1.- GENERAL INFORMATION

Learning unit		**Department**		**Format**
Analytical Chemistry Instrumentation II		Chemistry		Lecture
Prerequisites(P)	**Corequisites (CO)**	**Ascribed Academy**	**Module**	
Analytical Chemistry I	Analytical Chemistry Instrumentation Lab II	Analytical Instrumentation	M3 Analysis and characterization	
Type	**Lecture hours**	**Practice hours**	**Total hours**	**Credits**
Basic Particular mandatory	68 hrs.	0 hrs.	68 hrs.	**9**

2.- GENERIC COMPETENCIES

Students distinguish the different techniques used in the analytical field of separation: chromatographic, electrophoretic and electrochemical techniques.

3.- SPECIFIC CHARACTERISTICS OF THE COMPETENCIES

Knowledge	Students… …define the specific theoretical principle that rules over the instrumental techniques. … explain the laws and apply the corresponding formulas in different samples and their representative calculations. …identify the components of the different equipment and instruments.
Skills	…distinguish the different instrumental techniques and the basic components of the instruments and equipment used in each technique. … explain the principles of the different instrumental techniques. … carry out the adequate calculations to quantify analytes in different samples … do collaborative work.
Aptitudes	…acquire analytical, participative, and cooperative criteria.
Values	Responsibility, honesty, professional ethics and care for the environment.

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

1. Separation methods
2. Chromatographic methods
3. Electrochemical methods
4. Electrophoretic methods

6.- ASSESSMENT

☑	Numeric grade

7.- GRADING CRITERIA OF THE LEARNING UNIT

Indicator of evaluation	Percentage
Departmental exams	30
Partial exam	45
Homework	10
Research activities	5
Practice reports	0
Class participation	10

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**
1.1 Main operations in separation methods.	Students apply analytical, synthetic and critical thinking to differentiate the separation processes in the field of analytical chemistry.	1.1.1 Physical separation methods.	30 min	Professor - teaches the basic concepts of physical separation (decantation, filtration and centrifugation), and physicochemical separation (discoloration, crystallization and sublimation). -motivates the student sto solve problems about the topics seen in this unit.	Students -play a prominent role in the search for information and answers to problems stated by the teacher.	▪ Harris, D. C. (2007). *Análisis Químico Cuantitativo* 3rd Edition in Spanish, (pp. 548-562), Spain, Barcelona: Revertè. S.A. ▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp. 14-22) Spain, Barcelona: Revertè. S.A.
		1.1.2 Physicochemical separation methods.	30 min			
1.2 Simple chemical equilibria separation methods.	Students apply analytical, synthetic and critical thinking to select and use the most adequate equilibria as	1.2.1 Precipitation	30 min	Professor teaches the following topics: -Separation by precipitation based on the control over acidity with organic and inorganic precipitates.	Students -do homework aout the concept of precipitation. - solve some exercises about the topic.	▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.53-89) Spain, Barcelona: Editorial Revertè. S.A. ▪ Skoog, D., West, D., *et al* (2014). *Fundamentos de Química Analítica* (pp. 848 – 852). Mexico, D.F.: Editorial CENGAGE Learning

	separation methods. Students record and systematize the information through ideas, and concepts represented as graphics or reports to represent the separation methods through equilibria.			-Professor checks homework through brainstorming.	-Investigate the uses of precipitation.	
		1.2.2. Liquid-liquid extraction	30 min	Professor -teaches the liquid-liquid extraction process, partition coefficient, effects of pH, extraction through chelants agents. -solves some problem examples. -discusses the elements that influence the liquid-liquid extraction.	Students… -solve conceptual and numeric problems. -investigate the most common uses of liquid-liquid extraction in the industrial field. -analyze and discuss the efficiency of this technique nowadays.	▪ Harris, D. (2010). *Quantitative Chemical Analysis*, Eight Edition. (pp. 537-542). New York: W. H Freeman. ▪ http://goldbook.iupac.org/L03587.html (retrieved on November 2015)) ▪ Vogel, A. I., &Mendham, J. (2000). *Vogel's textbook of Quantitative Chemical Analysis*. (pp. 161-172) Chicago: Harlow Prentice Hall.
		1.2.3. Ion exchange	30 min	Professor teaches the following topics: - Fundamentals of cationic and anionic exchanges. - Organic and inorganic material resins. -classification of the ion exchange resins.	Students… - turn in a glossary of concepts seen during the course. -create a comparative chart of the resins	▪ Harris, D. C. (2007). *Análisis Químico Cuantitativo* 3rd Edition in Spanish. (pp. 733-740), Spain, Barcelona: Revertè. S.A. ▪ Ayres, G. H. (1970). *Análisis Químico Cuantitativo.* (pp. 188 - 192). Mexico: Harlam S,A, de C.V. ▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de*

