

**1. General information****Course:** CHEMICAL ANALYSIS II**Type:** CORE COURSE**Degree:** 376 - UNDERGRADUATE DEGREE PROGRAMME IN PHARMACY**Center:** 14 - FACULTY OF PHARMACY**Year:** 2**Main language:** Spanish**Use of additional languages:****Web site:****Code:** 14312**ECTS credits:** 6**Academic year:** 2022-23**Group(s):** 10**Duration:** First semester**Second language:** English**English Friendly:** Y**Bilingual:** N

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2. Pre-Requisites

Although no previous requirements are established, it is highly recommended, to ensure a certain guarantee of success, that the student has previously studied General Chemistry and Lab Introduction, and to possess basic knowledge on Physics and Mathematics as well.

To this extent, it is also recommended for the students to have studied and passed Chemical Analysis I.

3. Justification in the curriculum, relation to other subjects and to the profession**JUSTIFICATION IN THE CURRICULUM:**

The Pharmacist, as a health professional at the degree level, and according to the 2005/36/CE Guideline by the European Parliament and the European Council, from the 7th of September of 2005, is competent for performing the activities related to the production, preservation, and distribution of medicines, as well as to collaborate in the analytical, pharmacotherapeutic, and public health surveillance processes (article 6.2b). To develop these activities is necessary to have a wide knowledge, among others, of the contents and to acquire the competences related to the subject of Chemical Analysis II.

As described in the study programme for the degree of Pharmacy, the contents of the subject Chemical Analysis II, within the framework of the Chemistry Module, are mainly based on the study of the main prevailing analytical methods such as optical spectroscopy and non-spectroscopy methods, electrochemical methods, and methods of separation, with an special focus on chromatographic and electrophoretic techniques, which are the most prevalent separation techniques in the pharmaceutical field nowadays. Furthermore, part of the contents of the subject will be focused in other instruments of additional interest, such as mass spectrometry, sensors and the automation in pharmaceutical analysis.

RELATION TO OTHER SUBJECTS:

Chemical Analysis II is a subject taken in the first semester of the second course, as the continuation to the subject of Chemical Analysis I, which is taken in the first course of the degree.

Furthermore, to become the pharmacist a competent professional, capable of assuming all the challenges existent in a continuously growing field, which constantly demands of new experts, it will be essential to give the students a multidisciplinary education, which has permitted in the past to many pharmacists to give extraordinary contributions in many different fields of knowledge (i.e. botany, chemistry, biochemistry, bromatology, edaphology, parasitology, microbiology, etc.). It is, therefore, clearly exposed the multidisciplinary relation and links among the different basic subjects described at the Degree of Pharmacy.

RELATION TO THE PROFESSION:

As a consequence of this multidisciplinary formation in the scientific, technical and health science fields, the student who obtained the degree in Pharmacy will be capable to perform the profession in pharmacist's, at the pharmaceutical companies, in hospital and non-hospital specialized positions, in health analytical laboratories, in the field of health management, and in education or research works.

The subject of Chemical Analysis gives the professional a solid basis of knowledge in classical and instrumental analytical chemistry, in the validation of analytical methods at the pharmaceutical field, as well as in the chemical analysis using separation techniques coupled with different detection techniques (e.g. mass spectrometry) which allow to identify and determine many different compounds of pharmaceutical interest

4. Degree competences achieved in this course**Course competences**

Code	Description
B01	Proficiency in a second foreign language at level B1 of the Common European Framework of Reference for Languages.

B02	Knowledge of Information and Communication Technologies (ICT).
B03	A correct oral and written communication
B04	Ethical commitment and professional deontology.
B05	Ability to develop those learning skills necessary to undertake further studies.
EQ01	Identify, design, prepare, analyse and produce active principles, drugs and other materials and products of sanitary interest.
EQ02	Adequately choose the techniques and methodologies for the evaluation, design and application of chemical reagents, laboratory methodologies and analytical techniques.
EQ03	Complete standard laboratory processes including the employment of scientific equipment related to synthesis and analysis.
EQ04	Evaluate risks/hazards associated to the use of chemical substances and lab processes.
EQ09	Know origin, nature, design, production, analysis and drugs quality control and sanitary products.
EQ10	Know principles and procedures for the analytical determination of compounds: analytical techniques applied to water, food and environment analysis.
EQ11	Know and apply the main structural determination techniques, including spectroscopy.
G01	Identify, design, obtain, analyze, control and produce drugs and medicines, as well as other products and raw materials of sanitary interest for human or veterinary use.
G10	Design, apply and evaluate clinical reagents, methods and analytical techniques, knowing the basic principles of clinical analysis and the characteristics and contents of laboratory diagnostic reports.
G11	Evaluate the toxicological effects of substances and design and apply appropriate tests and trials.
G12	Develop hygienic-sanitary analyses, especially those related to food and environment.
G15	Recognise own limitations and the need to maintain and update professional competence, with particular emphasis on self-learning of new knowledge based on scientific evidence.
T01	Critical thinking skills based on the application of the scientific method
T02	Ability to manage quality scientific information, bibliography, specialized databases and resources accessible through the Internet.
T03	Handling of basic and specific software for the treatment of information and experimental results.
T04	Motivation for quality, safety at work and awareness of environmental issues, with knowledge of the internationally recognised systems for the correct management of these aspects.
T05	Organizational, planning and implementation skills.
T07	Ability to work as a team and, where appropriate, exercise leadership functions, encouraging entrepreneurship.

