1.- GENERAL INFORMATION

Learning unit	Department	Format
Physical Chemistry Lab II	Chemistry	Lab

Prerequisites (P)	Corequisites (CO)	Ascribed Academy	Module:
Physical Chemistry I	Physical Chemistry II	Physical Chemistry	M2 Chemical synthesis, purification and transformation

Type	Lecture Hours	Practice Hours	Total hours	Credits
Basic Common Mandatory	None	51	51	3

2.- GENERIC COMPETENCIES

-Problem solving
-Synthesis and analysis.
-Behavioral abilities.
-Value consolidation
- Teamwork.
-General basic knowledge
-Computer skills
-Managing information
-Oral and written production
-Discerning and decision-making
-Critical approach towards self and others.

Specific competencies:
- Autonomous development of the acquired knowledge.
-Ability to apply what is learnt to specific and complex situations.
-Autonomy and teamwork
-Ability to solve problems of specific areas.
-Ability to adapt to new situations
- Ability to generate new ideas.
-Project design and management.
-Initiative and entrepreneurship.

3.- SPECIFIC CHARACTERISTICS OF THE COMPETENCIES	
Knowledge	Students… • Understand and apply concepts of chemical equilibria. • Distinguish the type of solute in each solution depending on their chemical and colligative properties. • Solve problems related to electrochemistry involving transfer numbers, mobility and electrochemical cells.
Skills	• Use and handle lab equipment appropriately. • Apply the acquired knowledge in different fields to understand every day phenomena. • Are able to synthesize, analyze and evaluate. • Are able to use a computer.
Aptitudes	• …identify and solve problems through the formulation of hypotheses and the application of the necessary principles in an analytical and synthetic way. • … relate different knowledge of different fields and apply it in professional and ordinary situations. • …develop study habits and manage their own learning.
Values	• …develop and exercise values such as responsibility, honesty, tolerance, respect, solidarity, willingness and positive attitude towards individual and group work.

4.- TRANSVERSAL COMPETENCIES	
☐	Foreign Language (English)
☑	Critical, analytical and synthetic thinking.
☑	Oral and written expression
☑	Professional ethics
☑	Administration of human and material resources
☑	Leadership and sustainability
☐	Creativity, innovation and entrepreneurship
☐	Other

5.- COURSE CONTENT OF THE LEARNING UNIT

UNIT I. Phase equilibrium: one component's system.
1.1. Gibbs phase rule.
1.2. Equilibrium diagram.
1.3. Clapeyron equation.

1.4. Liquid-vapor, liquid-solid and solid-vapor equilibria.

UNIT II. Phase equilibrium: two or more components system.
2.1. Ideal solutions.
2.2. Ideal solutions of nonelectrolytes.
2.3. Henry's Law
2.4. Colligative properties of real solutions.
2.5. Nernst Distribution Law

UNIT III. Chemical equilibrium
3.1 Equilibrium constants of homogeneous and heterogeneous systems.
3.2 Equilibrium classification.
3.4 Liquid solutions equilibria.
3.5 Elements that affect the equilibrium constant.
3.6 Fugacity

UNIT IV. Ionic equilibrium
4.1. Liquid solutions chemical equilibrium.
4.1.1 Ideal dilute solutions equilibrium (ionic equilibrium)
4.1.2. Ideal solutions of nonelectrolytes equilibrium
4.1.3. Ideal solutions of electrolytes equilibrium
4.1.4. Reaction equilibrium in pure solids and liquids.
4.2. Equilibrium in real solutions, determination of activity and activity coefficients.
4.2.1. Ions in solution activities.
4.2.2. Activity coefficients in electrolyte solutions.
4.2.4. Debye- Hückel Law.

UNIT V. Electrochemistry
5.1. Introduction
5.1.1. Applications of electrochemistry: bioelectrochemical electrolysis, bioelectrochemistry, batteries, corrosion, fuel cells, and electrodeposits.
5.1.2. Faraday Laws
5. 1.2.1. First law of electrolysis.
5.1.2.2. Second law of electrolysis.
5.1.3. Basic concepts of electrochemistry
5.1.3.1. Electrolyte, interface, electrode- electrolyte, electrochemical cells, potential and standard potential.
5.1.3.2. Electric conductivity in solutions.
5. 1.3.3. Conductivity in an electrolytic solution.
5.1.3.4. Molar and equivalent conductivity.
5.1.3.5. Ionic mobility of transport numbers.
5. 1.3.6. Methods to determine ionic mobility.
5.1.3.7. Determination of transport number.
5.1.3.8. Relationship between ionic mobility and transport numbers.
5.1.3.9. Electrolytic solutions.

