COURSE DATA

Data Subject	
Code	36464
Name	Electroquímica
Cycle	Grade
ECTS Credits	4.5
Academic year	2018 - 2019

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	Second term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	15 - Physical Chemistry Applied	Optional

Coordination

Name	Department
VICENTE PEDROS, FRANCISCO	315 - Physical Chemistry

SUMMARY

The program is divided into six topics in which the most used electrochemical techniques are studied, some electrode processes in cells of current interest and the design and characterization of technological materials. Throughout the course we introduce examples of electrochemical reactions and electrode processes of professional interest: electrosynthesis of drugs, conductive polymer electrosynthesis, hydrogen, oxygen and chlorine electrogeneration, electrochromic processes, anodizing, galvanizing, surface metallization, electrocatalysis, electrodialysis, cataphoresis of paints, anodic dissolution of metals, decontamination of wastewater,

corrosion of technological metals, accumulation of charges in batteries and condensers, and also some bioelectrochemical processes.
Initially, general concepts about laboratory electrochemical techniques are described. Current intensity is introduced as a kinetic magnitude and the electrical potential as a thermodynamic magnitude. In the second topic, the transport of species in cells associated with electrochemical and mechanical gradients is analyzed, introducing the measure of electrical resistances associated with the transport of loaded species in solids and solutions. In the third topic an introduction to the electrochemical kinetics is made, focusing on the interpretation of the electron transfer stages from a molecular perspective, while in the fourth topic insists on the study of electrodes to complete the previous knowledge about processes in cells. The fifth

topic introduces electrochemical impedance spectroscopy as an example of electrochemical technique useful for the design and characterization of materials and electrode processes, analyzing the relationship between the perturbation caused by applying alternating current to cells and their electrical response, while that in the sixth theme the application of the contents of the previous topics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Related with all the disciplines with the following contents: Structure, Stoichiometric calculations. Balances of mass and energy. Basic knowledge of Physics and Mathematics, Macroscopic Thermodynamics and Statistical Thermodynamics, Kinetic and Interficial Phenomena.
Basic knoweldge of Physical Chemistry, Analytical Chemistry, Organic Chemistry and Inorganic Chemistry

OUTCOMES

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.
- Demonstrate knowledge of the characteristics and behaviour of the different states of matter and the theories used to describe them.

- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles of quantum mechanics and their application to the description of the structure and properties of atoms and molecules.
- Show knowledge of the metrology of chemical processes including quality management.
- Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.
- Show knowledge of the structure and reactivity of the main classes of biomolecules and the chemistry of the main biological processes.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Evaluate, interpret and synthesise chemical data and information.
- Handle chemicals safely.
- Handle the instrumentation used in the different areas of chemistry.
- Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.
- Evaluate the risks in the use of chemicals and laboratory procedures.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Develop sustainable and environmentally friendly methods.
- Relate chemistry with other disciplines.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES

At the end of the course, the student must be able to:
• Relate the knowledge of Electricity with those of Chemistry.
• Relate knowledge of chemical reactions with those of electrochemical reactions.
• Perform calculations from the measurement of electrical quantities of electrochemical processes, to relate them with other physical magnitudes of scientific or technological interest.

• Know the theoretical and practical aspects necessary to plan, apply and manage the most appropriate electrochemical methodology to address problems of industrial nature and environment.
• Have scientific criteria to apply electrochemical techniques to Electrosynthesis, Electroanalysis, design and characterization of materials.
• Understand the basics of electrical energy accumulation devices, electrophoresis processes, electrochemical metal deposition, electrochemical wastewater treatment and fuel cells.
• Understand the processes of metallic corrosion and propose measures for their inhibition.
• Prepare and present monographic works, individually and in groups on the contents of the previous topics.

DESCRIPTION OF CONTENTS

1. OVERVIEW OF ELECTROCHEMISTRY

1.1. Electrochemical techniques.
1.2. Faradic and non-faradic processes.
1.3. Equivalent electrical circuits.
1.4. Charge current and detection limit.
1.5. Dimensional analysis and units.