				– Ion selectivity and ion equilibrium –applications of the ion exchange.	of inorganic and organic material. -make a synoptic chart of the classification of ion exchange resins	*Separación.* (pp. 247-297) Spain, Barcelona: Reverté. S.A. ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 857 – 860). Mexico, D.F.: CENGAGE Learning.
2.1 Introduction and theory about chromatography	Students gather, record, and systematize the information to apply the concepts to the practice. Put information in order through ideas, concepts and through written or graphic representations. Distinguish the differences of the principles that make the	2.1.1 Chromatography	30 min	Professor… -organizes the information of the learning unit. - uses audiovisual resources about the topics of the learning unit. - makes sure students learn the concepts and knowledge through didactic resources. - designs and assigns homework that fosters feedback	Students… -give opinions and discuss the content of the audiovisual content. -respond the questions of the professor. -work collaboratively in the activities that were designed for them to learn. -do homework about the topics of the unit.	▪ Harris, D.C. (2007). *Análisis Químico Cuantitativo*. Pp (548-565) 3rd edition. SpainBarcelona: Reverté. S.A ▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.333-385) Spain, Barcelona: Revertè. S.A. ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 861 – 871). México, D.F.: CENGAGE Learning.
		2.1.2 Classification of the different types of chromatography.	30 min			
		2.1.3 Principles that make the chromatographic separations	120 min			

	chromatographic separations.			about the topics of the unit.		
2.2 Classic planar and column chromatographies.	Students… Skillfully and responsibly handle the material resources. -interpret and compare the chromatographic techniques: column and planar. -work collaboratively and ethically. -use chemical language to communicate appropriately.	2.2.1 How a column chromatography works.	90 min	Professor… teaches the fundamentals of the chromatographic techniques: column, paper, and thin-layer. -explains how the flow of the mobile phase (liquid to gas) through the stationary phase can occur through pressure, capillarity or gravity using practical examples. -designs homework and solves problems related to the topics of the unit.	Students… -distinguish and apply the different ways to find the stationary phase. -work in teams to deliver a synthetic report that is organized and systematized. -turn in homework and solved problems of the topics of this unit.	▪ Harris, D.C. (2007). *Análisis Químico Cuantitativo*. Pp (548-565) 3rd edition. Spain. Barcelona: Reverté. S.A ▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.333-385) Spain, Barcelona: Revertè. S.A. ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 861 – 871). México, D.F.: CENGAGE Learning. ▪ Domínguez X. A. (1975). *Cromatografía en papel y en capa delgada*. Monografphy #16 of the Regional Program of Scientific and Techological development (pp1-79). Monterrey Nvo. León. Mexico: Publisher Eva V.Chesneau.
		2.2.2 Paper planar chromatography	30 min			
		2.2.3 Thin-layer planar chromatography	60 min			

	organize information and follow procedures in a reflective way.			- motivates independent learning. - monitors and supervises group activities.		
2.3 Qualitative and Quantitative parameters of Chromatography.	Students -apply analytical, synthetic and critical thinking to use the theoretical concepts to solve quantitative problems about the parameters that rule chromatography. - develop cognitive strategies to interpret real data and mathematic calculations to optimize the chromatographic parameters.	2.3.1 Qualitative parameters (tr, tm, tr`, k, □, R, HEPT, W, $W_{1/2}$)	150 min	Professor… -teaches the following topics: -qualitative parameters. - Vam Deemter equation. -solves and discusses some examples of problems about qualitative parameters and quantification methods. -proposes feedback strategies to reaffirm the acquired knowledge.	Students… -solve conceptual and numerical problems of the topics in this unit. -investigate the uses and relationship of the qualitative parameters in chromatography. -investigate the application of Vam Deemter's equation -analyze the advantages and disadvantages if	▪ Harris, D. (2010). *Quantitative Chemical Analysis*, Eight Edition. (pp. 537-542). New York: W. H Freeman. ▪ Vogel, A. I., &Mendham, J. (2000). *Vogel's textbook of Quantitative Chemical Analysis*. (pp. 161-172) Chicago: Harlow Prentice Hall. ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 861 – 871). México, D.F.: CENGAGE Learning.
		2.3.2 Vam Deemter Equation	30 min			
		2.3.3 Quantification Methods (NAAN, EE, EI, NAFR)	180 min			