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Application of the gained knowledge on solution reactions for the qualitative analysis of substances of pharmaceutical interest.

To understand the validation strategies of analytical methodologies.

To understand the basis of the quality assurance program and of good laboratory practices with application in the pharmaceutical industry, as well as to learn about the control on raw materials, excipients, intermediary and final products.

To understand the physicochemical principles in which the different techniques of instrumental analysis are based.

Ability to apply the general system of the analytical process to solve simple practical issues with application in different fields.

Capacity to estimate the analytical results reliability together with a deep understanding of the statistical criteria applied for their evaluation, especially those related to accuracy and precision.

Good environmental practices for the management of chemical substances and residues.

Ability to select the ideal instrumental technique for the analytical and structural study of substances of pharmaceutical interest.

To identify and to understand the importance of each stage of the analytical process.

Capacity to elaborate reports on the analytical results obtained, also understandable for non experts in the field.

Self-learning: organization capacity, ability to analyze and to manage the information.

To learn the different automatic systems of analysis developed to obtain better productivity in a pharmaceutical lab.

Teamwork: critical and self-critical ability.

Additional outcomes

The student will demonstrate its ability at the use of the ICTs

The student will correctly use the language for oral and written communication.

The student will be capable of undertaking advanced subjects within the Area of Chemistry.

6. Units / Contents

Unit 1: Introduction to Instrumental Chemical Analysis.

Unit 2: PART I. OPTICAL TECHNIQUES OF ANALYSIS APPLIED TO PHARMACY. (Unit 2. Introduction to Optical Techniques)

Unit 3: Ultraviolet-visible molecular absorption spectrophotometry

Unit 4: Molecular fluorescence spectroscopy

Unit 5: Atomic spectroscopy

Unit 6: Atomic absorption

Unit 7: Atomic emission

Unit 8: PART II. ELECTROANALYTICAL TECHNIQUES APPLIED TO PHARMACY. (Unit 8. Basics of electrochemical techniques)

Unit 9: Potentiometry

Unit 10: Voltammetry. Polarography

Unit 11: PART III. SEPARATION TECHNIQUES APPLIED TO PHARMACY (Unit 11. Introduction to separation techniques)

Unit 12: Introduction to chromatography

Unit 13: Planar Chromatography

Unit 14: Column Liquid Chromatography

Unit 15: Gas Chromatography

Unit 16: Non-chromatographic techniques: Electrophoresis

Unit 17: PART IV. CURRENT ANALYSIS TRENDS (Unit 17. Mass Spectrometry)

Unit 17.1 Mass Spectrometry

Unit 18: Automated methods in analytical chemistry

Unit 19: PART V. LABORATORY PRACTICES

Unit 19.1 Optical methods: 1. Colorimetric determination of nitrites in water samples

Unit 19.2 Optical methods: 2. Determination of veterinary drugs (sulfaquinoxaline and sulfometacin). Resolution of mixtures using UV-vis spectrophotometry.

Unit 19.3 Electroanalytical methods: 1. Determination of conductivity, salinity, pH in biological fluids (urine). 2. Determination of Fluorides in mouth rinses using ESI.

Unit 19.4 Separation methods: 1. Separation and determination of AAS and paracetamol by HPLC in pharmaceutical formulations.

Unit 19.5 Separation methods: 2. Separation and determination of antidepressants (sertraline and citalopram) in pharmaceutical formulations by gas chromatography (GC-FID).

