NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES
CHEMISTRY PROGRAM

CQ251 – PHYSICAL-CHEMISTRY I

I. GENERAL INFORMATION

CODE	:	CQ251 – Physical-chemistry I
SEMESTER	:	3
CREDITS	:	05
HOURS PER WEEK	:	07 (Theory – Laboratory)
PREREQUISITES	:	CQ112 Chemistry II CM132 Integral Calculus
CONDITION	:	Mandatory

II. COURSE DESCRIPTION

The course prepares the student to solve the chemical problems associated with real thermodynamic gases, phases and chemical equilibrium. Likewise, the course allows the student to be guided in the study of materials, properties and applications. Problems and application experiments are developed in each of the topics of interest.

III. COURSE OUTCOMES

By the end this course the student will:

- Analyze and interpret the state variables in various models of real gases.
- Apply the laws of thermodynamics to macroscopic systems that allow describing, explaining and predicting the relations between the thermodynamic variables of a system and its environment during various physicochemical processes.
- Apply the concept of chemical potential and equilibrium to solve thermodynamic processes.
- Apply the concept of phase equilibrium to explain and predict various properties of pure substances and mixtures.

IV. LEARNING UNITS

1. **REAL GASES / 8 HOURS**
   Ideal gases: properties, laws and mixtures / Kinetics theory of gases / Real Gas: properties / Equations of states and mixtures / Dependence graphs of a real gas with temperature and pressure.

2. **FIRST LAW OF THERMODYNAMICS / 8 HOURS**
   Concept of heat / Energy and work / Thermodynamic system and its classification / State equation. Thermodynamic processes / Thermodynamic equilibrium / Properties of a system / State functions (mathematical description) / First principle of thermodynamics. Enthalpy / Heat capacity / Applications of the first law / Hess Law. Kirchoff equation.

3. SECOND AND THIRD LAW OF THERMODYNAMICS / 12 HOURS

Spontaneous and non-spontaneous processes / Second principle of thermodynamics / Entropy. Changes in the entropy of the systems. Carnot cycle / Gibbs and Helmholtz functions / Combination of the first and second law / Maxwell relations / Chemical potential of an ideal gas and a real gas / Fugacity. Compressibility factor / Third principle of thermodynamics: Nernst heat theory / Plank postulate.

4. CHEMICAL EQULIBRIUM / 8 HOURS

Spontaneity of a reaction / Chemical potential of the components of a mixture / Application of fugacities for the calculation of chemical equilibrium in real gas mixtures / Application of the law of mass action to heterogeneous systems / Principle of displacement of equilibrium de Le Chatelier - Brown / Chemical equilibrium response to certain conditions: temperature / Pressure / Catalyst. Applications: Elligan diagrams.

5. CHANGES OF STATE: PURE SUBSTANCES / 12 HOURS

Single-component systems / Clapeyron-Clausius equation. Application. Trouton rule / Solid-liquid equilibrium / Gas-liquid equilibrium / Solid –gas equilibrium.

6. CHANGES OF STATE: PHASE RULE/ 8 HOURS

Definition of phase / Components / Degrees of freedom / Gibbs phase rule / Single-component systems. Phase diagram: water / Sulfur and Phosphorus. Enantiotropies and Monotropy / Principle of correspondence and continuity / Two-component systems. Phase diagram: liquid - liquid: azeotropes / Solid-liquid: Eutectic mixture / Peritectic mixture / Three-component systems / Triangular diagrams.

V. LABORATORIES AND PRACTICAL EXPERIENCES

1. Laboratory 1: Reaction enthalpy
2. Laboratory 2: Hess's Law
3. Laboratory 3: Enthalpy of phase change
4. Laboratory 4: Enthalpy and free energy
5. Laboratory 5: Chemical equilibrium
6. Laboratory 6: Distribution coefficient
7. Laboratory 7: Binary system
8. Laboratory 8: Ternary system

VI. METHODOLOGY

The course is developed in theory sessions, qualified practices and laboratory practices. In the theory sessions, the teacher presents the concepts, definitions and applications. In the qualified practical sessions, various problems are solved and their solution is analyzed. In laboratory sessions, experiments are carried out where the concepts learned are applied. In all the sessions, the active participation of the student is promoted.

VII. EVALUATION FORMULA

Calculation of the final grade (FG):

$$FG = \frac{1 * PE + 2 * FE + 1 * PA}{4}$$

PE: Partial Exam
FE: Final Exam.
PA: Practices Average

$$PP = \frac{3 * QP + 6 * LP}{9}$$

QP: Qualified Practices
LP: Laboratory Practices

VIII. BIBLIOGRAPHY

- Levine, N. IRA. “Fisicoquímica” Volumen 1. Editorial McGraw-Hill Iberoamericana S.A. España 2004.

- Atkins P.W. “Fisicoquímica” Editorial Addison-Wesley Iberoamericana. Tercera Edición. E.U.A. 2003.

- Engel Thomas. “Química Física”. Editorial Pearson. 2006