2. TRANSPORT IN ELECTROCHEMICAL CELLS

2.1. Nerst-Planck equation.
2.2. Ionic conductivity in solutions.
2.3. Transport through membranes.
2.4. Electric percolation.
2.5. Ohmic drop effect.

3. ELECTRON TRANSFER

3.1. Voltammetry of electroactive thin films.
3.2. Butler-Volmer equation.
3.3. Tafel equation.
3.4. The symmetry parameter.
3.5. Simulation of voltammograms and chronoamperograms.

4. ELECTRODES

4.1. Potentials of Galvani and Volta.
4.2. Theory of the electrochemical potential.
4.3. Physical significance of the electrode potential of the first type.
4.4. Electrodes of the second type, redox, and gases.
4.5. Types of working electrodes.

5. ELECTROCHEMICAL IMPEDANCE ELECTROCHEMISTRY

5.1. Introduction to alternating current.
5.2. Electrochemical impedance spectroscopy.
5.3. Representations of Nyquist, Bode and Cole-Cole.
5.4. Equivalent circuits as analogs of electrode processes.
5.5 Applications to the design and characterization of materials.

6. OVERVIEW OF THE APPLIED ELECTROCHEMISTRY

6.1. Surface treatments.
6.2. Storage of electrical energy.
6.3. Fuel cells.
6.4. Electrochemistry and Environment
6.5. Corrosion.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	38,00	100
Tutorials	7,00	100
Development of group work	10,00	0
Development of individual work	10,00	0
Study and independent work	37,50	0
Preparation of evaluation activities	10,00	0
TOTAL	112,50	

TEACHING METHODOLOGY

The development of the course is structured around three axes: the theoretical-practical classes, the seminars and the realization of activities in the non-contact hours. As for the first ones, they will offer a global vision of the treated topic and will affect those key concepts for understanding. Likewise, it will be indicated the most recommendable resources for the subsequent preparation of each topic in depth. In some face-to-face sessions the student will be explained a series of problems of applications of the theoretical concepts and other sessions, however, the protagonism will pass completely into the hands of

the student. Regarding the group tutorials, the teacher will guide the student on all the elements that make up the learning process, both in terms of general issues and specific issues. Also, the student will receive a list of additional activities that will serve to strengthen their knowledge and exercise in each of the aspects discussed in class sessions. The student must submit resolved the activities and works that the professor indicate throughout the course.

EVALUATION

The students' learning will be evaluated in the first call considering three different contributions.
In the first place, there will be a continuous evaluation of the progress and activities developed throughout the course, which will be based on the measure of the issues and problems delivered to the students and in the work done in the tutoriial sessions. the numerical rating value in this section will constitute 40% of the final grade.
An additional 10% will be obtained by carrying out and presenting one or more monographic works.
Finally, the third contribution will correspond to the individual answer on the knowledge acquired in evaluation tests and a final exam that will rebound with 50% to the final grade.
In each of the parts must be rated with a grade of 4/10 to average the final overall grade.

REFERENCES

Basic

- Electrochemical Methods: Fundamentals and Applications, A.J. Bard, y A.R.N Faulkner, Ed. Wiley, ISBN 97811183112803 (1980).
- Electrochemistry, P.H. Rieger, Ed. S. Springer, ISBN 9789401106917 (1994).
- Guía de Electroquímica. F. Vicente. Ed. Gómez Coll, ISBN 8493226653 (2001).

Additional

- Fundamentos de la Electroquímica Teórica, B.B. Damaskin, y O.A. Petri, Ed. Mir, ISBN mkt00000252321 (1981).
- Materiales y Procesos Electródicos. Varios autores. Coordinado por F. Vicente. Ed. INSDE, ISSBN 8460753603 (2002).
- Aplicabilidad de la Microbalanza de Cuarzo, F. Vicente, J. Navarro, J.J. García, D. Benito, H. Perrot, D. Giménez. Ed. Gómez Coll. ISBN 8469941771 (2001).