					the quantification methods. -discuss about the optimization of parameters in chromatography.	
2.4 Liquid chromatography	Systematize information through ideas and concepts, structuring them through words or graphs to represent the chromatograph of liquids. Apply critical, analytical and synthetic reasoning to know what type of samples can be used in the liquid chromatograph	2.4.1 Fundamentals of liquid chromatography.	30 min	Professor… -Teaches the description and classification of the liquid chromatography. -Describes and systematize the components of a liquid chromatography -Describes the concepts of normal phase and reverse phase. -Analyzes and discusses with the group which detector,	Students… -give opinions and discuss the content of the audiovisual content. -investigate varieties of the basic elements of the HPLC systems and their applications. -analyze and discuss the function of each one of the components of a un HPLC	▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.333-385) Spain, Barcelona: Revertè. S.A. ▪ Harris, D.C. (2007). *Análisis Químico Cuantitativo*. Pp (548-565) 3rd edition. SpainBarcelona: Reverté. S.A ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 861 – 871). Mexico, D.F.: CENGAGE Learning. ▪ "Waters". Retrieved on July 25, 2015, from http://www.waters.com/waters/es_MX/HPLC---High-Performance-Liquid-Chromatography-Beginner%27s-Guide/nav.htm?cid=10048919&locale=es_MX ▪ "Agilent". Retrieved on July 25, 2015, from http://www.chem.agilent.com/en-US/Products-Services/Instruments-
		2.4.2 Instrumentation and its characteristics. (HPLC)	270 min			

				column, and mobile phase to use according to the type of sample and the scope of the analysis -Designs an activity to work collaboratively. -Solves examples of qualitative and quantitative problems -Designs and assigns homework that fosters feedback about the topics of the unit.	-distinguish normal phase and reverse phase and the cases in which they are applied. -identify the mobile phase, detector o column to use depending on the sample. -respond the questions of the professor. -work collaboratively in the activities that were designed for them to learn.	Systems/Liquid-Chromatography/Pages/default.aspx#

2.5 Gas chromatography	Students record and systematize the information through ideas, and concepts represented as graphics or reports to represent the gas chromatograph. Students apply analytical, synthetic and critical thinking to	2.5.1 Fundamentals of gas chromatograph y 2.51.1 Definition and classification	30 min	Professor… -teaches the description and classification of gas chromatography. -Describes and systematize the components of the gas chromatograph. -Discusses which column, detector and carrier gas to use	Students… - present the description and classification of gas chromatography. -Describe and systematize the components of the gas chromatograph.	▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.333-385) Spain, Barcelona: Revertè. S.A. ▪ Skoog, D. *et al.* (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 861 – 871). Mexico, D.F.: CENGAGE Learning.

	know what type of samples to use in the gas chromatograph.	2.5.2 Instrumentation and its characteristics (GC) 2.5.2.1 Basic elements of a chromatographic system and its characteristics. 2.5.2.2 Select carrier gas, type of column and detector depending on the sample.	270 min	depending on the sample. -designs the activity that students will work with collaboratively. -solves examples of quantitative problems. - designs and assigns homework that fosters feedback about the topics of the unit.	-Discuss which column, detector and carrier gas to use depending on the sample. -Design the activity that students will work with collaboratively. -Solve examples of quantitative problems. -Design and assign homework that fosters feedback about the topics of the unit.	
2.6 Other methods	Students record and systematize the information through ideas, and concepts	2.6.1 Super critical fluid chromatography (SCF)	30 min	Professor … -teaches the descriptions of SCF, UPLC, SHPMF and the methods coupled to	Students… Investigate and analyze the processes of the SCF, UHPLC,	▪ Valcárcel, C. M. and Gómez, H. A. (1994). *Técnicas Analíticas de Separación*, (pp.723-771) Spain, Barcelona: Revertè. S.A.

