



# NATIONAL UNIVERSITY OF ENGINEERING COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

## METALLURGICAL ENGINEERING PROGRAM

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### ME422 EXTRACTIVE PROCESSES I

#### I. GENERAL INFORMATION

<b>CODE</b>	: ME422 Extractive Processes I
<b>SEMESTER</b>	: 7
<b>CREDITS</b>	: 4
<b>HOURS PER WEEK</b>	: 6 (Theory, Practice, Laboratory)
<b>PREREQUISITES</b>	: ME320 Metallurgical Basics I
<b>CONDITION</b>	: Compulsory
<b>DEPARTMENT</b>	: Metallurgical Engineering

#### II. LEARNING UNITS

##### 1. PYRO-METALLURGY. ROASTING OF SULFURS

Importance of pyro-metallurgy in human development. Characteristics of conventional pyro-metallurgy and factors that affected its change. Modern pyro-metallurgy. Main characteristics. Autogenous processes and oxygen consumption. Examples for copper and lead metals. Calcination processes. Sulfurs roasting. Roasting thermodynamics. Main reactions. Kinetics of solid-gas reactions. Mathematic models of roasting reactions. Unreacted core model. Complete conversion model.

##### 2. CONTROLLING STEP. OXIDES REDUCTION

Reaction controlling step. Variables affecting different controlling steps. Reaction systems for roasting reactions. Examples of different types of roasting. Oxides reduction. Thermodynamics of oxide reduction. Main reducer systems and their characteristics. Kinetics of iron and lead minerals reduction. Reduction systems with and without load fusion.

##### 3. FUSION AND CONVERSION OF COPPER MATTES. FUSION TYPES

Fusion and conversion of copper mattes. Thermodynamics of the fusion of copper and iron mattes. Cu-Fe-S-O-SiO<sub>2</sub> diagrams for the thermodynamic analysis of fusion and matte conversion processes. Other fusion processes. Fusion types. Lightning fusion and bath fusion processes. Main reaction systems. Removal of impurities in conversion stage. Integral balance of a fusion-conversion process.

##### 4. PYRO-METALLURGIC REFINING. METAL VOLATILIZATION

Pyro-metallurgic refining. Thermodynamic approach to copper, lead and tin pyro-refining processes. Relevant characteristics of pyro-refining processes. Kinetics of pyro-refining processes. Metals volatilization. Thermodynamics of volatilization processes. Volatilization

processes for primary metal recovery. Secondary metal recovery processes. Metal refining processes. Kinetic of volatilization processes. Copper, tin and titanium volatilization processes.

### **5. METALLURGIC POWDER AND GAS RECOVERY. INTEGRATED FLOW DIAGRAMS**

Nature and characteristics of metallurgical powder appearing in different processes. Volatilization powder and transport dust. Powder recovery systems. Strategies for the recovery of sulfur in minerals. Extractive processes and environmental pollution. Integrated flow diagrams. Flow diagrams for copper, lead, zinc, tin, iron, etc.

### **6. MASS AND ENERGY BALANCE**

Balance of mass and energy using software. Analysis of quantitative data of most relevant integrated processes. Pyro-metallurgic extractive processes and environmental quality standards. Air pollution. Case analysis: copper, lead, zinc and tin industries.

## **III. LABORATORY AND PRACTICE EXPERIENCE**

Laboratory 1. Calcination processes

Laboratory 2. Thermal decomposition of sulfates and nitrates

Laboratory 3. Synthesis of metal nano-particles

Laboratory 4. Metal obtaining using organic reducers

Laboratory 5. Mass and thermal balance

Laboratory 6. Refining processes