1.- GENERAL INFORMATION

Learning Unit	Academic Department	Course Format
Analytical Chemistry I	Chemistry	Lecture

Prerequisites(P)	Corequisites (CO)	Ascribed Academy	Module
Chemistry II	Analytical Chemistry Lab I	Qualitative and Quantitative Analysis Academy	M3 Analysis and characterization

Type	Lecture Hours	Practice Hours	Total hours	Credits
Basic, particular, and mandatory	51	**0**	51 hrs.	**7**

2.- GENERIC COMPETENCY

Students …
- …express their ideas using chemical language.
- … analyze situations using basic concepts of analytical chemistry.
- …express critical judgements based on experience and conceptualization.
- …research scientific and technological innovations in order to develop and solve problems.
- …establish relationships between chemistry concepts and their applications.
- …offer solutions to stated problems through established methods.
- …utilize information and communication technologies to process and interpret data.

3.- SPECIFIC CHARACTERISTICS OF THE COMPETENCY

Knowledge	Students… …know the essential concepts of physical chemistry, analytical chemistry, and instrumentation. …understand the chemical reactions involved in analyzing. …develop oral and written expression skills by presenting reports of different topics about the subject.
Skills	Students… …critically analyze the elements that influence their decision-making. …administer the resources in a way they are aware of the limitations they have to achieve their goals. …face the challenges and design strategies for their solution. …implement their knowledge in different fields and relate it to their daily life. …have a constructive attitude that is congruent with the knowledge and skills they have in work teams.

	…learn independently. …relate the acquired knowledge in analytical chemistry to instrumental methods. …make decisions in order to contribute to the solution of problems. …follow the safety rules when handling substances, instruments and equipment inside the laboratory. …work collaboratively, expressing their point of views with an open mind and considering those of the others with a critical approach. …contrast the results of an investigation or experience against previous hypotheses and communicate their conclusions.
Aptitudes	Students… …explore, discriminate, and organize the information of situations or problems that concern their interests or those of their community, offering viable solutions.
Values	Students … …search for the common good and the success for themselves and that of their partners. …respect and follow the rules. …assume the consequences of their behavior and decisions. …are aware of the importance and the responsible handling of the resources that are available.

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
☐	Others

5.- COURSE CONTENT OF THE LEARNING UNIT

UNIT I. Introduction to Analytical Chemistry
1.1 Current overview of Analytical Chemistry.
1.1.1 Analytical Chemistry and its relation with other study fields.
1.1.2 Evolution of Analytical Chemistry.
1.1.3 The analytical problem.
1.2 Basic concepts.
1.2.1 Analyte, matrix and sample.
1.2.2 Analysis, determination, and measurement.
1.2.3 Technique, method, procedure, and protocol.
1.2.4 Classification of analytical techniques.
1.3 Stages in the analytical process.
1.3.1 Gathering samples.
1.3.2 Sample preparation.
1.3.3 Sample analysis.
1.3.4 Calculation of results and their report.

UNIT II. Chemical equilibria in an aqueous solution.
2.1 Water as a solvent.
2.1.1 Dipolar moment and dielectric constant of water.
2.1.2 Self-ionization of water.
2.1.3 Strong and weak electrolytes: solutions.
2.2 Equilibrium.
2.2.1 Mass action expression for general equilibrium.
2.2.2 Thermodynamic and apparent constants of equilibrium (activity and concentration).
2.2.3 Other expressions of the equilibrium constant.
2.2.4 Types of constants of equilibrium in analytical chemistry.
2.2.5 Factors affecting the constant of equilibrium: Le Châtelier's principle.

UNIT III. Acid- base equilibrium.
3.1 Base and acid concepts.
3.1.1 Arrhenius Theory and Solvent system theory.
3.1.2 Brønsted-Lowry's model
3.1.3 Theory of Lewis.
3.2 Acid-base equilibrium in aqueous solutions.
3.2.1 pH and pOH scales.
3.2.2 Relative force of acids and bases.
3.2.3 Acidity and basicity constants.
3.2.4 Polyfunctional acids and bases and their salts: distribution diagrams.
3.2.5 Acid- base properties of salt solutions (salt hydrolysis)
3.3 Additional aspects of the acid- base equilibria.
3.3.1 Common-ion effect.
3.3.2 Buffer solutions.

3.3.3 pH indicators.
3.4 Acid-base titrations.
3.4.1 Acid-base titration models.
3.4.2 Quantitative applications.

UNIT IV. Precipitation equilibrium.
4.1 Solubility and solubility product.
4.1.1 Concept of solubility.
4.1.2 Rules of water solubility.
4.1.3 Intrinsic solubility and total solubility.
4.1.4 Solubility product constant.
4.2 Precipitation.
4.2.1 Conditions of precipitation and dissolution.
4.2.2 Formation of precipitates.
4.2.3 Precipitate contamination
4.2.4 Fractional or selective precipitation.
4.2.5 Precipitate dissolution.
4.3 Modification of the solubility of slightly soluble ionic compounds.
4.3.1 Effect of the reaction rate: pH and temperature.
4.3.2 Common-ion effect.
4.3.3 Uncommon ion effect (salt effect).
4.3.4 Incomplete dissolution of the solute: ion pair formation.
4.4 Precipitation titrations.
4.4.1 Argentometric and non-argentometric titrations.
4.4.2 Precipitation indicators.
4.4.3 Quantitative applications.

