COURSE NAME

Applied Physical Chemistry with Laboratory

CONTACT INFORMATION

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COURSE CONTENT AND INTENDED LEARNING OUTCOMES (ILOs):

Ionics and Electrodics. Batteries and Corrosion. Lab. experience:
Electrochemical conversion of chemical energy into electrical energy: batteries and fuel cells.
Thermodynamics and kinetic of corrosion, the galvanic element in short circuit, corrosion prevention.
Lab. experiences: Structural and electrochemical characterization of materials

Aims of the lectures (5 CFU) are to supply the student with base knowledge about the physical chemistry of ionic conductors and the electrochemistry and its application in the energy conversion by electrochemical devices and in corrosion and protection of metals.
The lab part (3 CFU) is devoted to the characterization of functional materials. In the lab, FT-IR, XRPD, electrochemical and spectroelectrochemical techniques will be used.
At the end of the course, the student will be able to:

- recognize the main devices and interfaces in electrochemistry, describing the chemical-physical aspects underlying their thermodynamic and kinetic properties.
- design and implement structural and functional characterizations of materials

Aligning with the EIT OLOs:

1 = peripherally relevant to the course content; 2 = highly relevant to course content.

- ☐ EIT OLO 1 - Making value judgments and sustainability competencies
- ☐ EIT OLO 2 - Entrepreneurship skills and competencies
- ☑ EIT OLO 3 - Creativity skills and competencies - 1
- ☑ EIT OLO 4 - Innovation skills and competencies - 1
- ☑ EIT OLO 5 - Research skills and competencies - 2
- ☐ EIT OLO 6 - Intellectual transforming skills and competencies
- ☐ EIT OLO 7 - Leadership skills and competencies

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework Programme for Research and Innovation

Description of how the course covers the EIT OLO(s) and EIT Thematic Areas

The opportunity of joining lectures to a focused experimental activity in laboratory is used to create the conditions for developing research skills and personal creativity in the application of the acquired knowledge (**OLO 3**, **OLO 5**). The proposed topics are then centered on current applicative aspects of electrochemistry and related materials for stimulating innovative ideas and proposals (**OLO 4**). The course partially falls into the **EIT Thematic Area No. 6**: "Design of products and services for circular economy".

ASSESSMENT METHODS AND GRADING SYSTEM

Oral exam to verify the student knowledge about the fundamental concepts and their applications.
For each lab experiences, the students will prepare a scientific paper which will be judged regarding the internal coherence, the scientific correctness and the quality of the results, similarly to the review of a scientific paper on applicative topics, so as to evaluate both the skill in applying the acquired knowledge for solving a real technological problem (**OLO 3**), and the creativity in re-elaborating the proposed models to novel systems close to frontier research (**OLO 4**, **OLO 5**).
The final score will be the weighted average of the two scores

The grades in the Italian university system are expressed out of **30.** The passing grade is **18/30**.

ASSESSMENT METHOD	WEIGHT ON FINAL GRADE
Lab Class participation	5%
Lab / written outputs	35%
Oral exam	60%

COURSE SESSIONS

Session 1	INTRODUCTION TO THE COURSE
Content	• Fundamental aspects, • Development, • The relation of electrochemistry to other sciences.

Session 2	IONICS
Content	• Ionic conductors, • Ion-solvent interaction, • Ion-ion interaction and Debye-Hückel theory, • Diffusion, migration and conductivity, • Solid state crystalline electrolytes, • Polymer electrolytes.

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Session 3	Electrodics
Content	• Electrochemical potential, • Double-layer theories, • Electrochemical thermodynamics and Nernst law, • Electrode types, • Electron transfer at the interface and overpotential, • Charge transfer overpotential and Tafel law, • Diffusion overpotential and limiting current.

Session 4	Corrosion
Content	• Thermodynamics and kinetic of corrosion, • Galvanic element in short circuit, • Corrosion prevention.

Session 5	Electrochemical energy storage and conversion
Content	• Batteries, • Fuel Cells.

Session 6	FINAL EXAM
Date - hours	At least 7 exam sessions in the academic year, as reported in the published schedule accessible to all students.
Content	Oral exam on the program, with discussion of the evaluated written report on the laboratory activity

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