7. Activities, Units/Modules and Methodology							
Training Activity	Methodology	Related Competences (only degrees before RD 822/2021)	ECTS	Hours	As	Com	Description
Class Attendance (theory) [ON-SITE]	Combination of methods	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	1.44	36	Y	N	All the educational resources will be at the students' disposal at Moodle platform before the start of each activity. Furthermore, the students will have access to complementary bibliographic and audiovisual material (e.g. books, review articles, videos) sited at the University Library in the Campus of Albacete. The active participation of the student through the cooperative work, not only during the lessons but also out of the classroom for the elaboration of works as well as at problem solving, defense of works and seminars, will be considered for the final evaluation.
Class Attendance (practical) [ON-SITE]	Practical or hands-on activities	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	0.8	20	Y	Y	Labwork will be carried out in reduced groups within the time periods previously established at the academic schedule, in order to not concur with other educational activities. The activities will be carried out in laboratories totally equipped with the necessary instruments and reagents required to reach the proposed objectives. The student will not pass the whole subject unless he/she does not pass the practical lessons. The labwork of Chemical Analysis II consists of tutored practical lessons, closely related to the theoretical contents of the subject.
Study and Exam Preparation [OFF-SITE]	Self-study	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	3.6	90	Y	N	Individual work performed by the student to study and to acquire the required knowledge of the contents of the subject. The student can ask for individual tutorship sessions on certain contents of the subject. Previously, the student should arrange the appointment with the corresponding professor.
Mid-term test [ON-SITE]	Assessment tests	B01 B02 B03 B04 B05 EQ01 EQ02 EQ03 EQ04 EQ09 EQ10 EQ11 G01 G10 G11 G12 G15 T01 T02 T03 T04 T05 T07	0.16	4	Y	N	There are specific dates at the academic calendar reserved for the evaluation tests which do not coincide with other academic activities. Two proofs will be performed throughout the course, in which the student will demonstrate the correct acquisition of the required capacities to pass the subject by continuous evaluation.
Total:			6	150			
Total credits of in-class work: 2.4			Total class time hours: 60				
Total credits of out of class work: 3.6			Total hours of out of class work: 90				

As: Assessable training activity

Com: Training activity of compulsory overcoming (It will be essential to overcome both continuous and non-continuous assessment).

8. Evaluation criteria and Grading System			
Evaluation System	Continuous assessment	Non-continuous evaluation*	Description

Final test	70.00%	70.00%	<p>The student will pass the subject by continuous evaluation during the academic year. With this purpose, he /she will have to pass two progress tests including both theoretical contents and problems seminar or real cases to be solved. 70% of the final score will be distributed by these two non-mandatory tests, also recuperable. Each of these two progress tests will account for 35% of the final score each.</p> <p>Each progress test will consist of two independent tests, one to evaluate the theoretical concepts acquired and the second one focused in solving several problems or seminars proposed. Each part will account from 40 up to 60% of the score corresponding to each progress test.</p> <p>To pass the subject, the student must pass the module of theoretical contents (Parts I, II, III and IV).</p>
Laboratory sessions	20.00%	20.00%	<p>Application to labwork of the knowledge previously acquired. The skills obtained in reagents and lab material handling, as well as the student's attitude, and the adequate elaboration of the laboratory notebook will be evaluated. This part will represent the 50% of the final score of the labwork. Additionally, an exam regarding the practical activities will represent the remaining 50% of this final score.</p> <p>The final score of the practical module accounts for 20% of the final score of the subject. Once the student passes the Practical Module, the score obtained will be maintained for the following two courses.</p> <p>The assistance to lab practical lessons is mandatory to pass this module. Additionally, to pass the subject, the student should have passed this Practical Module (Part V).</p>
Assessment of active participation	10.00%	10.00%	<p>During the course, the professor will propose the students to elaborate individually a maximum of two theoretical works (Basic development of some units).</p> <p>The active participation of the student at the lectures, the tutored lessons and other diary activities will also be evaluated. Group or individualized tutored lessons will be given to monitor the learning process of the students. These lessons would contain theoretical contents, seminars, problem solving lessons, or performing real cases related to the contents of the subject.</p> <p>The autonomous work of the student performed for the individual works asked by the professor will be positively considered, as well as the rate of performance at the public exposition of this work, and/or his/her role at teamwork if required.</p> <p>Model exercises will be solved at the lessons in order to help the students to understand the theoretical concepts acquired during the previous lectures. The active role of the student at the seminars will additionally be considered.</p>
Total:	100.00%	100.00%	

According to art. 4 of the UCLM Student Evaluation Regulations, it must be provided to students who cannot regularly attend face-to-face training activities the passing of the subject, having the right (art. 12.2) to be globally graded, in 2 annual calls per subject, an ordinary and an extraordinary one (evaluating 100% of the competences).

