1. Module identification code:	
Name of the institution:	Universidad Autónoma de Nuevo León (UANL)
Name of school:	School of Medicine
Name of the degree program:	Clinical Chemistry
Name of the course (learning unit):	Instrumental Analysis
Total number of class hours-theory and practice:	140 hours
Class hour per week :	7 hours
Independent study:	10 hours
Course modality:	Face to face instruction
Module level:	Fifth semester
Core/elective module:	Core
Curricular area:	ACFB
UANL credit points:	5
Create date:	April 10th, 2018
Date of last amendment made:	June 28th, 2024

Person(s) responsible for the design and amendment of the module:	Dr. C. Blanca Alicia Alanís Garza Dr. C. Ricardo Salazar Aranda Dr. C. Norma Cecilia Cavazos Rocha

2. Presentation:

The module (learning unit/LU) of Instrumental Analysis focuses on the study of instrumental analytical techniques used by the professional field of Clinical Chemistry, such as ultraviolet-visible spectrophotometry, fluorometry, infrared, atomic emission and absorption, polarimetry, refractometry, mass spectrometry, nuclear magnetic resonance, X-ray, high-resolution liquid chromatography and gas chromatography.

Stage I includes the analysis of the fundamentals of the techniques and their application, the most common sample preparation techniques and their application. In this same phase, the student learns to interpret the results obtained for correct decision-making. In **stage II**, the automated analysis methods used in clinical laboratories are reviewed and justified. The course concludes with **stage III** in which the student integrates the acquired knowledge to select the most appropriate instrumental analysis technique and method according to the characteristics of the sample and the analyte being studied.

As a Course Integrated Proyect/Product (CIP), the student demonstrates his/her ability to apply the knowledge acquired during this LU by making proposed solutions to real situations posed by the teacher, justifying the selected instrumental technique, applying the performance criteria to evaluate the proposed analytical methodology, and interpreting results.

3. Purpose:

The LU of Instrumental Analysis contributes to achieving the graduate profile that will allow the student to propose and apply an adequate methodology for chemical analysis in all its stages from sampling, sample preparation, use of instrumental equipment for spectroscopy, spectrometry and chromatography, as well as the interpretation and evaluation of the results.

With this learning unit, the student will develop some of the general competencies of the UANL, since he will use traditional and cutting-edge research techniques for the development of his/her practical work once this has been reviewed in the theoretical part, this experience will be very useful in the exercise of his/her profession. At the same time, the student develops his/her practices adhering to safety regulations, reviews the safety data sheets of solvents or reagents and makes sure to generate the least possible amount of waste, which he handles responsibly as marked in the Mexican Official Standards as a form of respect for nature and the environment. With the material reviewed during this LU, the student is able to resolve personal and social conflicts in the field of his/her profession to make appropriate decisions when responding to real problems posed by teachers.

At the same time, this LU also develops specific competencies for the graduate profile. For example, in this LU the fundamentals of different analytical methodologies that are being incorporated into analysis laboratories are studied. Likewise, the parameters used to validate bioanalytical methods that allow for the reliability of the results are practiced. Competencies are also developed to use the criteria that allow for interpreting results and thus making timely and pertinent decisions.

Within the LU of previous semesters there is a relationship with **General Chemistry** when interpreting the physical and chemical properties of inorganic compounds of biochemical interest, with **Physic** when justifying the basis of the instrumental methods and the behavior of the analytes, with **Biostatistics** when applying the statistical methods for the validation of methods, with **Fundamentals of Analytical Chemistry** when applying the knowledge of concentration, chemical equilibrium and data analysis, with **Basic Organic Chemistry** when identifying and justifying the behavior of organic molecules compared to measurement methods and with **Biochemistry** when relating the instrumental methods in the analysis of samples of biochemical interest.

4. Competences of the graduate profile:

General competences to which this module (learning unit) contributes:

- *Instrumental:*

8. To use traditional and cutting-edge research methods and techniques for the development of their academic work, the exercise of their profession and the generation of knowledge.

