NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF ENVIRONMENTAL ENGINEERING

SANITARY ENGINEERING PROGRAM

AA233 – PHYSICAL CHEMISTRY I

I. GENERAL INFORMATION

CODE	**:**	AA233 Physical Chemistry
SEMESTER	**:**	3
CREDITS	**:**	3
HOURS PER WEEK	**:**	5 (Theory, Practice, Laboratory)
PREREQUISITES	**:**	AA223 Chemistry II, AA221 Mathematics II
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

The course prepares students in the application of physics and chemistry laws for analyzing processes involving physical and chemical transformations. Physical-chemical calculations methods are applied to optimize the behavior and outcomes physical-chemical processes including one-component and multi-component systems, homogeneous and heterogeneous systems, as well as electrolytic and non-electrolytic solutions. Students carry out laboratory experiences to verify theoretic developments.

III. COURSE OUTCOMES

At the end of the course, students:

1. Resolve problems applying the laws of physics and chemistry to different physical-chemical processes and verify them in the laboratory.
2. Complete kinetic and thermodynamic calculations to predict the spontaneity and speed of physical-chemical processes in order to optimize their efficiency.
3. Analyze phase diagrams to separate and purify with effectiveness the mixtures that are found in different aggregation stages.

IV. LEARNING UNITS

1. INTRODUCTION

The nature of physical-chemical sciences / The place of physical chemistry in the science system and its importance in the study of environment and industrial development / Physical-chemistry and mining / Review of thermodynamic laws.

2. PHASE EQUILIBRIUM IN ONE-COMPONENT SYSTEMS

Thermodynamics of phase transformations / Clausius-Clapeyron equation / Phase diagrams of one-component systems: water, carbon dioxide, sulfur and phosphorus.

3. HOMOGENEOUS MULTICOMPONENT SYSTEMS. NON-ELECTROLYTIC SOLUTIONS

Definition and classification of solutions / Vapor pressure of solutions / Units of multicomponent systems concentration / Chemical potential / Partial molar quantities / Criterion for phase equilibrium / Gibbs-Duhem equation / Mixture of ideal gases / Mixture of real gases / Ideal liquid solutions / Law of Raoult / Composition, vapor pressure diagrams / Positive and negative deviations of Raoult law / Henry's law / Colligative properties / Vapor pressure decrease / Boiling point increase / Freezing point decrease / Osmosis / Osmotic pressure / Non-ideal solutions / Activity and activity coefficient.

4. **PHASE EQUILIBRIUM IN MULTICOMPONENT SYSTEMS**
Gibbs's phase law / Vapor-liquid equilibrium in two component systems / Temperature-composition diagrams / Distillation / Azeotropes / Fractional distillation / Distillation of immiscible liquids / Distillation of partially miscible liquids / Liquid-liquid equilibrium in two component systems / Critical temperature of solubility / Solid-liquid equilibrium in two-component systems / Thermal analysis / Crystallization curves / Simple eutectic phase diagrams / Formation of compounds with congruent melting point / Formation of compounds with incongruent melting point / Partial miscibility in solid stage with eutectic. / Partial miscibility in solid state with peritectic / Three component systems.

5. **ELECTROLYTE SOLUTIONS**
Definition and classification of electrolytes / Colligative properties of electrolytes / Van´t Hoff factor / Arrhenius electrolytic dissociation theory / Law of dilution of Ostwald / Chemical potentials in electrolyte solutions / Debye-Hückel theory / Ionic strength / Activity and electrolyte activity coefficients / Electric conductivity of electrolyte solutions / Molar conductivity / Equivalent conductivity / Independent ion migration / Kohlrausch law / Ionic mobility / Transport numbers / Experimental methods of determination of transport numbers / Electrochemical cell / Standard electrode potentials / Thermodynamics of electrochemical cells / Nernst equation / Classification of electrochemical cells / Applications of EMF determinations / Electrolysis. / Faraday laws in electrolysis.

6. **CHEMICAL KINETICS**
Classification of kinetic reactions / Homogeneous reactions / Heterogeneous reactions / Order and molecularity of reactions / Speed constant / Analysis of kinetic results / Method of integration / Chemical average life / Differential method / Types and kinetics of compound reactions / Opposite reactions / Influence of temperature in reaction speed / Arrhenius equation / Activation energy / Pre-potential factor.

V. LABORATORY AND PRACTICAL EXPERIENCES

Laboratory 1. Phase equilibrium in one-component system
Laboratory 2. Non-electrolytic solutions
Laboratory 3. Phase equilibrium in multi-component systems
Laboratory 4. Electrolyte solutions
Laboratory 5. Chemical kinetics

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 to verify physical-chemistry theory. At the end of each laboratory experience, students present 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 + PL) / 3

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

VIII. BIBLIOGRAPHY

1. ADAMSON ARTHUR W.
   Physical Chemistry, Reverte Editorial, Barcelona, Spain.
2. ADAMSON ARTHUR W.
   Physical Chemistry - Problems and Applications, Reverte Editorial, Barcelona, Spain.
3. CASTELLAN GILBERT W.
   Physical Chemistry – Pearson Education, Spain.