

**COURSE DATA****Data Subject**

|                      |                   |
|----------------------|-------------------|
| <b>Code</b>          | 34064             |
| <b>Name</b>          | Chemical Analysis |
| <b>Cycle</b>         | Grade             |
| <b>ECTS Credits</b>  | 9.0               |
| <b>Academic year</b> | 2021 - 2022       |

**Study (s)**

| <b>Degree</b>  | <b>Center</b>                         | <b>Acad. year</b> | <b>Period</b> |
|--|---------------------------------------|-------------------|---------------|
| 1201 - Degree in Pharmacy  | Faculty of Pharmacy and Food Sciences | 2                 | Annual        |
| 1211 - Double Degree in Pharmacy and Human Nutrition and Dietetics | Faculty of Pharmacy and Food Sciences | 2                 | Annual        |

**Subject-matter**

| <b>Degree</b>  | <b>Subject-matter</b>  | <b>Character</b> |
|--|--|------------------|
| 1201 - Degree in Pharmacy  | 4 - Chemical analysis  | Obligatory       |
| 1211 - Double Degree in Pharmacy and Human Nutrition and Dietetics | 1 - Asignaturas obligatorias del PDG Farmacia-Nutrición Humana y Dietética | Obligatory       |

**Coordination**

| <b>Name</b>                       | <b>Department</b>          |
|-----------------------------------|----------------------------|
| ESTEVE TURRILLAS, FRANCESC ALBERT | 310 - Analytical Chemistry |

**SUMMARY**

Chemical Analysis is a compulsory core subject of 9 ECTS credits to be taught in the second course of the degree in Pharmacy. Attending to the proficiencies that a pharmacist has to develop, chemical analysis can be considered as a needed discipline, essential for the proper development in their professional practice. This subject introduces and develops the essential knowledge needed for the identification and determination of chemical compounds in matrices of pharmaceutical interest. The program consists of 12 thematic units divided into three blocks and a thematic unit that includes a series of laboratory practices involving the application of some of the analytical methods included in the program.



In the first block general objectives and work in chemical analysis are discussed. Steps of the analytical process are described and finally referring to statistical treatment of analytical results.

Then, work methods and applications of volumetric and gravimetric methods commonly known methods of analysis are studied.

The program ends with 6 lessons that are dedicated to the description of different instrumental methods of analysis: optical methods, electroanalytical methods and chromatographic methods.

For each basis and necessary instrumentation, way of working and usefulness for analysis of substances of interest in the pharmaceutical field it indicated.

Subject concepts will be related to those sustainable development goals that are part of the 2030 Agenda.

## PREVIOUS KNOWLEDGE

### Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

### Other requirements

In order to successfully address the subject, is essential that the student gathers a number of previous knowledge and skills:

- Nomenclature and chemical formulation.
- Adjusting of chemical reactions.
- Chemical equilibrium in solution.
- Stoichiometric calculations.
- Basic mathematical calculations (solving equations, operations with logarithms, systems of equations ...)
- Use of the scientific calculator for performing mathematical operations and least squares regression.

## COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

### 1201 - Degree in Pharmacy

- To possess and to understand the knowledge in the different areas of study included in the formation of the pharmacist.
- To apply this knowledge to the professional world, contributing to the development of Human Rights, democratic principles, principles of equality between women and men, solidarity, protection of the environment and promotion of a culture of peace with Gender perspective.
- To know how interpret, value and communicate relevant data in the different aspects of pharmaceutical activity, making use of information and communication technologies.
- Skill to communicate ideas, analyze problems and solve them with a critical mind, achieving team-working abilities and assuming leadership whenever required.



- Development of skills to update their knowledge and undertake further studies, including pharmaceutical specialization, scientific research and technological development, and teaching.
- Ability to collect and transmit information in English with a level of competence similar to the B1 of the Council of Europe.
- Identify, design, obtain, analyze, control and produce drugs and medicines and other products and raw materials of health interest for human or veterinary use.
- Module: Chemistry - Ability to select appropriate techniques and procedures in the design, application and evaluation of reagents, methods and analytical techniques.
- Develop hygienic-sanitary analyzes, especially those related to food and the environment.
- Identify and understand the importance of each stage of the analytical process.
- Understand the importance of quality control in the analytical laboratory, as well as the statistical procedures and tools necessary to carry out this control.
- Establish the classification of the main analytical methods, understand their fundamentals and know how to select their use according to the purpose of the analysis.
- Properly employ the working methodologies of the techniques used in practical laboratory sessions and know how to prepare and submit an analytical report.