5.1.4 Electrodes
5. 1.4.1. Metal electrode
5. 1.4.2. Amalgamated electrode.
5.1.4.3. Gas electrode
5.1.4.4. Redox electrode
5.2. Reaction thermodynamics in electrochemical cells.
5.2.1. Reversibility
5.2.2. Gibbs free energy and reversibility.
5.2.3. Free Energy Minimization (FEM) and Gibbs energy of an electrochemical cell.
5.2.4. Half-cell reactions and reduction potentials.
5.2.5. Thermodynamic properties from electrochemical measurements.
5.2.6. Free Energy Minimization (FEM) and concentration.
5.2.7. Potential measurements
5.2.8. Liquid junctions

6.- ASSESSMENT

☑	Numeric Grade
☐	
☐	

7.- GRADING CRITERIA OF THE LEARNING UNIT

INDICATOR OF EVALUATION	PERCENTAGE
Departmental exams	0
Partial exam	0
Homework	20
Research activities	20
Practice reports	40
Class participation	20

8.- REQUIRED MATERIAL (for students)	
☑	Calculator
☐	Periodic table
☑	Lab coat
☐	Text book
☑	Workbook
☐	Other

9.-SPECIFIC CONTENT BY LEARNING UNITS

Content unit	Generic competency of the content unit	Topics	Class hours	Professor activities	Student activities	Bibliography
UNIT I. Phase equilibrium: one component's system			3	Professor demonstrates sublimation through a practice.	Students… review and observe	- Marón and Prutton, *Fundamentos de Fisicoquímica* Limusa -Levine. *Principios de Fisicoquímica*. 6th edition,. - Castellán. *Fisicoquímica*. 2nd edition. -Moore. *Fisicoquímica Básica*. Prentice Hall. - Jiří Bareš, Čestmír Černý, *Collection of Problems in Physical Chemistry*. Addison-Wesley. - Requena/ Bastida, *Química Física.* Alfaomega. - Keith J. Leidler, John H. Meiser, *Fisicoquímica* 1st edition, Pub cultural/Grupo Patria.

UNIT II. Phase equilibrium: two or more components system.		12	Professor… Assesses and explains the methodology	Students… Carry out practices 1, 2, 3 and 4 from the Physical Chemistry II lab workbook.	- Marón and Prutton, *Fundamentos de Fisicoquímica* Limusa -Levine. *Principios de Fisicoquímica*. 6th edition,. - Castellán. *Fisicoquímica*. 2nd edition. -Moore. *Fisicoquímica Básica*. Prentice Hall. - Jiří Bareš, Čestmír Černý, *Collection of Problems in Physical Chemistry*. Addison-Wesley. - Requena/ Bastida, *Química Física.* Alfaomega. - Keith J. Leidler, John H. Meiser, *Fisicoquímica* 1st edition, Pub cultural/Grupo Patria.
UNIT III. Chemical equilibrium		3	Professor… Assessed and explains the methodology.	Students… Carry out practice 5 from the Physical Chemistry II lab workbook.	- Marón and Prutton, *Fundamentos de Fisicoquímica* Limusa -Levine. *Principios de Fisicoquímica*. 6th edition,. - Castellán. *Fisicoquímica*. 2nd edition.

					-Moore. *Fisicoquímica Básica*. Prentice Hall. - Jiří Bareš, Čestmír Černý, *Collection of Problems in Physical Chemistry*. Addison-Wesley. - Requena/ Bastida, *Química Física.* Alfaomega. - Keith J. Leidler, John H. Meiser, *Fisicoquímica* 1st edition, Pub cultural/Grupo Patria.
UNIT IV. Ionic equilibrium		6	Professor… assesses and explains the methodology.	Students… carry out practice 6 and 7 from the Physical Chemistry II lab workbook.	- Marón and Prutton, *Fundamentos de Fisicoquímica* Limusa -Levine. *Principios de Fisicoquímica*. 6th edition,. - Castellán. *Fisicoquímica*. 2nd edition. -Moore. *Fisicoquímica Básica*. Prentice Hall. - Jiří Bareš, Čestmír Černý, *Collection of Problems in Physical Chemistry*. Addison-Wesley.

					- Requena/ Bastida, *Química Física.* Alfaomega. - Keith J. Leidler, John H. Meiser, *Fisicoquímica* 1st edition, Pub cultural/Grupo Patria.
UNIT V. Electrochemistry		6	Professor… Assesses and explains the methodology.	Students… Carry out practice 8 and 9 from the Physical Chemistry II lab workbook.	- Marón and Prutton, *Fundamentos de Fisicoquímica* Limusa -Levine. *Principios de Fisicoquímica*. 6th edition,. - Castellán. *Fisicoquímica*. 2nd edition. -Moore. *Fisicoquímica Básica*. Prentice Hall. - Jiří Bareš, Čestmír Černý, *Collection of Problems in Physical Chemistry*. Addison-Wesley. - Requena/ Bastida, *Química Física.* Alfaomega. - Keith J. Leidler, John H. Meiser, *Fisicoquímica* 1st edition, Pub cultural/Grupo Patria.

COURSE EVIDENCE (Deliverables)
- Lab practice reports - Answered lab practice workbook - Homework
11.-AUTHORS OF THE LEARNING UNIT
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