Universitat Autònoma de Barcelona

2023/2024

Electrochemistry and Corrosion

Code: 102499
ECTS Credits: 6

Degree	Type	Year	Semester
2502444 Chemistry	OT	4	1

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

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

Lesson 1. Heterogeneous electron transfer (ET) reactions.
Oxidation-Reduction. Homogeneous ET vs. Heterogeneous ET. Electrochemical systems: Electrodes. Fundamental thermodynamic and kinetic aspects: Nernst and Butler-Volmer

Lesson 2. The electrochemical cell and the reactor.
Electrochemical Cells and electrodes. I-E curves. Variables affecting the rate of an electrode reaction. Figures of merit in Electrolysis. Types and design of reactors

Lesson 3. Electrosynthesis of inorganic compounds.
The chlor-alkali industry. Obtaining aluminum and alkaline metals. Other inorganic processes: electrolysis of water, obtaining fluorine and sodium chlorate.

Lesson 4. Electrochemistry and metals.
Metal extraction and refining. Metal finishing: Electroplating and anodizing. Metal processing: electroforming and electochemical machining.

Lesson 5. Electrosynthesis of organic compounds.
Electrode reactions with coupled homogeneous chemical reations. Methods to investigate the mechanisms: Molecular electrochemistry. Comparison between chemical and electrochemical methods. Hydrolymerization of acrylonitrile.

Lesson 6. Indirect electrosynthesis.
REDOX heterogeneous catalysis. Thermodynamics of the process. Examples

Lesson 7. Electrochemistry and membranes. Separation processes.
Electrodialysis Ion selective membranes. Bipolar membranes. Electroosmosis and electrophoresis. Desalination.

Lesson 8. Treatment of industrial effluents.
Recovery of metals by electrodeposition. Treatment of organic waste. Treatment of inorganic waste. Electroflotation

Lesson 9. Batteries, rechargeable batteries and fuel cells.
Types. Examples Thermodynamics and kinetics of batteries. Power and other parameters of the batteries. Fuel cells. Examples: The hybrid car.

Lesson 10. Corrosion
Types of corrosion. Thermodynamics and kinetics of corrosion. Corrosion in everyday life. Corrosion control

Laboratory
Group 1
Electrochemical preparation of peroxodisulphate.
Kinetics of the attack to metals by acids.
Differential aeration
Cathodic protection by sacrificial anode.
Group 2 (according to calendar)
Visit to an electrochemical industry

Methodology

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

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. The visit to an electrochemical industry will be made according to availability

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.

Activities

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			
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	22	0.88	2, 5, 22, 23, 25, 14
The study	52	2.08	1, 3, 2, 4, 17, 11, 12, 7, 8, 9, 10, 18, 19, 5, 20, 21, 22, 27, 28, 29

Assessment

The tests (60% of the grade). According to the academic calendar two tests will be carried out. A grade equal to or higher than 4.0 (out of 10) is required in the tests so that the remaining 40% of points can be added (classroom work and laboratory practices). In the event that the grade is lower than 4.0, the student will have to take the recovery exam, which will include all the material, to pass the subject. In addition, to participate in the recovery the students must have been evaluated in a set of activities whose weight equals a minimum of two thirds of the total grade of the subject.

Realization of classroom work (20% of the grade). The completion of this work is mandatory and is not recoverable.

Laboratory work (20% of the grade). Attendance at laboratory sessions is mandatory and is not recoverable.

Unique assessment

Laboratory:

Laboratory work (TL) (20% of the grade). Attendance at laboratory sessions is mandatory, as well as handing in reports if required by the teacher. The TL grade will be graded between 0 and 10.

Exams:

A final test (PF), which will consist of an examination of the entire syllabus of the subject. This will take place on the day that the students of the continuous assessment take the second part. The Final Test (PF) will be graded between 0 and 10.

Qualifications:

The final grade of the student who opts for continuous assessment, before and after the recovery, will be calculated according to:

NF = 0.20 TL + 0.8 PF.

To pass the subject per course, you must obtain an NF greater than or equal to 5.0.

Students who do not pass the subject by year:

If the NF does not reach 5, the student has another chance to pass the subject by means of the make-up exam.

The student's new qualification will replace the PF of the previous formula. The TL grade cannot be recovered.

To pass the subject with recovery, the student must meet the same requirements as to pass the subject by course.

If it is detected copying a student will be urged to leave the classroom with the consequence of a failure in the subject.

During written tests, mobile phones or any communication system must be disconnected and stored in bags or backpacks. The use of these devices is strictly prohibited. In the case of detecting that a student contravenes these instructions will be expelled from the exam and / or test with the consequence of a failure in the subject.

Attention:

The student who is involved in an incident that may have serious consequences on safety may be expelled from the laboratory and suspend the subject

Assessment Activities

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

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