	represented as graphics or reports to represent SCF, UHPLC, SPME and the methods coupled to liquid chromatography. Students apply analytical, synthetic and critical thinking to know on what type of sample we can use SCF, UHPLC, SPMF and the methods coupled to liquid chromatography.	2.6.2 Ultra high resolution chromatography (UHPLC)	60 min	the liquid chromatography. -describes and synthesizes the processes of the SCF, UHPLC, SPMF and the coupled methods to the liquid chromatography. -teaches the fundamentals and the main objective of the SCF, UHPLC, SPMF and the methods coupled to liquid chromatography. -discusses with the group the scope of the possible applications of the SCF, UHPLC, SPMF and the methods coupled to liquid chromatography	SPMF and the methods coupled to the chromatography of liquids. -give opinions, discuss and comment the possible applications of the SCF, UHPLC, SPMF and the methods coupled to liquid chromatography. -do homework about the topics seen in class.	▪ Harris, D.C. (2007). *Análisis Químico Cuantitativo*. Pp (517-538) 3rd edition. Spain, Barcelona: Reverté. S.A ▪ "Phenomenex". Retrieved on July 25, 2015 from http://www.phenomenex.com/sample-preparation
		2.6.3 Solid-phase Micro extraction (SPME)	60 min			
		2.6.4 Coupled methods.	30 min			

3.1 Introduction to Electrochemistry	Students apply analytical, synthetic and critical thinking to differentiate the basic aspects of electrochemistry as well as categorize the type of cells and electrodes. Students record and systematize the information through ideas, and concepts represented as graphics or reports to represent the analytical applications of Nernst Equation	3.1.1 Fundamentals of Electrochemistry	30 min	Professor… -organizes the information about the topics of the unit. -presents audiovisual resources related to the topics of the learning unit. - makes sure students learn the concepts and knowledge through didactic resources. - designs and assigns homework that fosters feedback about the topics of the unit.	Students… -give opinions and discuss the content of the audiovisual content. -answer professor's questions. -work collaboratively to do the activities planned for this unit. -do homework about the topic of this learning unit.	▪ Harris, D.C. (2007). *Análisis Químico Cuantitativo*. Pp (283-312) 3rd edition. Spain, Barcelona: Reverté. S.A ▪ Ayres, G. H. (1970). *Análisis Químico Cuantitativo.* (pp. 188 - 192). Mexico: HARLAM S,A, DE C.V. ▪ Skoog, D. et al. (2014). *Fundamentos de química analítica*, Ninth Edition, Mexico, D. F., (pp. 857 – 860). Mexico, D.F.: Editorial CENGAGE Learning ▪ Rubinson K & Rubinson, J. (2000) *Análisis Instrumental* (pp. 209-279) Madrid, Spain: Editorial Prentice Hall
		3.1.2 Types of electromagnetic cells.	60 min			
		3.1.3 Electrode classification	30 min			
		3.1.4 Standard potential	60 min			
		3.1.5 Nernst equation	60 min			
3.2 Potentiometry	Students apply analytical, synthetic and critical thinking to understand the	3.2.1 Indicator electrodes	30 min	Professor…	Students… -give opinions and discuss the	• Harris, D. C. (2007). *Análisis Químico Cuantitativo* (3rd edition, (pp. 314 - 346), Spain Barcelona: Reverté. S.A.
		3.2.2 Direct potentiometry	60 min			