### **LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)**

After completing this subject, students should be able to:

- Identify and describe each stage in the analytical process.
- Apply basic statistic basis for evaluating the quality of analytical results.
- Apply the procedures and statistical tools needed to carry out quality control in the analytical laboratory.
- Establish the classification of the main instrumental techniques for analysis.
- Apply properly different calibration methods for quantification in instrumental analysis.
- Define and calculate the most important figures of merit in the instrumental methods.
- Enumerate the main separation techniques and understand their basis and objectives.
- Define and explain concepts related to the volumetric and gravimetric methods and expose their main applications of health interest.
- Apply an adequate methodology for performing calculations in volumetric and gravimetric applications.



- Enumerate and explain the main electrochemical techniques and their applications.
- Describe the basis, experimental methodology and the main applications of the various techniques of molecular spectrometry and analytical characteristics of them.
- Describe the basis, experimental methodology and the main applications of the different techniques of atomic spectrometry and analytical characteristics of them.
- Enumerate and expose the basis of the different chromatographic methods and how to interpret adequately the information provided by chromatograms.
- Define the concept of hybrid (coupled) instruments and their importance for the elucidation and analysis of samples.
- Describe the most important coupled systems based on gas chromatography and liquid chromatography.
- Detail the highlights of automation in the analytical laboratory.
- Explain the basis and the main applications of chemical sensors.
- Work properly in an analytical laboratory.
- Use adequate working methods of the techniques used in practice laboratory sessions.

Develop and submit an analytical report based on data obtained in the laboratory, after performing the calculations and the appropriate statistical treatment.

## DESCRIPTION OF CONTENTS

### 1. INTRODUCTION TO ANALYTICAL CHEMISTRY

Concept and structure. Types and levels of information. Stages of the analytical process. Classification of analytical techniques. Importance of qualitative and quantitative analysis in the pharmaceutical field.

### 2. SAMPLING, STORAGE, TRANSPORT AND PREPARATION OF MATERIALS

Importance of the processes of sampling and treatment of materials. Sampling. Sampling plan. Implementation of the sampling plan. Previous treatments of the sample. Filtration and centrifugation. Initial dissolution. Deproteinization. Extractive separation techniques. Other isolation and preconcentration techniques.

### 3. EVALUATION OF DATA, CALIBRATION AND VALIDATION OF ANALYTICAL METHODS



Errors in chemical analysis. Precision and accuracy. Rejection of discordant results. Presentation of analytical results. Concept of calibration. Linear calibration. Analytical figures of merit: sensitivity, detection and quantification limits, dynamic range. Standard addition method. Internal standard method. Concept validation. Hypothesis testing. Validation of accuracy. Validation of accuracy.

#### **4. VOLUMETRIC AND GRAVIMETRIC ANALYSIS**

Introduction to volumetric methods. Fundamentals of gravimetric methods. Precipitation mechanisms. Basic operations of gravimetric analysis. Calculations. Combustion analysis. Some applications of pharmaceutical interest.

#### **5. ACID-BASE TITRATIONS AND BUFFER SOLUTIONS**

Acid-base equilibrium. Titrating strong acids and strong bases. Titrating weak acid, weak bases and polyprotic systems. Buffer solutions: concept, limitations and utilities.

#### **6. OTHER TITRATIONS. CONCEPT OF SIDE REACTION**

Equilibrium of complex formation and precipitation: concepts of side reaction and conditional constant. Complexation and precipitation titrations. Equilibrium and redox titration.

#### **7. ELECTROCHEMICAL ANALYSIS**

Electrochemical cells. Electrode potentials. Potentiometry. Voltammetry. Instrumentation. Analytical methodology. Analytical features and performance. Some applications of pharmaceutical interest in qualitative and quantitative analysis. Electrochemical sensors.

#### **8. ANALYTICAL SPECTROMETRY**

Fundamentals. Instrumentation. Analytical methodology. Analytical features and performance. Some applications of pharmaceutical interest in qualitative and quantitative analysis in molecular and atomic spectrometry. Optical sensors.

#### **9. INTRODUCTION TO CHROMATOGRAPHIC ANALYSIS AND COUPLED METHODS**

Concept and classification of chromatographic techniques. Chromatographic modes. Main parameters in chromatography. Theory of the chromatographic separations. Coupled methods.

**10. GAS CHROMATOGRAPHY**

Fundamentals. Components in a gas chromatograph. Columns and stationary phases. Detectors. Effect of temperature. Analytical methodology. Some applications of pharmaceutical interest in qualitative and quantitative analysis. GC-MS analysis.

**11. LIQUID CHROMATOGRAPHY**

Fundamentals. Classification. Thin Layer Chromatography. Column chromatography. Components in a liquid chromatograph. Analytical methodology. Some applications of pharmaceutical interest in qualitative and quantitative analysis. LC-MS analysis.

**12. ELECTROPHORESIS**

Fundamentals. Classification. Basic parameters. Capillary and gel electrophoresis. Methodology. Applications of pharmaceutical interest.

