UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

## Physical Chemistry Applied

**2425-3-E2702Q099**

### Aims

D1 - KNOWLEDGE AND UNDERSTANDING ABILITY
At the end of this formative activity, the student will have to demonstrate to be able to:
1 Describe the ionic transport processes in solution and in simple solid state systems
2 Describe the basic principles of conductivity in solution
3 Describe the basic principles of electrochemistry in solution

D2 - ABILITY TO APPLY KNOWLEDGE AND UNDERSTANDING
At the end of this formative activity, the student will have to demonstrate to be able to:
1 Determine the ionic transport properties in simple systems
2 Use the laws of Fick
3 Understand and use the Nernst and Butler-Volmer equations
4 Understand and use the concepts of migration and diffusion.

D3 - AUTONOMY OF JUDGMENT
At the end of this formative activity, the student will have to demonstrate to be able to:
1 Choose the most useful techniques for the analysis of transport properties in solution and in simple state solid systems

2 Apply the concepts of conductivity and electrochemistry to the study of devices of technological interest

D4 - COMMUNICATION SKILLS
Knowing how to describe in a clear and concise written form, and to present orally the objectives, the procedure and the results of the processes carried out.

D5 - LEARNING SKILLS
Expected results:
1 Collect and understand new information useful for rationalizing transport and electrochemical properties

2 Collect and understand information about the technological evolution of electrochemical devices of technological interest, such as batteries and fuel cells.

## Contents

Ionic conductors: ion-solvent interaction, ion-ion interaction and transport properties.

Fundamentals of Electrodics: electrochemical thermodynamics and kinetics.

Applications to electrochemical devices.

## Detailed program

Fundamental aspects, development and the relation of electrochemistry to other science. Ionic conductors: ion-solvent interaction, ion-ion interaction and Debye-Hückel theory; diffusion, migration and conductivity; solid state electrolytes. Fundamentals of Electrodics: electrochemical potential, double-layer theories and adsorption phenomena; electrochemical thermodynamics and Nernst low, electrode types; electron transfer at the interface and overpotential, charge transfer overpotential, exchange current, symmetry factor, Butler Volmer equation and Tafel low, diffusion overpotential and limiting current, other kinds of overpotential.

Electrochemical applications.

## Prerequisites

Standard physics and mathematics knowledge. Basic chemical thermodynamics and kinetics.

## Teaching form

14 two-hour lectures, in person, Delivered Didactics

## Textbook and teaching resource

Slides

Bockris Reddy, Modern Electrochemistry 1 – Ionics (second edition)

Bockris Reddy Gamboa-Aldeco, Modern Electrochemistry 2A – Fundamental of Electrodics (second edition)

Bard Faulkner: Electrochemical Methods, Fundamental and Applications (2° Edition)

## Semester

first semester

## Assessment method

1. there are no ongoing tests;

2. Verification of the learning of the results expected from the D1-D5 descriptors is carried out through an interview, during which the student is asked at least two questions on different parts of the program (conductimetry, electrochemistry). The interview, in addition to ascertaining the acquisition of disciplinary knowledge and skills, will tend to verify the student's critical analysis skills, independent judgment and expository skills;

3. The final grade, which refers only to the interview, is graded according to the following criterion:
   18-20: preparation on a limited number of topics present in the course program, with limited discussion and analysis skills that emerge only following the help and questions of the teacher; expository skills and vocabulary not always correct, limited critical processing skills;
   21-23: preparation on some of the topics in the course program, ability to independently analyze only purely practical and executive issues, use of correct vocabulary even if not entirely accurate and clear and an at times uncertain expository ability;
   24-27: preparation on a large number of topics covered in the course program, ability to independently carry out argumentation and critical analysis, ability to apply knowledge to contexts and connect themes to concrete cases, use of correct vocabulary and competence in the use of disciplinary language;
   28 – 30: complete preparation on the topics in the exam program, personal ability to independently discuss and critically analyze topics, ability to reflect and connect themes to concrete cases and different contexts, ability to think critically and independently, mastery of disciplinary vocabulary and a rigorous and articulated expository ability, ability to argue and reflect, ability to connect to other disciplines;
   30L: complete and exhaustive preparation on the topics in the exam program, personal ability to deal autonomously and critically analyze the topics, ability to reflect and self-reflect and to connect the topics to concrete cases and different contexts, excellent ability to think critically and autonomously, full mastery of the disciplinary vocabulary and a rigorous and articulated ability to present, ability to argue, reflect and self-reflect, ability to connect to other disciplines.

## Office hours

By appointment

## Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | SUSTAINABLE CITIES AND COMMUNITIES | CLIMATE ACTION