•*Personal and social interaction:*

11. To practice the values promoted by the UANL: truth, equity, honesty, freedom, solidarity, respect for life and others, peace, respect for nature, integrity, ethical behavior and justice, in their personal and professional environment to contribute to building a sustainable society.

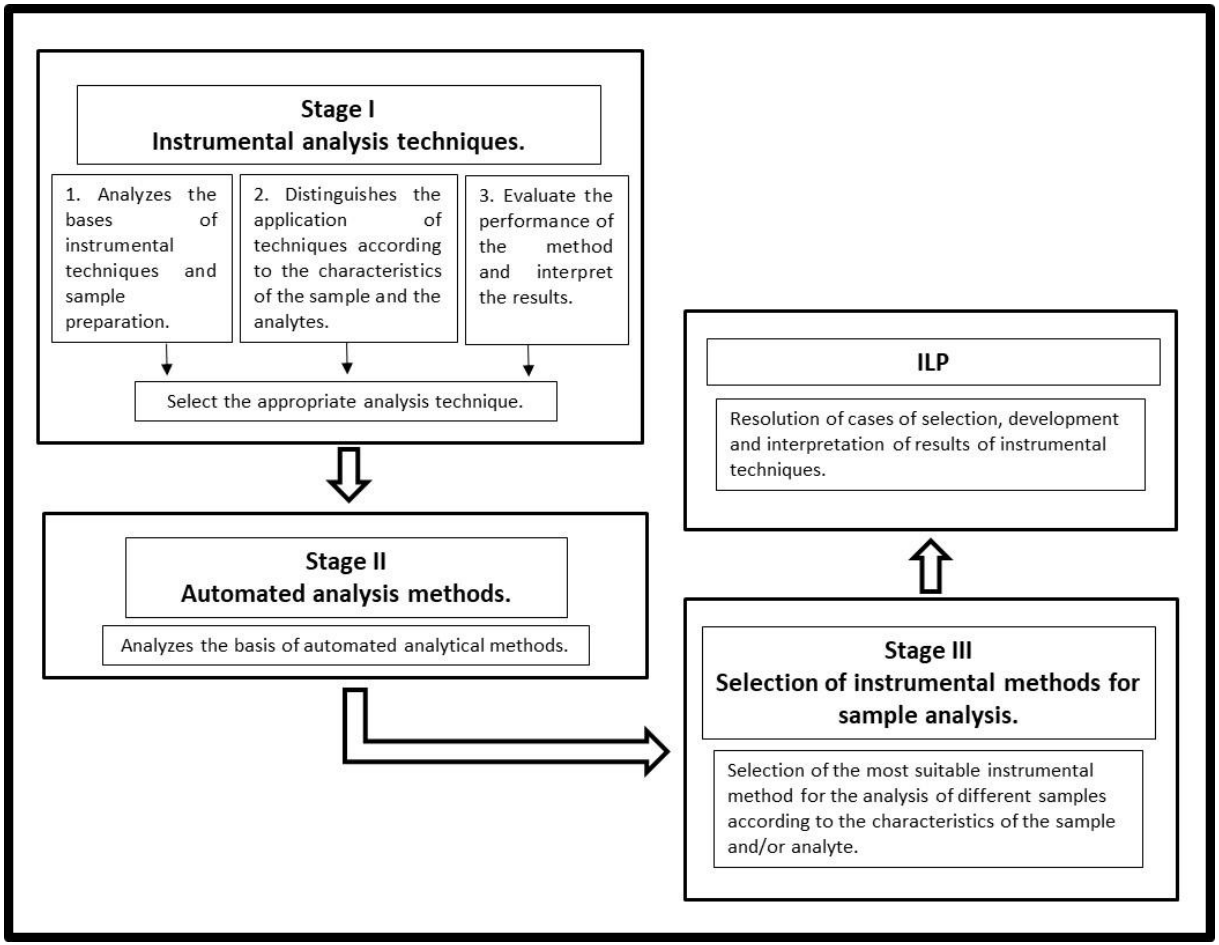
• *Integrative:*

14. To resolve personal and social conflicts, in accordance with specific techniques in the academic field and in their profession for appropriate decision-making.