**13. LABORATORY SESSIONS**

SESSION 1.- Determination of total hardness of water by complexometric titration

SESSION 2.- potentiometric determination of fluoride in toothpaste

SESSION 3.- Colorimetric determination of N-acetyl-L-cysteine with Fe (III) and 1,10-phenanthroline in pharmaceutical preparations

SESSION 4.- Determination of calcium content in tablets by atomic absorption spectrometry

SESSION 5.- Quality control of pharmaceutical preparations: determination of paracetamol, aspirin and caffeine by HPLC

**WORKLOAD**

| ACTIVITY                                     | Hours         | % To be attended |
|--|---------------|------------------|
| Theory classes                               | 40,00         | 100              |
| Laboratory practices                         | 25,00         | 100              |
| Seminars                                     | 15,00         | 100              |
| Tutorials                                    | 4,00          | 100              |
| Preparing lectures                           | 62,50         | 0                |
| Preparation of practical classes and problem | 70,00         | 0                |
| <b>TOTAL</b>                                 | <b>216,50</b> |                  |



## TEACHING METHODOLOGY

The subject is structured considering five types of activities for its development: lectures, problems seminars, laboratory sessions, tutorial sessions and workshops.

**Lectures and problems seminars.** Since the subject has a very practical nature, lectures and problem classes are alternated throughout the course, up to a total of forty hours of lectures (20 hours / semester). The time spent on theory and problems will vary depending on the needs.

**Lectures.** In the lectures, the instructor will offer an overview of the topic, emphasizing in the key concepts for understanding, and he/she will answer incidental doubts or questions.

**Problems seminars.** They have the aim of applying the knowledge acquired the lectures by solving questions and problems. The instructor will resolve for the whole class some selected problems; the students will work other new examples in small groups. Additional problems will be proposed to the students, to be resolved individually and they will be discussed with the instructor along individual evaluation meetings.

**Tutorial sessions.** Students will assist in small groups, participating in 4 sessions along the course. In them, the teacher will give to the student advices on all the elements of the learning process, in terms of global strategies and specific issues. Also, students will present the results they have obtained on the additional problems and the questions set by the teacher, and will discuss them on the blackboard.

**Laboratory sessions.** Prior to attending the lab, the student must have studied the script of each practice, review all the theoretical concepts involved, answer a series of previous questions, and prepare a flow diagram of the work to do. In the lab, the teacher will emphasize the most important points on the current session and will supervise the experiments. Once completed the experimental work, the student will perform the relevant calculations and will process statistically the gathered data, using spreadsheets and software available in the lab PCs. During the last laboratory session, the students will be evaluated by an oral exam on some issues discussed during the practical sessions. Finally, the student will prepare a detailed report showing the analytical results in all experiments performed.

**Workshops.** Throughout the course there will be workshops on various aspects of depth on the subject. The teacher will provide the necessary materials and propose a series of activities to promote learning.



## EVALUATION

The assessment of student learning will take into account all aspects outlined in the methodology section of this guide and be conducted in a continuous manner by the teacher. For this, the course is divided into three sections: theory, practice and other activities.

The rating of block theory constitutes 60% of the final grade. This section describes the knowledge acquired will be evaluated by performing two written tests throughout the course, the first at the end of the first quarter and the second will coincide with the first call. The tests will consist of two parts: (i) conceptual issues, which may also include topics to be developed for demonstrating the ability of synthesis and exposure, and (ii) problems that allow the student to demonstrate the degree of assimilation of fundamental concepts. The minimum offset between the two parts of the tests will be 4.

The minimum offset between the two partial exams note will be 4. The minimum mark to be obtained in theory block to average with the other activities of the subject is 4.5. Those students who do not pass the minimum grade average in theory but have received a higher rating to 5 in either of the two parties (first or second semester) will be able to keep that note for the second call the academic year in force, but it will not be maintained for subsequent courses.

To evaluate laboratory practice, compulsory attendance, will have to deliver memory and analytical report with the results obtained in all the practices. In addition, during the final practice session, an examination on issues discussed during the performance thereof will be made. The practice report 20% of the practice note, 30% consideration of issues and 50% the results obtained (depending on the precision and accuracy thereof) will be assessed. This rating will involve 20% of the final grade. In the case of not passing the subject, if the mark obtained in this block is equal or higher than 5.0, it can be maintained over the next two academic years.

20% of the overall grade for the course will come from activities in any of the sections of the learning process. Aspects are taken into account: active participation in tutorials, preparation and presentation of the proposed activities; class attendance, reasoned and clear participation in the discussions raised; progress in the proper use of chemical language; raising doubts; critical thinking and ability to collaborate with the rest of the group. In the case of not passing the subject, the mark obtained in this block will NOT be maintained for subsequent courses.