UNIT V. Compound formation equilibrium.
5.1 Compound formation.
5.1.1 Definition of compound in the analytical context.
5.1.2 Compound stability.
5.1.3 Constants of compound formation or stability.
5.1.4 Factors affecting compound stability.
5.1.5 Chelate stability: the chelate effect and the macrocyclic effect.
5.2 Additional aspects of the equilibria in compound formation.
5.2.1 Formation curves.
5.2.2 Distribution diagrams.
5.2.3 Formation of insoluble complexes.
5.2.4 Formation of complexes with proton ligands: conditional constants.
5.3 Complexometric titrations
5.3.1 Metal-EDTA titration curves.
5.3.2 Complexometric indicators.
5.3.3 Quantitative applications.

UNIT VI. Redox equilibrium.
6.1 The oxidation-reduction processes.
6.1.1 Oxidation and reduction concepts.
6.1.2 Oxidation numbers and redox reactions.
6.1.3 Oxidation and reduction agents.
6.1.4 Redox reactions of disproportionation and comproportionation.
6.2 Equilibrium of oxide-reduction in an aqueous solution.
6.2.1 Electrochemical cells.
6.2.2 Standard potentials of half-reaction and cell potentials.
6.2.3 Concentration effect on the potentials: Nernst equation.
6.2.4 Equilibrium potential and formal potential (non-standard).
6.3 Redox titrations.
6.3.1 Titration curves of redox systems.
6.3.2 Titrations with oxidizing agents.
6.3.3 Reducing agent titrations.
6.3.4 Redox indicators.
6.3.5 Quantitative applications.

6.- ASSESSMENT

☑	Numeric grade
☐	
☐	

7.- GRADING CRITERIA OF THE LEARNING UNIT

Indicator of evaluation	Percentage
Departmental exam	25
Partial exam	35
Homework	20
Research activities	5
Practice reports	0
Class participation	5
Project	10

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

9.-SPECIFIC CONTENT BY LEARNING UNITS

Content unit	Generic competency of the content unit	Topics	Class hours	Professor activities	Student activities	Bibliography
Unit I Introduction to Analytical Chemistry	Students analyze critically the basic aspects of analytical chemistry. -Express their ideas using chemical language in an oral and written way. -Plan the learning processes to carry independent and collaborative activities.	1.1 Current overview of analytical chemistry.	1 h	Professor… -Presents the topic. -Checks the investigations carried out by students. -Assesses and gives feedback of the homework exercises and projects. -Creates didactic activities to study the concepts of this unit. -Evaluates constantly - Motivates.	Students… -Learn the basic concepts of analytical chemistry. - Carry out the assigned research for the unit. - Respond exercises and do homework about the content unit. - Develop a practical project about this unit. - Study constantly and learn on their own.	Gary D. Christian. *Química Analítica*. Sixth Edition. McGraw-Hill Education. Daniel C. Harris. *Análisis Químico Cuantitativo*. Third Edition. Reverté. David Harvey. Modern *Analytical Chemistry*. First Edition. McGraw-Hill Higher Education.
		1.2 Basic concepts.	1 h			
		1.3 Stages of the analytical process.	1 h			

Unit II. Chemical equilibrium in an aqueous solution.	Students… Establish relationships between chemical concepts and their application. Solve problems in different contexts. Build hypotheses, designs a project and applies models to prove their validity.	2.1 Water as a solvent.	1 h	Professor… -Presents the topic. - Checks the investigations carried out by students. - Assesses and gives feedback of homework exercises and projects. - Prepares didactic activities to study the concepts of this unit. - Evaluates constantly - Motivates. - Makes teams to plan and carry out the practical project.	Students… -Carry out the assigned research for this unit. - Respond exercises and do homework about the content unit. - Develop a practical project about this unit. - Study constantly and learn on their own.	Douglas A. Skoog y colabs. *Fundamentos de Química Analítica*. Ninth Edition. Cengage Learning. Gary D. Christian. *Química Analítica*. Sixth Edition. McGraw-Hill Education. Jean-Louis Burgot. *Ionic Equilibria in Analytical Chemistry*. First Edition. Springer.
		2.2 The equilibrium state	4 h			