Specific skills of the graduate profile to which the LU contributes:

4. To validate bioanalytical methods under established performance criteria that allow reliability of the results obtained in chemical-biological samples.
5. To incorporate new analytical methodology that contributes to the functional, economic and/or environmental improvement of laboratory processes to respond to needs in health areas.
6. To interpret the results of analyses based on established criteria that allow timely and pertinent decision-making in clinical, toxicological, chemical, food, forensic, and environmental diagnosis.

5. Course roadmap:



6. Structuring into stages or phases:

Stage I.- Instrumental analysis techniques.
Stage II.- Automated analysis methods.
Stage III.- Selection of instrumentals methods for simple analysis.

Stage I: Instrumental analysis techniques.

Component(s) of the competence:

Select the most appropriate instrumental technique taking into account its fundamentals, application and performance, as well as the characteristics of the sample for adequate determination of an analyte.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
1. Four partial evaluations: A) Molecular absorption spectrometry. B) Extraction techniques. Chromatographic methods. Infrared molecular absorption spectrometry.	In the evaluations, the student: • Writes the rationale for each instrumental technique, advantages and limitations with correct spelling and coherence. • Justifies the selection of an instrumental technique.	In the first session, the course is presented, the student reviews the LU analytical program accompanied by the professor, its importance in the degree curriculum and its relationship with other LUs. In a second session, the student analyses, in the electronic graph presented by the professor, the characteristics of the	• Introduction to instrumental analysis • Instrumental Analysis Techniques. • Quality parameters. • Electromagnetic radiation (EMR) and its interaction with matter. • Spectra resulting from the interaction of EMR with matter. • Beer's law and its deviations. • Basis of each technique.	A**) Molecular absorption spectrometry**: Skoog D.A., Holler F., J., Crouch S. Chapters: - Introduction to ultraviolet-visible molecular absorption spectrometry. - Applications of molecular absorption spectrometry in the

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
C) Mass spectrometry. Nuclear magnetic resonance. Polarimetry and refractometry. Molecular emission and dispersion spectrometry. D) X-ray spectrometry. Atomic absorption and emission spectrometry and Automated Analysis Methods.	• Interprets the quality parameters of an analytical method. • Obtains the results of a quantitative analysis. • Includes all calculations • Proposes modifications to an instrumental method to improve results • Interprets the design of the instrumental equipment and its variants, identifies its components, component materials and its operation. For evaluation D: • Includes automated analysis methods seen during classes • Identifies automated equipment and its instrumentation,	Classical and Instrumental Methods. In the form of a graphic presentation, he/she reviews the quality parameters for the selection of an analytical method. The student makes a general comparison of the methods from the point of view of quality/analytical performance parameters, using electronic supporting documents presented by the professor. The student, individually, participates by answering questions asked by the teacher during his presentation. For each of the instrumental techniques, the following activities will be carried out:	• The equipment for each instrumental technique (Equipment components, Selectors, Transducers, Output Devices, Tests for the verification of equipment operation). • Classification and Identification of the species to be determined. • Application of each qualitative and quantitative technique. • Presentation of Problems • Derivative Spectrophotometry, Titrations and Kinetics • Sampling and variables that affect it. • Sample preparation. • Extraction technique. • Separation parameters in chromatography. • Van Deemter equation	ultraviolet-visible region. Harris D. Chapters: - Fundamentals of spectrophotometry. - Applications of spectrophotometry. Spectrophotometers. **B) Infrared molecular absorption, emission and molecular scattering spectrometry.** Skoog D.A., Holler F., J., Crouch S. Chapters: - Molecular luminescence spectrometry - Infrared spectrometry - Applications of infrared spectrometry. **C) Extraction techniques. High-**

