Universidad de Alcalá

COURSE GUIDE

ANALYTICAL TECHNIQUES II

(Revisada en CD el 18-06-24)

DEGREE IN PHARMACY
University of Alcalá

Academic Year 2024/2025
2nd Year – 2st Semester

COURSE DESCRIPTION

Name of the course:	**Analytical Techniques II**
Code:	**577014**
Degree:	**DEGREE IN PHARMACY**
Department and Area of Knowledge:	**Analytical Chemistry, Physical Chemistry, and Chemical Engineering / Analytical Chemistry**
Type of course:	**Compulsory**
ECTS:	**6 ECTS (4,5 theory + 1,5 experimental)**
Course and period	**Second / Second semester**
Instructor:	Dra. Ana María Diez Pascual Dra. Merichel Plaza del Moral
Coordinator:	**Dr. Fidel Ortega Ortiz de Apodaca**
Schedule for Tutorials:	Appointment with the instructor
Language of Instruction:	**English**

1. PRESENTATION

Learning of this course will allow students to know and apply different instrumental techniques used in quantitative and qualitative analysis of chemical species of pharmaceutical interest. This course focuses on formulating questions, selecting, and studying analytical techniques, understanding the analytical problem, and developing critical reasoning for the provision of analytical information. This matter is an essential element in the pharmacist's professional training covering different fields such as drug, food, environmental and clinical analysis.

Prerequisites and Recommendations (if applicable)

It is highly recommended an adequate comprehension of the English language to easily follow the lectures.

2. COMPETENCES

General Competencies (Orden CIN/2137/2008, 3 de julio) and Learning Outcomes

1. Identify, design, obtain, analyze, control and produce drugs and medicines, as well as other products and materials of sanitary interest for human or veterinary use.

2. Know how to apply the scientific method and acquire skills in managing legislation, sources of information, bibliography, elaboration of protocols and other aspects that are considered necessary for the design and critical evaluation of clinical and preclinical trials.

3. Develop hygienic-sanitary analysis, especially those related to food and the environment.

4. Develop communication and information skills, both oral and written, to deal with patients and users involved in the future professional activity of the graduates. Promote work and collaboration skills in multidisciplinary teams and those related to other health professionals.

5. Recognize one's own limitations and the need to maintain and update professional competence, paying special attention importance to the self-learning of new knowledge acquired in the available scientific evidence.

Specific competencies:

1. Identify, design, obtain, analyze and produce active ingredients, drugs and other products and materials of interest sanitary.

2. Select the appropriate techniques and procedures in the design, application and evaluation of reagents, methods and techniques analytics.

3. Carry out standard laboratory processes including the use of scientific equipment for synthesis and analysis, appropriate instrumentation included.

4. Know the origin, nature, design, production, analysis and control of medicines and medical devices.

5. Know the principles and procedures for the analytical determination of compounds: analytical techniques applied to the analysis of water, food and environment.

6. Know and apply the main structural research techniques, including spectroscopy.

3. CONTENTS

Lectures:

THEMATIC UNIT I – OPTICAL METHODS.

Chapter 1. Overview. Introduction to instrumental analysis. Transduction: concept and types. Classification of instrumental techniques. Signal and noise. Calibration in instrumental analysis.

Chapter 2. Overview of spectroscopy. Electromagnetic radiation: wave and particle properties. The electromagnetic spectrum. Interaction of electromagnetic radiation with matter: Origin of the spectra. Spectroscopy based on absorption. Spectroscopy based on emission. Instrumentation: basic components of spectroscopic instruments.

Chapter 3. UV/Vis molecular absorption spectroscopy. Introduction. Transmittance and absorbance. Absorbance and concentration: Lambert-Beer's law. Lambert-Beer's law and multicomponent samples. Limitations of Lambert-Beer's law. Instrument designs for molecular UV/Vis absorption. Quantitative and qualitative applications.

Chapter. 4. Infrared molecular absorption spectroscopy. Molecular vibrations. General approach to IR spectrum analysis. Factors controlling frequency groups. Instrument designs and components for infrared absorption. Applications.

Chapter 5. Molecular emission spectroscopy. Overview of luminescent techniques. Photoluminescence: fluorescence and phosphorescence. Factors that affect fluorescence. Excitation and emission spectra. Relation between fluorescence intensity and concentration. Instrumentation. Applications. Chemo- and bioluminescence.

Chapter 6. Atomic absorption spectroscopy. Overview. Atomic spectra. Instrumentation: spectral line sources, flame atomizers, electrothermal atomizers. Interferences. Applications.