Unit III Acid-base equilibrium	Students… -Distinguish the types of acids and identify the presence of the common ion and its effects, applying analytical and critical thinking. -Know and apply the Henderson-Hasselbalch equation in the acid base equilibrium of buffering solutions. -Distinguish and utilize the different types	3.1 Concepts of acidity and basicity.	2 h	Professor… -Presents the topic. - Checks the investigations carried out by students. - Assesses and gives feedback of homework exercises and projects. - Prepares didactic activities to study the concepts of this unit. - Evaluates constantly - Motivates.	Students… -Carry out the assigned research for this unit. - Respond exercises and do homework of the content unit. - Develop a practical project about this unit. - Study constantly and learn on their own.	Gary D. Christian. *Química Analítica.* Sixth Edition. McGraw-Hill Education. Jean-Louis Burgot. Ionic Equilibria in Analytical Chemistry. First Edition. Springer. Douglas A. Skoog et al. *Fundamentos de Química Analítica*. Ninth Edition. Cengage Learning. Daniel C. Harris. *Análisis Químico Cuantitativo*. Third Edition. Reverté. Theodore L Brown. *Química. La Ciencia Central*. Twelfth edition. Pearson.
		3.2 Acid-base equilibrium in aqueous solutions.	3 h			
		3.3 Additional aspects of the acid-base equilibrium.	4 h			
		3.4 Acid-base titrations.	2 h			

	of acid-base titration. -Gather, record, and systematize the information to respond scientific questions, resorting to relevant sources and carrying out relevant experiments.					
Unit IV Precipitation equilibrium	Students… Analyze scientific information and predict the formation of precipitates through the calculus of the	4.1 Solubility and solubility product.	3 hr.	Professor… -Presents the topic. - Checks the investigations carried out by students. - Assesses and gives feedback of	Students… - Carry out the assigned research for this unit. - Respond exercises and do homework of the content unit.	Gary D. Christian. *Química Analítica.* Sixth Edition. McGraw-Hill Education. Jean-Louis Burgot. *Ionic Equilibria in Analytical Chemistry*. First Edition. Springer.
		4.2 Precipitation.	3 hr.			
		4.3 Modification of the solubility of ionic	4 hr.			

	constant of the solubility product. (Kps), In addition to this, students correlate the factors that influence the formation or solubilization of a precipitate. Contribute and participate with a sense of leadership through developing a collaborative project. Investigate the different argentometric methods and applies the volumetric	compounds slightly soluble. 4.4 Precipitation titrates.	 2 hr.	homework exercises and projects. - Prepares didactic activities to study the concepts of this unit. - Evaluates constantly - Motivates. - Makes teams to plan and carry out the practical project. - Solves exercises in class. - Designs and check homework exercises.	- Develop a practical project about this unit. - Study constantly and learn on their own.	Alfonso Clavijo Díaz. *Fundamentos de Química Analítica: Equilibrio Iónico y Análisis Químico*. First Edition. National university of Colombia.

	principle through precipitation.					
Unit V Compound formation equilibrium	Students… -Relate the types of ligands and their properties to use them as complex formation agents in quantitative determinations. -Explore the different complexometric methods and apply the volumetric principle through compound formation.	5.1 Compound formation.	4 hr.	Professor… -Presents the topic. - Checks the investigations carried out by students. - Assesses and give feedback of homework exercises and projects. - Prepares didactic activities to study the concepts of this unit. - Evaluates constantly - Motivates.	Students… - Investigate concepts. - Solve exercises and activities in class. - Solve homework problems. - Develop a specific project to this unit.	Jean-Louis Burgot. *Ionic Equilibria in Analytical Chemistry.* First Edition. Springer. Gary D. Christian. *Química Analítica*. Sixth Edition. McGraw-Hill Educación. Douglas A. Skoog y colabs. *Fundamentos de Química Analítica*. Ninth Edition. Cengage Learning. Alfonso Clavijo Díaz. *Fundamentos de Química Analítica: Equilibrio Iónico y Análisis Químico*. First edition. National University of Colombia
		5.2 Additional aspects of the compound formation equilibria.	4 hr.			
		5.3 Complexometric titrations.	3 hr.			

				- Makes teams to plan and carry out the practical project.		
Unit VI Redox equilibrium	Students… -Follow instructions and procedures in a reflexive way. -Understand how each step contributes to reaching an objective. -Recognize and organize the information related to the oxidant and reducing agents to apply them in different samples.	6.1 Generalities of the oxide-reduction processes.	3 hr.	Professor… -Presents the topic. - Checks the investigations carried out by students. - Assesses and gives feedback of homework exercises and projects. - Prepares didactic activities to study the concepts of this unit. - Evaluates constantly - Motivates.	Students… - Carry out the assigned research for this unit. - Respond exercises and do homework of the content unit. - Develop a practical project about this unit. - Study constantly and learn on their own.	Jean-Louis Burgot. *Ionic Equilibria in Analytical Chemistry*. First Edition. Springer. Gary D. Christian. *Química Analítica*. Sixth Edition. McGraw-Hill Educatioin. Alfonso Clavijo Díaz. *Fundamentos de Química Analítica: Equilibrio Iónico y Análisis Químico*. First Edition. National University of Colombia.
		6.2 Equilibrium in oxide-reduction in an aqueous solution.	3 hr.			
		6.3 Redox titrations.	3 hr.			

				- Makes teams to plan and carry out the practical project.		

COURSE EVIDENCE
(Deliverables)

Exams
Project report
Homework
Research activities

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