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
	advantages and limitations. • Respects the schedule established for each evaluation.	The student individually studies the topic that will be covered in the session. The sessions will be scheduled in the "Class Script" document which will be uploaded to the available platform. In each session, students participate, individually and guided by the teacher, in a brainstorming session on the fundamentals of the instrumental technique, the components and operation of each instrument; the characteristics of the sample and the analytes that are analyzed according to the requirements of the method; the performance of the method and the procedures to perform the qualitative and/or quantitative analysis, as well as the interpretation of results.	• Equipment with Fourier Transform. • Ion sources and mass analyzer. • Automated equipment and its instrumentation. • Characteristics of discontinuous equipment.	**resolution thin layer chromatography, high-resolution liquid chromatography and gas chromatography. Automated analysis methods.** Skoog D.A., Holler F., J.,Crouch S. Chapters: - Sample preparation - Introduction to chromatographic separations - Gas chromatography. - High-performance liquid chromatography **D) Mass spectrometry, X-rays**

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		The student solves exercises presented by the teacher in infographics with examples of quantification of analytes determined using the instrumental technique studied. As the course progresses, and supported by problem solving, questionnaires, preparation of synoptic tables and participation in classes, the student solves 4 partial evaluations, which will be scheduled in the "Class Script" document found on the available platform. Accredited activity 1A – 1D. Problems to solve. At the end of each instrumental technique reviewed, the student solves individually and according to the criteria		**and nuclear magnetic resonance.** Skoog D.A., Holler F., J., Crouch S. Chapters: - Nuclear Magnetic Resonance Spectrometry - Mass spectrometry - Atomic X-ray spectroscopy **E) Atomic absorption and emission spectrometry. Polarimetry and refractometry methods. Automated methods of analysis.** Harris D. Chapters: - Atomic spectroscopy. Skoog D.A., Holler F., J., CrouchS. Chapters: - Atomic spectroscopy.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		established by the teacher, the following activities: The teacher publishes the document containing the problems to be solved, the student solves and submits the solved problems on the day and time indicated following the instructions for delivery. Assessment instrument: checklist. Accredited activity 2. Class participation The student reviews on the platform the document published by the professor with the formation of the work teams and the topic assigned to each team, which must be presented in class during the course of the LU. During the development of the LU, in an extra-classroom activity,		Sierra I, Pérez D, Morante S, Pérez Y, Ballesteros R, Sánchez A - Refractometry - Polarimetry Articles obtained from open access databases (example: SciELO, REDALYC, Latindex, PubMed, etc...) that include the validation and application of instrumental methods. Computer with internet connection. Learning platforms. Open access videos from authors such as Eliana Rocha,

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		students in teams prepare one or two slides to stimulate the active participation of their classmates through dynamics to highlight important points on the topic, express ideas, present answers to questions or propose solutions to problems on the topic assigned by the teacher. The student presents the prepared material to the group and explains the solution to the activity assigned by the teacher. This presentation will have a maximum time of 15 minutes. Evaluation instrument: rubric. The student submits in writing the solution to the assigned material individually and according		KhanAcademy, Jhon Jesus, AutoChem Solutions to name a few. Class script.

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		to the criteria established by the teacher. Accredited activity 3A – 3C. Comparative tables of instrumental techniques. The student, individually, creates, as the topics are reviewed, 3 comparative tables of the following instrumental techniques: A. Molecular absorption and emission spectrophotometry. B. Atomic absorption and emission spectrophotometry. C. High-performance liquid and gas chromatography. The characteristics to be compared for each chart you make are found in the instructional guides.		

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		This chart is made in the form of handwritten text, delivered on the day and time indicated, and following the criteria established by the teacher on the platform. Assessment instrument: checklist. (Accredited activity 4A – 4C, Questionnaire and problem set for the topics of A. Mass spectrometry B. X-ray spectrometry C. Nuclear magnetic resonance The student consults the document published by the professor, which contains the questionnaires or problem sets, and solves it. The student, individually, analyzes and solves each problem or question that is raised in the document.		