Chapter 7. Atomic emission spectroscopy. Overview. Flame emission spectroscopy and Inductively Coupled Plasma (ICP). Instrumentation and applications.

THEMATIC UNIT II – ANALYTICAL SEPARATIONS.

Chapter 8. Overview of analytical separations. Classification of separation techniques. Chromatographic separation techniques. Principles of chromatographic techniques. Classification. Column chromatography: fundamental parameters and equations governing the chromatographic process. Resolution of practical exercises.

Chapter 9. High-Performance Liquid Chromatography (HPLC). Basic instrumentation and components: mobile phase, column, pumping system, injector, and detector. Separation modes. Applications. Thin-layer chromatography. Resolution of practical exercises.

Chapter 10. **Gas chromatography (GC).** Basic instrumentation and components: mobile phase, column, pumping system, injector, and detector. Chromatographic process control. Derivatisation. Applications. Supercritical Chromatography.

Chapter 11. Electrophoretic techniques. Principles of electrophoretic techniques. Characteristics of capillary electrophoresis. Separation modes. Instrumentation. Applications.

THEMATIC UNIT III – OTHER TECHNIQUES.

Chapter 12. Non-spectroscopic optical methods. Refractometry, refractometers. Applications. Polarimetry, instrumentation, applications. Turbidimetry and nephelometry. Theoretical basis, instrumentation. Applications. Resolution of practical exercises.

Chapter 13. **Mass spectrometry (MS).** Basic principles. Instrumentation. Coupled techniques. Applications.

Chapter 14. Thermal analysis. Overview. Thermogravimetry. Differential thermal analysis. Differential scanning calorimetry. Instrumentation. Applications

Laboratory:

1. Analysis of mixtures by molecular absorption spectrophotometry
2. Detemination of sodium and potassium by flame photometry.
3. Determination of paracetamol and ascorbic acid by infrared spectroscopy.
4. Separation of compounds of a pharmaceutical preparation by by High-Performance Liquid Chromatography (HPLC)
5. Determination of sulphates by turbidimetry.
6. Refractometry: measurement of the refractive index of samples of analytical interest.
7. Polarimetric measurement of optically active substances.

Seminars:

Seminars 1-4. - Exercises and case studies on chapters 1-7
Seminars 5-8. - Exercises and case studies on chapters 8-14.

3.1. Organization of the course

Thematic Unit	Topics	Hours
I. Optical methods	**Chapters 1-7** **Seminars 1-4** **Practical work 1-3**	14 hours (lectures) 4 hours (seminars) 10 hours (laboratory)
II. Analytical Separation	**Chapters 8-11** **Seminars 5-6** **Practical work 4**	9 hours (lectures) 2 hours (seminars) 4 hours (laboratory)
III. Other Techniques	**Chapters 12-14** **Seminar 7-8** **Practical work 5**	5 hours (lectures) 2 hours (seminars) 4 hours (laboratory)

4. TEACHING-LEARNING METHODOLOGIES. TRAINING ACTIVITIES

4.1. Distribution of the teaching (Number of hours)

Number of classroom hours:	• Number of lecture hours: 28 hours • Number of hours in seminars: 8 hours • Number of hours in laboratory: 18 hours • Group Tutorials: 4 hours
Number of hours of independent study:	• Calculations and analysis of laboratory results: 15 hours • Independent study and elaboration of works: 72 hours • Self-assessment tests and/or evaluation through the virtual platform: 5 hours
Total	150 hours (6 ECTS)

4.2. Methodological strategies

Presential activities	**Large group (T):** lecture classes and discussion with the students. The contents of the chapters will be presented, the most important concepts will be explained and questions that help to understand the concepts will be solved. Some theoretical content will be illustrated with computer and/or audiovisual materials. Participative dynamics may be used to encourage student participation and interaction with the teacher. The resolution of numerical problems and questions previously provided and related to the subject will be undertaken. Some group activity may be proposed so that students solve small cases or proposed problems. **Laboratory group (P):** the student will develop experiments to learn, with real systems, to apply and interpret the basic principles developed in the theoretical classes, contributing to develop their observation capacity, the analysis of results, critical thinking, and understanding of the scientific method. **Materials and resources to be used for the development of each activity:** mainly blackboard, complemented with audiovisual material prepared by the teacher (slides, PowerPoint presentations), printed materials (fact sheets with numerical exercises and questions, complementary examples), laboratory related materials (specific contents for each practice and practice scripts), online materials (Virtual Classroom Platform, My Portal,

	specialized websites for simulation and practices), etc.
Remote activities	**Autonomous study.** Analysis and assimilation of the contents of the subject, problem solving, bibliographic search and reading, recommended reading, use of virtual simulation applications, preparation of individual and/or group assignments, and self-evaluation tests. Use of the **virtual classroom** to promote the interaction of the students with the subject outside the classroom, as well as to facilitate their access to selected information useful for their non-classroom work.