### FIRST CALL

The final course grade is calculated from the marks of theory, practices and activities by the following expression

$$\text{FINAL rating} = \text{THEORY} \times 0,60 + \text{LABORATORY} \times 0,20 + \text{CONTINUOUS ASSESSMENT} \times 0,20$$

This expression only applies in the case of having obtained a minimum score of 4.5 points out of 10 on each of the parties. In order to pass the subject it is necessary to obtain a final grade of 5 points out of 10. If you obtain a final grade of less than 5 points, or if you did not obtain the minimum grade of 4.5 to compensate for any of the parts, you will not exceed the subject.



**Note:**

The student may request in writing, within a maximum period of one month after the start of the course, only be evaluated with an exam. This examination shall consist, in this case, of three parts. One will be identical to the test that made the other students, will take place simultaneously and will contribute 60% to the overall mark. Another part will consist of a number of issues with which the powers that the other students have been shown to possess by performing the activities proposed in seminars and tutorials (20%) will be evaluated. The third part will consist of a practical examination in the laboratory (20%).

**SECOND CALL**

In the second call, the rating is obtained by applying the same criteria as in the first call. Students suspended in the first call one of the three parts of the evaluation should undertake a review of all parties not overcome.

Those students who do not show the theory exam (June and July) but who have participated and have noted in some / s of educational activities (partial review, seminars practices, tutorials) were qualified as *Not presented* in the first call Thriller course as in the second.

**REFERENCES****Basic**

- QUÍMICA ANALÍTICA. D.A. Skoog, D.M. West , F.J. Holler y S.R. Crouch, 8ª edición, Thomson, 2005.
- ANÁLISIS QUÍMICO CUANTITATIVO. D.C. Harris, 3ª edición, Reverté, 2007.
- QUÍMICA ANALÍTICA MODERNA. D. Harvey, McGraw-Hill Interamericana, 2002.
- PRINCIPIOS DE QUÍMICA ANALÍTICA. M. Valcárcel, Springer, 1999.
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**Additional**

- QUÍMICA ANALÍTICA. G. D. Christian, McGraw-Hill Interamericana, 2009.
- APROXIMACIÓ A LANÀLISIS QUANTITATIVA MITJANÇANT LA RESOLUCIÓ DE PROBLEMES. C. Gómez Benito, S. Torres Cartas, S. Meseguer Lloret, C. Cháfer Pericás, Y. Martín Biosca, editorial UPV, 2009.
- QUÍMICA ANALÍTICA CONTEMPORÁNEA. J.F. Rubinson y K.A. Rubinson, Prentice Hall, 1999.
- TOMA Y TRATAMIENTO DE MUESTRAS. C. Cámara (ed.), P. Fernández, A. Martín Esteban, C. Pérez Conde y M. Vidal., Síntesis, 2002.
- PROBLEMAS RESUELTOS DE QUÍMICA ANALÍTICA. P. Yáñez-Sedeño, J.M. Pingarrón y F.J.M de Villena, Síntesis, 2003.

**ADDENDUM COVID-19**

**This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council**

**1. Contents**

The contents initially included in the teaching guide are maintained

**2. Volume of work and temporal planning of teaching**

The workload for the student is maintained, derived from the number of credits, but the methodology of the activities changes with respect to the teaching guide, due to the current situation that makes it necessary to adopt a hybrid teaching model

**3. Teaching methodology**

- **Theoretical teaching:** They will be face-to-face and in accordance with the course calendar, but with the appropriate modifications to comply with the safety regulations against CoVid19. In the event that the capacity of the classroom does not allow the presence of the entire group of students, the students will be distributed by groups, so that 50% will be in the Faculty classroom while the other 50% will connect online (from home), alternating their attendance for weeks. The class will always be held following the schedule (date and time) approved by the Center Board
- **Tutorials and Seminars:** All will be face-to-face according to the dates set by the course calendar
- **Practical classes:** They will be face-to-face and in accordance with the course calendar, but with the appropriate modifications to comply with the security regulations against CoVid19, limiting the capacity of laboratories and computer rooms to 50%, establishing attendance shifts in each group. Audiovisual material will be used to cover the non-face-to-face teaching of the sessions, the students will be provided with data to perform calculations or any other material that allows complementing what was seen in the laboratory sessions.

If there were a worsening of the situation or a state of total confinement, all face-to-face teaching would be carried out online with synchronous teaching.

**4. Evaluation**

If the evolution of the current pandemic allows it, it will be face-to-face and in the terms, indicated in the teaching guide. Only in case this is not possible, the evaluation will be carried out online, using multiple-choice questions in the virtual classroom that can be supplemented with short questions and / or on certain occasions through an oral exam via videoconference.

The relative weight of the theory, practices and seminars is maintained as indicated in the teaching guide