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		Following the criteria established by the professor, the student delivers his documents on the day and time scheduled by the professor. Assessment instrument: checklist. Throughout the semester, students maintain active communication with teachers through the available platform.		
2. Evidence: Laboratory Practices (Reports and performance): o Introduction to the Laboratory. Sample preparation calculations. Hazardous waste management.	The student: o Attends the laboratory sessions punctually in person, at the time indicated by the professor according to the laboratory group. o Correctly answers questions about fundamentals, instrumentation and	The student, individually, reviews in advance in his/her Instrumental Analysis Practice Manual the practice to be performed and analyzes the theoretical basis of sample preparation and the instrumental technique to be used. Before starting the session, the student fills	Practices: o Introduction to the Laboratory. Sample preparation calculations. Hazardous waste management. o Quality control in UV-Vis spectrophotometry. o Absorption spectrum in UV-Vis spectrophotometry. o Determination of caffeine in serum by	Instrumental Analysis Laboratory Procedures Manual of the Department of Analytical Chemistry. Learning platforms. Videos authored by the professors of this LU on the YouTube channel Instrumental Analysis Laboratory".

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
o UV-Vis spectrophotometry (three reports). o Molecular emission spectrometry. o Turbidimetry. o Refractometry. o Polarimetry. o Flame atomic absorption spectrophotometry. o High-resolution liquid chromatography (two reports). o Gas chromatography (two reports).	operation of the equipment. o Complies with the laboratory regulations. o Correctly handles materials and reagents and disposes of the waste generated. o For all laboratory sessions, answers the reports with correct spelling, coherence, correctly, completely and clearly. o Include the calculations performed in the report. o Submits the report, individually, on the date and time indicated.	out the toxicity and residue tables found at the end of each practice. To get the most out of each session, the student carefully watches the videos available on the YouTube channel "Instrumental Analysis Laboratory" corresponding to the practice prior to the session. The student attends the laboratory at the time and day indicated, complying with the regulations regarding clothing and safety glasses. At the beginning of each practice, the professor gives an explanation of the development of the practice and asks the students questions.	UV-Vis spectrophotometry. o Determination of quinine in quinine mineral water by molecular emission spectrometry. o Determination of sulfates in drinking water by turbidimetry. o Determination of saccharose in juices and soft drinks by refractometry. o Determination of carbohydrates in beverages by polarimetry. o Determination of iron in water by flame atomic absorption spectrophotometry. o Separation parameters in high-performance liquid chromatography (Qualitative). o Determination of caffeine by high-performance liquid	Laboratory equipment: - Analytical balance - Ultraviolet-visible spectrophotometer Atomic absorption spectrophotometer. - Fluorometer - High Resolution Liquid hromatograph - Gas Chromatograph. - Polarimeter Refractometer

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		The student makes the determination according to the manual's guide, complying with the laboratory regulations and the safety guidelines implemented in the department. The student is guided by the professor throughout the process to resolve any doubts. The professor evaluates the performance. Evaluation instrument: rubric. At the end of the practice, the student treats and confines the waste generated. The student completes the report and delivers it on the date and time indicated by the professor.	chromatography (Quantitative). o Separation parameters in gas chromatography (Qualitative). ○ o Quantitative analysis of alcohols by gas chromatography.	

Evidence of student learning	Performance criteria	Learning activities	Content	Resources
		The professor evaluates the report and returns feedback to the student. Evaluation instrument: checklist.		

Stage II: Automated analysis methods: continuous flow and batch flow.

Component(s) of the competence:

Analyzes the basis of automated analytical methods according to technological advances for use in the clinical laboratory.

Evidence of learning	Performance criteria	Learning activities	Contents	Resources
3. Synoptic table of automated continuous flow and discontinuous flow systems.	The synoptic table must be completed with a maximum length of one page, with correct spelling and coherent writing. For each type of automated system it must include: • Components • Advantages. • Limitations. • Two applications used in the instruments. It is delivered on the day and time indicated by the teacher.	In class, students discuss with the professor about automated systems and their use in biochemical and/or clinical analysis. The student watches the videos from the links provided by the professor showing the operation of the different automated instruments in the clinical laboratory. At home, the student individually watches the videos, reviews the notes and prepares a synoptic table of the automated analysis	Application of automated methods in biochemical analysis.	Skoog, Holler, 7ª. Ed. Chapter: - Automated análisis methods. Learning platforms. Free access videos by authors such as Ha Hoang and others.

		systems and hands it in at the established time. Assessment instrument: Rubric		

Stage III: Selection of instrumental methods for sample analysis.