	working of ion selective electrodes in analytical chemistry Students record and systematize the information through ideas, and concepts represented as graphics or mathematical presentations to solve analytical applications of Nernst Equation through direct potentiometric measurements.	3.2.3 Ion-selective electrodes	30 min	-organizes the information about the topics of the unit. -presents audiovisual resources related to the topics of the learning unit. - monitors the learning of concepts and knowledge through didactic resources. -designs and assigns homework that fosters feedback about the topics of the unit.	content of the audiovisual content. -answer professor's questions. -work collaboratively to do the activities planned for this unit. -do homework about the topic of this learning unit.	• Ayres, G. H. (1970). *Análisis Químico Cuantitativo*. (pp. 188-192). Mexico: HARLAM S,A, DE C.V. • Skoog, D. et al. (2014). *Fundamentos de química analítica,* Ninth Edition, Mexico, D. F., (pp. 857 – 860). Mexico, D.F.: l CENGAGE Learning. • Rubinson K & Rubinson, J. (2000) *Análisis Instrumental* (pp. 209-279) Madrid, Spain: Prentice Hall
		3.2.4 Applications of direct potentiometry	120 min			
3.3 Potentiometric titrations	Students apply analytical, synthetic and critical thinking to understand the process of potentiometric titrations.	3.3.1 Fundamentals	30 min	Professor… -organizes the information about the topics of the unit.	Students… -give opinions and discuss the content of the audiovisual content.	• Harris, D. C. (2007). *Análisis Químico Cuantitativo* (3rd edition, (pp. 314 - 346), Spain Barcelona: Reverté. S.A.
		3.3.2 End point detection methods.	30 min			
		3.3.3 Classification of	30 min			

	Students record and systematize the information through ideas, and concepts represented as graphics or mathematical representations to solve analytical applications of the potentiometric titrations.	potentiometric titrations.		-presents audiovisual resources related to the topics of the learning unit. - monitors the learning of concepts and knowledge through didactic resources. -designs and assigns homework that fosters feedback about the topics of the unit.	-answer professor's questions. -work collaboratively to do the activities planned for this unit. -do homework about the topic of this learning unit.	• Ayres, G. H. (1970). *Análisis Químico Cuantitativo*. (pp. 188-192). Mexico: HARLAM S,A, DE C.V. • Skoog, D. et al. (2014). *Fundamentos de química analítica,* Ninth Edition, Mexico, D. F., (pp. 857 – 860). Mexico, D.F.: l CENGAGE Learning. • Rubinson K & Rubinson, J. (2000) *Análisis Instrumental* (pp. 209-279) Madrid, Spain: Prentice Hall
		3.3.4 Acid-base titrations (*potentiograms, acid mixture, pka, pkb, spread sheets*)	120 min			
		3.3.5 Redox titrations	30 min			
▪						
3.4 Conductometry	Students identify and distinguish the applications in the field of conductometry. Students apply analytical, synthetic and critical thinking to integrate	3.4.1 Concepts and fundamentals	30 min	Professor… Teaches the topics of the unit: conductance, equivalent conductance, cell constant, ion mobility, conductometry. Solves and comments examples about the	Students… -Solve conceptual and numeric problems about conductometry. -Investigate about the application of conductometry of in analytical areas.	▪ Willard, Merrit, Dean. (1965). *Métodos Instrumentales de Análisis*.. 1rst edition (pp 883-917) Spain. CIA.Editorial Contiental. ▪ Rubinson & Rubinson. (2000). *Quimica Analítica Contemporanea*. First edition. (pp 501-504). Madrid, Spain: Prentice Hall ▪ Vogel, A. I., &Mendham, J. (2000). *Vogel's textbook of quantitative*
		3.4.2 Classification of conductometric techniques (direct and titrations).	120 min			

	electrochemical concepts in the conductometric applications.	3.4.3 Applications of conductometry.	30 min	current uses of conductometry.	Discuss the advantages and limitations of conductometry, comparing them to other analytical techniques.	*chemical analysis*. (pp. 519-527) Chicago: Ed. Harlow Prentice Hall.
3.5 Coulometry	Identify and distinguish the applications in the field of coulometry. Students apply analytical and critical thinking to apply the coulometric methods.	3.5.1 Fundamentals	30 min	Professor… -teaches the topics of the unit: -fundamentals -classification - instrumentation - solves and comments examples about current uses of coulometries.	Students -solve conceptual and numeric problems about the topics of coulometry. -Investigate about the application of conductometry of in analytical areas. -Discuss the advantages and limitations of conductometry, comparing them	• Harris, D. (2010). *Quantitative Chemical Analysis*, Eighth Edition. (pp. 369-371). New York: Ed. W. H Freeman. ▪ Skoog, D. A., West, D.J., Holler, F. J., Crouch, S. R, (2014). *Química Analítica,* Ninth Edition. (pp. 594- 609.) Mexico, D. F. ▪ Dean Merrit. (1965) *Métodos Instrumentales de Análisis.* Willard, 1rst Edition in Spanish. (pp 803-827) CIA. Continental.
		3.5.2 Classification (controlled current and controlled potential)	30 min			
		3.5.3 Instrumentation	30 min			
		3.5.4 Applications of coulometries and solution of problems.	90 min			

