

PONTIFICIA UNIVERSIDAD CATÓLICA DE CHILE
COLLEGE OF ENGINEERING
DEPARTMENT OF MINING ENGINEERING
ABET COURSE SYLLABI
IMM2053 METALLURGICAL PROCESSES

Credits and contact hours:	10 UC credits / 10 hours (3 h. Lectures and 7h. Independent learning experiences)
Instructor's name:	Álvaro Videla
Course coordinator's name	Álvaro Videla
Textbook:	Extractive Metallurgy of Copper, Davenport, King, Schlesinger and Biswas, 2002. Hydrometallurgy, Esteban M. Domic, 2001.
Course Catalog Description:	This course assumes that the student is familiar with different ore types and minerals commonly found in industrial processes, and with physical separation mechanisms carried out to reach a reasonable concentration to continue with chemical separation methods for the final extraction of the valuable metal.
Prerequisite Courses:	QIM100 General chemistry, IMM2003 Mining geology and IMM2023 Mineral Processing.
Co-requisite Courses:	None
Status in the Curriculum:	Required
Course Learning Outcomes:	<ol style="list-style-type: none">1. Describe, analyze and use thermodynamic variables involved in metallurgical processes.2. Identify, analyze and evaluate every internal variables related to any stage of the leaching extraction process and pyrometallurgical processing.3. Identify advantages and disadvantages of available technologies for copper and gold mining, and shallowly evaluate new technologies on the way.4. Understand and describe every chemical processes implicated in any industrial processes involving chemical reactions
Relation of Course to ABET Criteria:	<ol style="list-style-type: none">a. Knowledge of mathematics, science and engineeringb. Design and conduct experiments: analyze and interpret datac. Design a system, component, or processd. Multidisciplinary teamse. Identify, formulate, and solve engineering problemsf. Professional and ethical responsibilityg. Effective communicationh. Broad education necessary for global, economic, environmental and societal contextj. Knowledge of contemporary issues

k. Techniques, skills, and modern tools for engineering practice.

Topics covered:

1. Introduction

Metallurgical process characteristics.

Industrial process flow.

Description of extraction unitary operations.

Leaching, Solvent Extraction and Electrowinning operations.

Smelting, Converting and Electrorefining operations.

2. Process in aqueous solution – Hydrometallurgy

Introduction to chemical metallurgy in aqueous media.

pH and chemical stability; Electrochemical Reactions; Nernst's equation; Eh-pH diagrams; Speciation Diagrams

Kinetics in aqueous media

Equilibrium and reversibility

Kinetic Models - Shrinking Core Model

Metal leaching

Principles of gold leaching

Principles of secondary oxides and sulphides copper ore leaching

Percolation and Hydrology in heap leaching

Selective concentration basics

Carbon Adsorption

3. Selective recovery basics - Electrometallurgy

Electrochemistry - Butler-Volmer's Kinetic Theory

Electro-refining

Electro-winning

4. High Temperature Processing - Pyrometallurgy

Thermodynamic elements in Metallurgy.

Energy concepts: Thermic energy and enthalpy.

Free energy: Gibbs-Helmholtz' equation.

Chemical equilibrium.

Thermodynamic solutions.

Free energy calculations and Ellingham diagrams.

Phase diagrams.

Reactors' type for solid/gas reactions.

5. Sulphide smelting and conversion.

Detailed flow of copper smelting.

Study of principal chemical reactions.

Mass and energy balances.

Phase diagrams applied to matte and slag production.

Technologies for copper smelting

Suspension

Technologies for copper conversion stage

6. Effluent Treatment and Control (SO₂)

Other process

Concentrate drying, calcination and roasting

Fire refining

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