Evaluation criteria for the final exam:

Continuous assessment:

As previously mentioned in the evaluation criteria section, the subject contains two Modules, theoretical and practical, respectively. In case of not passing the subject by continuous assessment, and according to the previously established criteria, the student will have to take a final retrievable exam at the ordinary call.

In this test, the student will be examined on the Module of Theory (70%), but the score on activities performed by the student during the course (10%) and on practical lessons (20 %) will also be considered.

Non-continuous evaluation:

Evaluation criteria not defined

Specifications for the resit/retake exam:

In case of not passing the final retrievable exam, the student can take the resit exam. For the final score, the contents evaluated in this test will account for 70% of it, as well as the score obtained for practical work performed, will account for 20% of the final score. The activities performed by the student during the course will also be evaluated, accounting for 10 % of the final mark.

In case of not having passed the Practical Module of the subject, the student will have to take a resit exam, in which he/she will be evaluated of the theoretical (70%) and practical contents of the subject (20%). These two results will sum up 90% of the final score of the subject. At this exam, the score related to the activities performed by the student during the course will also be considered (10%).

Specifications for the second resit / retake exam:

Only the students who accomplished the requisites exposed at the Student Evaluation Regulation of the University of Castilla-La Mancha will have access to this exam, and they will be evaluated according to the criteria exposed for the Retake Exam.

9. Assignments, course calendar and important dates	
Not related to the syllabus/contents	
Hours	hours
Class Attendance (theory) [PRESENCIAL][Combination of methods]	36
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20

Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Mid-term test [PRESENCIAL][Assessment tests]	4
Global activity	
Activities	hours
Class Attendance (theory) [PRESENCIAL][Combination of methods]	36
Class Attendance (practical) [PRESENCIAL][Practical or hands-on activities]	20
Study and Exam Preparation [AUTÓNOMA][Self-study]	90
Mid-term test [PRESENCIAL][Assessment tests]	4
Total horas: 150	

10. Bibliography and Sources							
Author(s)	Title/Link	Publishing house	Citv	ISBN	Year	Description	
Ángel Ríos Castro, María Cruz Bondi Moreno y Bartolomé M. Simonet Suau	Técnicas espectroscópicas en química analítica Volumen I. Aspectos básicos y espectrometría molecular https://www.sintesis.com/biblioteca%20de%20qu%C3%ADmica-138/t%C3%A9cnicas%20espectrosc%C3%B3picas%20en%20qu%C3%ADmica%20anal%C3%ADtica.%20volumen%20i-ebook-1714.html	Sintesis	Madrid		2012		
Ángel Ríos Castro, María Cruz Bondi Moreno y Bartolomé M. Simonet Suau	Técnicas espectroscópicas en química analítica. Volumen II. Espectrometría atómica, de iones y electrones https://www.sintesis.com/biblioteca-de-quimica-138/tecnicas-espectroscopicas-en-quimica-analitica-volumen-ii-libro-1715.html	S	Madrid	978-84-995893-1-2	2012		
Gary D. Christian	Química Analítica (6ª Edición)	Mc Graw Hill		0-471-21472-8	2009		
L. Hernández y C. González	Introducción al Análisis Instrumental	Ariel Ciencia	Barcelona	84-344-8043-8	2002		
R. Cela, R.A. Lorenzo, M.C. Casais	Técnicas de separación en Química Analítica	Sintesis	Madrid	84-9756-028-0	2002		
Schwedt, G.	The Essential Guide to Analytical Chemistry	John Wiley and Sons	Chichester	0471974123	1999		
Skoog D. A., West D. M., Holler F. J. y Crouch S.R.	Fundamentos de Química Analítica	Thomson Editores		8497323335	2005		
Walton, Harold F.	Análisis Químico e Instrumental moderno	Reverté	Barcelona	8429175199	1983		
R. Compañó y A. Ríos	Garantía de la calidad en los laboratorios analíticos	Sintesis	Madrid	84-9756-024-8	2002		
Skoog, D. A.; Leary, J.J.	Análisis Instrumental	McGraw-Hill	Madrid	84-481-0191-X	1998		
Bard, A. J.; Faulker, L. R	Electrochemical Methods: Fundamentals and Applications	John Wiley and Sons	Chichester	0471043720	2001		
Rubinson K. A.; Rubinson J.F.	Análisis Instrumental	Ed. Prentice Hall		8420529885	2004		
Skoog, D. A; Holler, F. J.; Nieman, T. A	Principios de Análisis Instrumental	McGraw-Hill	Madrid	8448127757	2010		