UCLouvain

lmapr2231 — Metallurgical and electrochemical processes

2025

The version you're consulting is not final. This course description may change. The final version will be published on 1st June.

5.00 credits	30.0 h + 22.5 h	Q2

Teacher(s)	Proost Joris ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	LFSAB1101, LFSAB1102, LFSAB1201, LFSAB1202, LFSAB1301, LFSAB1401, LFSAB1302, LMAPR1310
Main themes	A first part of the course provides an introduction to electrochemical processes, based on previously developed concepts in chemical thermodynamics. The course starts with a description of aqueous, ionic solutions. Next, quantitative expressions are derived that establish the conditions of electrochemical equilibrium for redox reactions occurring at electrode surfaces. Finally, it is explained how, based on the concept of overpotential, classical rate theory can be applied to describe the kinetics of charge transfer at electrodes. Some typical current-potential regimes are discussed, as well as relevant technological applications. In a second part, both the chemical and the electrochemical thermodynamic and kinetic principles will be applied to the processing and the chemical stability of inorganic materials. Most materials in use by mankind are indeed unstable relative to their environment. It is shown that, for understanding and describing this chemical (in)stability, the same thermodynamic and kinetic principles can be used as the ones governing their metallurgical extraction (corrosion is merely metal extraction in reverse). Specific attention will be given in this part to the construction and interpretation of relevant metallurgical engineering diagrams.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **Contribution of the course to the program objectives** Having regard to the LO of the programme "Bachelor in Engineering", this activity contributes to the development and acquisition of the following LO : • AA1.1, AA1.2 • AA2.3, AA2.6, AA2.7 • AA4.1, AA4.2, AA4.3 **Specific learning outcomes of the course** More specifically, with respect to the disciplinary LO, the student at the end of the course will be able to : • determine, based on thermodynamic equations and diagrammes, the appropriate operating conditions to produce a metal from its oxidised form, either by reduction in a gaseous atmosphere, or electrochemically in an aqueous medium ; • identify and derive mass and energy balances for such a process ; • apply the principles of electrochemical kinetics to understand a number of technological applications (corrosion, electrodeposition, fuel cells). Transversal Learning Outcomes Students will also be able to complete an elaborate exercise as a written examination under time constraint, as well as explain in their own words a theoretical concept during a final examination.
Evaluation methods	vol 1 : Examination during exam session. The exact modalities will be communicated in due time (50%) vol 2 : Mandatory lab report (25%) & HSC test during the year (25%) The subject matter of the examination includes everything said or shown in class orally, on screen or using other media, and is therefore not limited exclusively to the "course material". Volume 2 will be assessed on the basis of assignments, for which a single overall mark will be awarded. Failure to comply with the methodological instructions, particularly with regard to the use of online resources or collaboration between students, for any assignment will result in an overall mark of 0 for volume 2.

Teaching methods	vol 1 : Classical courses vol 2 : 2 mandatory electrochemical lab sessions + 5 to 6 exercise sessions using thermodynamic HSC software This course also addresses issues related to sustainable development and transition through the following activities: - practical work (laboratories) on the electrochemical production of H2 via the electrolysis of water and its subsequent use in fuel cells. In the explanatory note for the labs, students are given more details on the role of green H2 in the energy transition. During the writing of their lab report, they are also invited to think about improvements to the H2 production and fuel cell process to reduce energy consumption. - exercise sessions demonstrating quantitatively how and by how much CO2 emissions from metallurgical processes can be reduced
Content	Part 1 : Metallurgical processes : • Ellingham, Kellogg and Chaudron diagrams, for predicting high temperature reactivity of inorganic materials in gaseous environments ; • Applications : the relative stability of oxides, the working principle of a blast furnace; Part 2 : Electrochemical processes : • description of ionic solutions and ion-solvent interactions (Debye-Hückel) ; • structure of electrified interfaces (double layer, zeita-potential) ; • electrochemical free energy change (Nernst) ; • Pourbaix diagrams, for predicting low temperature reactivity of inorganic materials in aqueous solutions ; • overpotentials and electrode kinetics (Butler-Volmer, polarisation curves) ; • electrochemical reactions and processes (electrodeposition, corrosion, water electrolysis, fuel cells)
Faculty or entity in charge	FYKI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemical and Materials Engineering	KIMA2M	5		🔍