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

METALLURGICAL ENGINEERING PROGRAM

ME321 – MINERALS AND MATERIALS PROCESSING I

I. GENERAL INFORMATION

CODE	**:**	ME321 Minerals and Materials Processing I
SEMESTER	**:**	6
CREDITS	**:**	4
HOURS PER WEEK	**:**	6 (Theory–Practice)
PREREQUISITES	**:**	GE323 Descriptive Mineralogy, MA311 Statistics
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

The course prepares students for the understanding and analysis of mineral classification processes, mineral surface physical-chemical properties, interface electrical phenomena, minerals flotation, and solid-liquid separation. Students solve diverse engineering problems related to mineral processing at laboratory scale and industrial plants.

III. COURSE OUTCOMES

At the end of the course, students:

1. Recognize minerals classification as a probabilistic process, classification can be done with sieves and mechanical or hydraulic classifiers.
2. Analyze and interpret the influence of surface physical-chemistry properties in the flotation of minerals, studying interfaces derived from physical states of materials.
3. Carry out and analyze mineral concentration processes by flotation, and select reagents and flotation equipment.

IV. LEARNING UNITS

1. CONCENTRATION METHODS AND PROCESSES

Requirements for designing mineral treatment plants / Mineralogical characterization / Determination of mineral properties and their relationship with concentration processes / Required equipment / Concentration plant design and process diagram / Knowledge and systematization of process design, process limitations and separation methods / Mineralogy.

2. SELECTION OF OPERATIONS AND PROCESSES

Preliminary comparison of results in the selection of processes for treatment of minerals of high economic value and treatment of minerals of low economic value / Determination of sampling errors in design stages, its quantitative definition and optimal design / Analysis of variance and Gy equation / Balance in closed circuit, determination of integral closing errors including sampling, analytical errors and their impact on each metallurgical parameters determined in balance / Simulation models with nodes closing balances / Use of Lagrange multipliers for results correction and balance sheet.

3. METHODS AND PROCESSES OF MINERAL PREPARATION

Procedures for minerals selection including sifting, classification and reduction of sizes, agglomeration and complementary hydrometallurgical processes / Circuits of washing treatment of minerals with high content of fines and high humidity / Design of circuits of crushing and design of conventional crushing, including three stages with sifting for secondary crushing with sifts of double floor in open circuit and closed circuit, and for the tertiary crushing with simple floor shaker or alternatively double floor shaker / Dimensioning of processes equipment by the use of conventional methods, meeting normal design

protocols for balance and equilibrium, as well as considering contingencies and attrition of main components / Sizing of pumps for hydrocyclones feeding / Determination of Re and rheological parameters.

4. **EQUATION FOR SIZE REDUCTION. CORRECTION FACTORS**
   Bond equation / Charles law / Comparison of results / Determination of correction factors for the design of conventional balls and bars mills, as well as incorporating diaphragms / Efficiency of energy conversion total in size reduction including HCRM / Conventional milling circuit dimensioning, design in closed circuits, determination of operating parameters of each mill / Circulating loads / Sizing of hydrocyclones and determination of optimal operation conditions / Metallurgical balance in closed circuit / Efficiency / Tromp curves and comparison with stack sizers of high frequency vibration sifts.

5. **DESIGN OF PRECONCENTRATION CIRCUITS FOR TREATMENT OF LOW-GRADE MINERALS**
   Methods of gravimetric concentration, comparing JIG and HMS / Separation criteria and definition of treatable particle size limits on individual equipment / Magnetic separation and separation criteria of high and low intensity in both dry and humid environments / Limit of particle size to be applied in each separator / Results of application at laboratory and industrial scale / Reagents for flotation / Use of stabilizers to minimize oxidation by consumption reduction / Selective flotation.

6. **DESIGN OF FLOTATION CIRCUITS**
   Conversion of time of batch process to time of continuous processes / Application of closed laboratory tests / Short cut probability in flotation processes. / Solid-liquid separation in final and intermediate products using conventional, high consistency and conical thickeners / Alternative design methods / Method of Coe & Clevenger / Pilot tests, limitations and suitability / Properties of thickeners / Filtration with vacuum and ceramic filters, as well as air compressed filters, ranges of application / Chemical extraction of Cu, Au and Ag, combined processes LPF and lixiviation-flotation. Design of treatment processes.

V. LABORATORY AND PRACTICAL EXPERIENCES

Session 1: Preparation of minerals and Bond equation for size reduction.
Session 2: Pre-concentration for mineral treatment.
Session 3: Flotation kinetics.
Session 4: Design of flotation circuits, and conversion of flotation times from batch to continuous processes.

VI. METHODOLOGY

The course takes place in theory, practice and laboratory sessions. In theory sessions, faculty presents concepts, laws and applications. In practice sessions, various problems are solved and their solution analyzed. In laboratory sessions students carry out experiments on minerals processing methods. At the end of each laboratory experience, students present a report summarizing main findings, results and conclusions. Student's active participation is promoted throughout the course.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + EF + PP) / 3

EP: Mid-term Exam EF: Final Exam
PP: Average of Practical and Laboratory Works

VIII. BIBLIOGRAPHY

1. MULAR, Doug Halbe & BARRATT, Derrek.
   Mineral Processing Plant Design, Practice and Control. 2009.
2. D.FUERTENAU, Maurice.
   Principles of Mineral Processing, SME.