5. ASSESSMENT

PROCEDURES FOR EVALUATION

In each academic year, the student has the right to have two calls, one ordinary and one extraordinary. The ordinary call will be based on continuous evaluation, except in those cases contemplated in the regulations for the evaluation of the UAH, and students will have access to the final evaluation. To benefit from this final evaluation procedure, the student will have to request it in writing to Dean or Center Director in the first two weeks of the subject, explaining the reasons why the continuous assessment system will continue.

In case there are students who for justified reasons have not formalized their registration on the date of the start of the course or the period of delivery of the subject, the term indicated is a computation from its incorporation to the degree.

Regular call:

Continuous assessment

The continuous assessment will follow the regulations for the evaluation of the UAH (Art. 9). Attendance to classes, seminars, and tutoring is mandatory and only a maximum of 20% of absents will be allowed. The active participation of students in all face-to-face activities and work carried out, as well as the skills developed during the practical lessons, will be evaluated. The students must demonstrate a minimum level in the acquisition of the corresponding competencies so that their global qualification is obtained.

The theoretical knowledge of the subject will be assessed through two written tests corresponding to Thematic Unit I and Thematic Units II + III, all of which constitute 75% of the overall grade. It will be considered that each of the theory parts (Thematic Unit I and Thematic Units II +II) will be passed when the grade obtained in each of them is equal to or greater than 5.0.

The practical contents of the subject will be assessed through a theoretical-practical test, also considering the student´s performance in the laboratory, as well as the realization of reports, all of which constitute 25% of the overall grade. It will be considered that the practices will be passed when the grade obtained is equal to or greater than 5.0.

Participate in the continuous evaluation implies to consume the ordinary call. Continuous assessment students who wish to appear as not presented in this call must communicate it through writing to the Department's secretariat within the established deadline (towards the middle of the subject).

In case of not participation in the ordinary call, students will have the right to perform a final exam in the extraordinary call.

Final assessment

Exceptionally, students who have not opted for continuous assessment and are registered in the Dean's Office, will perform a global examination consisting of questions, problems and / or practical exercises that allow assessing the acquisition of the skills included in the teaching guide.

Extraordinary call:

It will be assessed through one written test corresponding to all thematic units that will consist of questions, problems, and/or practical exercises that allow assessing the acquisition of the skills included in the Course Guide. Students who have completed the practices and have failed must pass one test of a practical nature in the laboratory.

ASSESSMENT CRITERIA

1. Attendance and participation in seminars.
2. Assimilation and understanding of course's content.
3. Ability to apply acquired knowledge.
4. Integration and communication of knowledge.
5. Interpretation of results and resolution of questions and problems.
6. Time management for planning activities and laboratory experiments.

RATING CRITERIA

Carrying out the laboratory practices is mandatory for all students taking the course because this subject has experimental and technical character. The students must also pass the corresponding exam, regardless of the type of exam they take.

Numerical ratings (%) of activities

To pass the course will require:

Continuous assessment. Normal and extraordinary calls: theoretical content (75%) and practical work (25%). This percentage will be shared 50% between Thematic Unit I and Thematic Units II + III.

Final assessment. Normal and extraordinary calls: theoretical content (75%) and practical work (25%). Due to the different competencies pursued with theoretical content and practical work and lacking information from continuous assessment, students will have to demonstrate sufficient knowledge and skills within each part, separately.

During the development of the evaluation tests, the guidelines established in the Coexistence Rules of the University of Alcalá will be followed, as well as the possible implications of the irregularities that could be committed in the evaluation tests, including the consequences for committing academic fraud according to the Regulations for the Disciplinary Regime of the Students of the University of Alcalá.

6. BIBLIOGRAPHY

[1] Quantitative Chemical Analysis, Daniel C. Harris. Eighth edition, 2010. W.H. Freeman & Company. New York. **BAF543.062HAR**

[2] Analytical Chemistry 2.0 (eText), David Harvey.

[3] Fundamentals of Analytical Chemistry. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch. Ninth edition, 2014. Thomson – Brooks/Cole. **BAF543SKO**