					to other analytical techniques.	
3.6 Voltammetric techniques	Students record and systematize the information through ideas, and concepts represented as graphics or reports to represent the voltammetric techniques. Students apply analytical and critical thinking to select the voltammetric technique.	3.6.1 Fundamentals of amperometry	30 min	Professor… -Teaches and describes the fundamental principles of amperometry; its origin, measurements, data treatment and its different polarizable types. -Solves examples of applications. -Programs and organizes the information that is relevant to the topics.	Students… -solve conceptual and numeric problems about the topics of this learning unit. -give opinions and discuss the content of the audiovisual content. - distinguish the behavior of titrations with a polarizable electrode or with two electrodes.	▪ Rubinson & Rubinson. (2000). *Quimica Analítica Contemporanea*. First edition. (pp 509-513). Madrid, Spain: Prentice Hall ▪ Willard, Merrit, Dean. (1965). *Métodos Instrumentales de Análisis*. 1rst edition (pp 867-881) Spain. CIA.Editorial Contiental. ▪ Harris, D. (2010). *Quantitative Chemical Analysis*, Eighth Edition. (pp. 461-481). New York: Ed. W. H Freeman. ▪ Willard, Merrit, Dean. (1965). *Métodos Instrumentales de Análisis*. 1st edition (pp 829-9865) Spain. CIA. Continental. • Rouessac, F. and Rouessac, A. (2000).
		3.6.2 Classification of amperometric titrations.	30 min			
		3.6.3 Karl Fischer methods	60 min			
		3.6.4 Fundamentals of polarography	30 min			
		3.6.5 Qualitative methods (half way potential)	30 min			

		3.6.6 Quantification methods (direct, calibration curve and standard addition)	120 min	-Teaches examples of polarographic titrations using ICT tools. -Discusses, evaluates, and concludes the elements that affect the form of the polarograms through a chart. -Teaches the methods to develop polarographic quantitative procedures.	Students… -work collaboratively to do the activities planned for this unit. -answer professor's questions - Present a glossary of the concepts seen during the course. - make a comparative chart of the polarographic forms in teams. -make a synoptic chart of the polarographic forms.	*Análisis Químico. Métodos y Técnicas Instrumentales Modernas*. Madrid, Spain: Mc Graw – Hill. 377 – 386.

					-investigate and report the applications of polarography and the quantitative methods. -answer quantitative exercises of the polarographic methods.	
4.1 Electrophoretic methods	Students -apply analytical, synthetic and critical thinking. -develop oral and written skills in English. - identify and administer the necessary material resources to develop the technique.	4.1.1 Fundamentals of de Electrophoresis	30 min	Professor… -teaches the different electrophoretic methods. -utilizes multimedia tools to clarify concepts. -motivates the analysis of a case applied in biotechnology.	Students… -solve conceptual problems about the topics of this learning unit. -discuss articles about the topic. -do a cost-benefit analysis of the electrophoretic techniques. -evaluate study cases in order to differentiate each	▪ Harris, D. (2010). Quantitative Chemical Analysis, Eight Edition. (pp. 634-665). New York: Ed. W. H Freeman. ▪ http://www.intechopen.com/books/electrophoresis (Retrieved on November, 2015) ▪ Reiner Westermeier (2001) Electrophoresis in Practice: A Guide to Methods and Applications of DNA and Protein Separation. (pp 1-25 Wiley VCH.
		4.1.2 Electrophoresis in Polyacrylamide y Agarose	120 min			
		4.1.3 Capillary and isoelectric focusing	30 min			
		4.1.4 Bidimensional electrophoresis	30 min			
		4.1.5 Modern applications and sources of error.	30 min			

					one of the techniques. Investigate about the modern applications.	

COURSE EVIDENCES
(Deliverables)

- Partial Exams
- Departmental exam
- Research homework
- Problem solving

11.-AUTHORS OF THE LEARNING UNIT

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