Component(s) of the competence:

Select the most appropriate instrumental method for the analysis of different samples according to the characteristics of the sample and/or analyte.

Evidencias de aprendizaje	Criterios de desempeño	Actividades de aprendizaje	Contenidos	Recursos
4. Written report of the proposed resolution to a case or situation raised.	The report must be a maximum of one page long, with correct spelling, order and coherence in the writing. To solve the problem, the student: • Proposes an appropriate treatment for the sample. • Proposes an appropriate instrumental technique for the analysis of the analyte(s) indicated. • Evaluates the analytical methodology based on the established performance criteria that provide reliability in the results obtained and that contribute to the	The student carefully reviews the problems of real cases that the professor presents with infographics. The student is guided and oriented in solving them. The student relates the information of the theoretical problems with the knowledge acquired in the study of each of the instrumental methods. The student, individually, prepares the report according to the criteria established by	Applications of instrumental methods in the determination of analytes of biochemical interest.	Learning platforms. Skoog, Holler y Crouch. Harris D Articles and rules for open access journals or pages. Example: Journal of AOAC, Journal of

	functional, economic and environmental improvement of the analysis. • Interprets the results Note: in each case the student **justifies** his/her response. The work is delivered to the teacher before leaving the classroom.	the professor, which must be delivered at the end of the session. Assessment instrument: Checklist		Analytical Chemistry, etc… Mexican Official Standards in cofepris.gob.mx, economia-nmx.gob.mx, etc…

7. Summative evaluation :

Evidence	Description	Weighing
1	Written evaluations.	**30**
2	Laboratory practices.	**30**
3	Comparative of automated systems.	**2**
4	Written report with proposed solutions for real problems.	**1**
Acredited activity	**Description**	**Weighing**
1A-1D	Problem solving of: A) Molecular absorption spectrometry (3 points; 3 tasks), B) Molecular emission and dispersion spectrometry (1 point; 1 task), C) Atomic absorption and emission spectrometry (1 point; 1 task) and D) High-resolution liquid and gas chromatography (5 points; 5 tasks).	**10**
2	Class participation	**5**
3A – 3C	Comparative tables of instrumental techniques: A) Molecular absorption and emission spectrophotometry. B) Atomic absorption and emission spectrophotometry. C) High-performance liquid and gas chromatography.	**6**
4A – 4C	Resolution of A) Questionnaires and problems of Mass spectrometry (1 questionnaire; 1 problem), B) Questionnaire and problem set of X-ray spectroscopy (1 questionnaire; 2 problems) and C) Problem set of nuclear magnetic resonance (1 questionnaire; 2 problems).	**6**
Course integrative project/product (CIP)		**10**

Total	**100**

8. Course integrative project/product:

Written proposal for a solution to situations raised by the teacher, justifying the selected instrumental technique, applying the performance criteria to evaluate the proposed analytical methodology and interpreting results.

9. References:

Textbook:

Skoog D.A., Holler F. J., Crouch S. (2018) *Principios de Análisis Instrumental*. (7ª edición) España: Ed. Cengage Learning.

Electronic access textbook:

Skoog, D. A. Holler F. J., Crouch S. (2009). *Principios de Análisis Instrumental*. (6ª edición) https://www.academia.edu. https://www.academia.edu/37326567/Principios_de_an%C3%A1lisis_instrumental_6ta_Edici%C3%B3n_Douglas_A._Skoog_LIBROSVIRTUAL

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Practice manual:

Dr. C. Blanca Alicia Alanís Garza, Dra. Norma Cecilia Cavazos Rocha, Dr. Ricardo Salazar Aranda, Q.C.B. Olga Catalina Rodríguez Martínez, Dr. C. David Paniagua Vega. (2024) *Manual de procedimientos de laboratorio de Análisis Instrumental*. (12ª edición) México: Ed. UANL