst and Butler-Volmer.

2. Molecular Electrochemistry. Transport of matter and chemical reactions coupled to ET. Electrochemical methods.

Macro- and micro-electrolysis. Transport of material. Stationary and transient methods. Examples. Chemical reactions coupled to ET: types and treatment.

3. Supramolecular Electrochemistry.

Electrochemical considerations in supramolecular systems. Electrochemical Switching. Electrochemical switchable recognition of cations and anions. Electroactive Langmuir-Blodget films and self-assembled monolayers. Molecular Machines.

4. The electrochemical cell and the reactor.

Cell and electrodes. Type. I-E curves. Factors that influence the rate of electrolysis. Electrochemical performance parameters. Reactors: type and design.

5. Electrochemistry and Sustainability (I).

Electrosynthesis of inorganic and organic compounds. The chlorine-alkali industry. Obtaining aluminum and alkali metals. Hydrodimerization of acrylonitrile. Indirect electrosynthesis.

6. Electrochemistry and Sustainability (II).

Treatment of effluents from industries. Recovery of metals by electroplating. Treatment of organic waste. Treatment of inorganic waste. Electro-flotation.

7. Industrial electrochemistry (I). Electrochemistry and metals.

Extraction and refining of metals. Metal finish: Silver plated and anodized. Metal processing: Electro-molding.

8. Industrial electrochemistry (II). Electrochemistry and membranes. Separation processes.

Electrodialysis. Ion-selective membranes. Bipolar membranes. Electro-osmosis and electrophoresis. Desalination.

9. - Green Energy Generation Technologies

Electrochemical generators. Type. Examples. Thermodynamics and kinetics of batteries and batteries. Power and other parameters of the batteries. Fuel cells. Examples. The hybrid car.

10. Corrosion.

Types of corrosion. Thermodynamics and kinetics of corrosion. Corrosion in everyday life. Corrosion control.

Laboratory

Electrochemical preparation of peroxodisulphate.

Kinetics of the attack to metals by acids.

Differential aeration

Cathodic protection by sacrificial anode.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	8	0.32	1, 17, 15, 16, 13, 5, 20, 21, 22, 24, 27, 30
Problem classes	8	0.32	2, 5, 22, 23, 25, 14
Theoretical classes	30	1.2	3, 4, 11, 12, 6, 7, 8, 9, 10, 5, 26, 22, 29
Type: Supervised			
Tutorials	4	0.16	6, 18, 19, 20, 22, 24, 28
Type: Autonomous			
Automous Study and Presentation on a scientific article	59	2.36	1, 3, 2, 4, 17, 11, 12, 7, 8, 9, 10, 18, 19, 15, 5, 20, 21, 22, 27, 30, 28, 29
Laboratory work Preparation and drafting of reports	13	0.52	1, 17, 6, 18, 19, 15, 16, 13, 5, 26, 20, 21, 22, 24, 27, 14, 30, 28
Problem solving	15	0.6	2, 5, 22, 23, 25, 14

The acquisition of knowledge will be carried out through the use of theoretical classes, problem classes, laboratory practices and presentation of scientific articles

Theoretical classes (on the board with the help of audiovisual media) in which the basic concepts will be introduced to be able to understand the fundamental and applied aspects of Electrochemistry.

Problem classes (with more student participation) in which the methodology will be indicated to quantitatively solve numerical questions

Laboratory practices (which will be carried out according to economic availability) in which the knowledge acquired during the theoretical classes and of problems to the habitual electrochemical manipulation will be applied. The purpose is twofold, to affirm the fundamental concepts and acquire the necessary experimental skills in Electrochemistry.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory work Preparation and drafting of reports	15%	2	0.08	1, 17, 6, 18, 19, 15, 16, 13, 5, 26, 20, 21, 22, 24, 27, 14, 30, 28
Oral presentation on a scientific article	15%	0	0	17, 6, 19, 15, 26, 20, 27, 30, 28, 29
Written Exercices	10%	3	0.12	2, 5, 22, 24, 23, 25, 14
Written exams	60%	8	0.32	1, 3, 4, 11, 12, 6, 7, 8, 9, 10, 18, 5, 26, 21, 22, 24, 27, 14, 29

Continuous Assessment

Written tests (60% of the grade). According to the academic calendar, two tests will be held. Each of these exams will have a weight of 30% of the final grade. If the average grade of these two exams is less than 5, a final exam must be taken at the end of the semester that will include the contents of the entire course, and whose grade will be equivalent to 60% of the total. In order to take the final exam, students must have participated in assessment activities throughout the course that are equivalent to 2/3 of the grade of the subject. Otherwise, the grade will be "Not presented".

Continuous work (10% of the grade): Evidence from the student will be collected throughout the course (problems solved, individually or in groups, short tests in class, etc.). These activities cannot be recovered unless the student provides a greater justification with the corresponding official documentation. This activity will have a weight of.

Oral presentation on a scientific article (15% of the grade): Each student or group of students will be assigned a scientific article related to the contents of the subject. Students must make an oral presentation on this article. Each student will be awarded a grade based on the presentation made and their answers to the questions asked. This grade will have a weight of 15% on the final grade of the subject. Carrying out group work (15% of the grade). The completion of this work is mandatory and cannot be recovered.

Laboratory practices (15% of the grade). Attendance at the laboratory sessions is mandatory, as well as the delivery of reports if the professor requires it. The lab grade will be graded between 0 and 10.

Single assessment

Single assessment: Students who have taken advantage of the single assessment modality must take a final test that will consist of the following activities:

1. Written theory test: A single written exam will be held at the end of the academic year in which the theoretical continuums of the subject will be evaluated, which will have a weight of 70%. If the mark of these exams is less than 5, a final retake exam must be taken. *In order to take the retake exam, students must have participated in the final single assessment test. Otherwise, the grade will be "Not presented".*
2. Laboratory practices (15% of the grade). Attendance at the laboratory sessions is mandatory, as well as the delivery of reports if the professor requires it. The lab grade will be graded between 0 and 10.
3. Oral presentation on a scientific article: Students will make an oral presentation on an assigned scientific article. The presentation and the answer to the questions asked will be evaluated with a grade, which will have a weight of 15% of the final grade of the subject.

Regardless of the evaluation modality chosen, in order to pass the subject, students must have:

1) A mark of theoretical exams higher than 5.

2) An average grade of the subject higher than 5.

3) Have attended the practice sessions in the laboratory. Laboratory Safety Warning: Students who are involved in an incident that may have serious safety awareness may be expelled from the laboratory and fail the subject.

Bibliography

P. Atkins; J de Paula, "Physical Chemistry" 9Ed. Oxford, N.Y 2010

I.N. Levine, "Principios de fisicoquímica" 6Ed. McGrawHill, Mexico 2014

A.J.Bard y L.R.Faulkner, "Electrochemical Methods: Fundamental and Aplications". 2Ed. Wiley, N.Y. 2000

D.Brynn, "Introduction to electrochemistry"McMillan Press, London, 1993

P.M.S.Monk, "Fundamentals of Electroanalytical Chemistry" Wiley, N.Y., 2001

D.Pletcher, "Industrial Electrochemistry", 2Ed. Chapman and Hall, London 1999

K.Scott, "Electrochemical processes for clean technology" Royal Society of Chemistry, 1995

Software

Word, Excel, Power Point

Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	1	Catalan	first semester	afternoon
(TE) Theory	1	Catalan	first semester	morning-mixed