SAGRADO
Universidad del Sagrado Corazón

SCHOOL OF HEALTH AND SCIENCES

SYLLABUS

TITLE: Physical Chemistry II

CODE: QUI 402

PREREQUISITE: QUI 401

CORREQUISITES: QUI 402L

CREDITS: 4 credits | 45 contact hours | 45 lab hours | 1 term

DESCRIPTION

The Physical Chemistry II course uses active learning methodology for Chemistry students to acquire knowledge related to thermodynamics, physical transformations of pure substances, simple mixtures, phase diagrams, chemical equilibrium, and statistical thermodynamics. It is a theoretical and practical course.

JUSTIFICATION

The course belongs to the area of general training in Chemistry, with a theoretical-experimental character related to the development of thinking skills, social responsibility, and the environment. The proposed topics allow the student to interpret the phenomena related to thermodynamics and statistical mechanics that are observed in daily life. Likewise, this course allows Chemistry students to apply this knowledge in their professional development either in the chemical industry or in scientific research.

COMPETENCES

The course develops the following competences in students:

- **Critical questioning**
- **Research and exploration**
- **Communication**

OBJECTIVES

After completion of the course, students will be able to:

1. Describe the physical and chemical processes that occur in nature applying thermodynamic laws.
2. Analyze and relate thermodynamic functions, assigning them their corresponding physicochemical meaning, when applied to the physical transformations of pure substances.
3. Express chemical potentials in terms of activity and activity coefficients in non-ideal solutions.
4. Use phase equilibrium in multicomponent systems to describe phenomena that occur in chemistry, chemical engineering, materials science, and geology.
5. Analyze the thermodynamic processes that take place in an electrochemical system such as the fuel cell and battery.
6. Deduce the macroscopic properties of matter from the properties of the molecules that make up a system using statistical thermodynamics.

CONTENTS

I. Thermodynamics
   A. Introduction
      1. Ideal gases
      2. Real gasses
   B. Thermodynamic laws
      1. First law of thermodynamics
      2. Second law of thermodynamics
      3. Third law of thermodynamics

II. Physical Transformations of Pure Substances
   A. Phase diagrams
      1. Phase stability
      2. Phase boundaries
      3. Typical phase diagrams
   B. Phase stability and transitions
      1. Thermodynamic equilibrium criterion
      2. Dependence on the stability of conditions
      3. Location of phase boundaries

III. Simple Mixtures
    A. Thermodynamic description of mixtures
        1. Partial molar property
        2. Thermodynamics of mixing
        3. Chemical potential of liquids
    B. Properties of solutions
        1. Liquid mixtures
        2. Colligative properties
    C. Activity
        1. Solvent activity
        2. Solute activity
        3. Activity of regular solutions
        4. Activities of ions in solution
IV. Phase Diagrams
    A. Phases, components, and degrees of freedom
        1. Definitions
        2. Phases rules
    B. Two-component systems
        1. Vapor pressure diagrams
        2. Temperature-composition diagrams
        3. Liquid-liquid phase diagrams
        4. Liquid-solid phase diagrams
V. Chemical Equilibrium
    A. Spontaneous chemical reactions
        1. Minimum Gibbs energy
        2. Description of equilibrium
    B. Equilibrium response to different conditions
        1. Equilibrium response to pressure variations
        2. Equilibrium response to temperature variations
    C. Equilibrium electrochemistry
        1. Semi-reactions and electrodes
        2. Cell types
        3. Applications of standard potentials

VI. Statistical Mechanics
    A. Partition function
        1. Boltzmann's distribution
        2. Interpreting the partition function
        3. The molecular partition function
    B. Thermodynamic properties
        1. Internal energy & heat capacity
        2. Entropy and Gibbs energy
        3. Statistical basis of chemical equilibrium
        4. Calculation of the equilibrium constant

LAB EXPERIENCES

A. Determination of molecular weight of volatile liquids.
B. Properties of gases: Boyle's law and Charles' law.
C. Heat lost in total and partial melting of ice and neutralization heat
D. Determination of the heat capacity of a solid
E. Determination of molecular weight - colligative properties
F. Ternary system
G. Electrolyte conductance
H. Electromotive force and concentration cells
I. Computational models in thermodynamics and thermodynamics statistics.

METHODOLOGY

The following strategies from the active learning methodology are recommended:

- Solution of a problem posed
- Literature research
- Lecture
- Phenomenon-based learning: observation, discussion, and analysis of processes, problems, or phenomena
- Collaborative learning and teamwork
- Demonstration & hands-on exercises

EVALUATION

Participation	15%
Partial assignments	30%
Compositions	15%
Final exam	20%
Immersion experience	20%
Total	**100%**

LEARNING ASSESSMENT

The institutional assessment rubric is applied to the course's core activity.

BIBLIOGRAPHY

TEXTBOOK

Atkins, P., De Paula, J., & Keeler, J. (2018). *Physical Chemistry* (11th ed.). Oxford University Press.

REFERENCES

Engel, T. (2019). *Physical Chemistry: Quantum Chemistry and Spectroscopy* (4th ed.). Pearson.

Tinoco, I., Sauer, K., Wang, J., Puglisi, J., Harbison, G., & Rovnyak, D. (2014). *Physical Chemistry: Principles and Applications in Biological Sciences* (5th ed.). Pearson.

ELECTRONIC RESOURCES

Massachusetts Institute of Technology (2020). MITOPENCOURSEWARE. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/

Scientific Research an Academic Publisher (2011-2020). Open Journal of Physical Chemistry. https://www.scirp.org/journal/ojpc/

For more information resources related to the course's topics, access the library's webpage http://biblioteca.sagrado.edu/

REASONABLE ACCOMMODATION

For detailed information on the process and required documentation you should visit the corresponding office. To ensure equal conditions, in compliance with the ADA Act (1990) and the Rehabilitation Act (1973), as amended, any student in need of reasonable accommodation or special assistance must complete the process established by the Vice Presidency for Academic Affairs.

ACADEMIC INTEGRITY

This policy applies to all students enrolled at Universidad del Sagrado Corazón to take courses with or without academic credit. A lack of academic integrity is any act or omission that does not demonstrate the honesty, transparency, and responsibility that should characterize all academic activity. Any student who fails to comply with the Honesty, Fraud, and Plagiarism Policy is exposed to the following sanctions: receive a grade of zero in the evaluation and / or repetition of the assignment in the seminar, a grade of F (*) in the seminar, suspension, or expulsion as established in the Academic Integrity Policy effective in November 2022.