# NATIONAL UNIVERSITY OF ENGINEERING
# COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING
# CHEMICAL ENGINEERING PROGRAM

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# PI146 – OPERATIONS IN CHEMICAL ENGINEERING

## I. GENERAL INFORMATION

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| **CODE** | **:** | PI146 Operations in Chemical Engineering |
| **SEMESTER** | **:** | 8 |
| **CREDITS** | **:** | 3 |
| **HOURS PER WEEK** | **:** | 4 (Theory, Practice, Laboratory) |
| **PREREQUISITES** | **:** | PI142 Momentum Transfer |
| **CONDITION** | **:** | Compulsory |

## II. COURSE DESCRIPTION

The course prepares students for the understanding and analysis of solid-solid, solid-liquid and solid-gas systems, their properties and applications for the concentration and separation of minerals and biological products. Students learn and apply criteria for selecting and dimensioning equipment used in unit operations applied in the treatment and processing of particle systems. Students carry out experimental work, as well as visit chemical plants to analyze the performance of different separation processes common in industry.

## III. COURSE OUTCOMES

At the end of the course, students:

1. Understand and analyze metal characteristics and properties applicable to mineral processing and treatment.
2. Understand granulometric and sifting operations and analyze the most important variables and parameters affecting their performance.
3. Understand milling and grinding operations, their more relevant variables, and size and select milling systems and equipment.
4. Understand floating operations, their more relevant variables, and size and select floating systems and equipment.
5. Understand and analyze solid-liquid transportation systems, analyzing pipeline requirements, as well as pressure drop and flow behavior.
6. Understand and analyze magnetic and electrostatic separation process and lixiviation process applied to mining and industry operations.

## IV. LEARNING UNITS

### 1. FUNDAMENTALS

Raw materials / Mineral and biological resources / Unit operations / Metal and non-metal mass / Ore preparation: Samples, Metallurgical balance.

### 2. MINERAL CHARACTERISTICS

Color and shining / Hardness and fragility / Tenacity / Particle size / Structure / Specific gravity / Electrical conductivity / Magnetism / Fluorescence / Radioactivity / Form factor / Repose angle.

### 3. GRANULOMETRIC ANALYSIS AND SIZE DISTRIBUTION

Generalities / Sieving / Standard series / Gates-Gaudin-Shuhmann distribution function / Rosin-Rammler / Three representative parameters.

### 4. SIFTING

Generalities / Sieve types / Sieving operating variables / Vibrating sieves / Optimization / Sieve dimensioning.

5. **MILLING AND GRINDING**
   Generalities / Grinding operating variables / Grinding circuit / Grinding machinery / Mill dimensioning.

6. **CLASSIFICATION**
   Generalities / Classifiers / Classifier operating curves / Classification efficiency / Hydrocyclone / Rake and helical classifiers / Selection criteria / Gravimetry / Dense means / Vibrating table / Tigs.

7. **FLOTATION**
   Generalities / Flotation equipment / Flotation reactants / Flotation circuit / Dimensioning of flotation cells.

8. **SEDIMENTATION**
   Generalities / Free sedimentation / Forced sedimentation / Thickener / Filter selection

9. **TRANSPORT OF SOLID-LIQUID SYSTEMS**
   Generalities / Solid-liquid mixtures / Transport through pipelines / Parameters affecting transport performance / Solid concentration / Critic velocity / Pressure gradient.

10. **MAGNETIC AND ELECTROSTATIC CONCENTRATION**
    Magnetic fields / Electric fields / Generation of magnetic fields / Generation of electric fields / Materials / Variables affecting performance.

11. **LIXIVIATION**
    Solid-liquid extraction / Solute extraction / Extracting sugar from beets / Metal separation from ore / Factor affecting lixiviation performance.

## V. LABORATORY AND PRACTICAL EXPERIENCES

- Visit to chemical plant 1
- Visit to chemical plant 2
- Laboratory of granulometry and sifting
- Laboratory of magnetic and electrostatic concentration
- Laboratory of lixiviation

## VI. METHODOLOGY

The course takes place in theory, practice, laboratory and plant visit sessions. In theory sessions, faculty presents concepts, methods and applications. In practice sessions, various problems are solved and their solution analyzed. In plant visit session, students analyze diverse chemical process in actual plants around Lima city. At the end of each visit, students present a report summarizing main findings 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 + PL) / 3**

EP: Mid-term Exam. EF: Final Exam.
PL: Average grade of Practice Works.

## VIII. BIBLIOGRAPHY


1. **ERROL Kelly**
   Introduction ot Mineral Processing, McGraw Hill Editorial, 2008

2. **McCABE and SMITH**
   Basic Operations in Chemical Engineering, Prentice Hall, 2010.