COURSE DATA

Data Subject	
Code	36459
Name	Applied Instrumental Analysis Laboratory
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	4	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	14 - Analytic Chemistry Applied	Optional

Coordination

Name	Department
CARRASCO CORREA, ENRIQUE JAVIER	310 - Analytical Chemistry

SUMMARY

On this course students will put into practice the knowledge they have acquired on previous courses in Analytical Chemistry. These include the theoretical courses Analytical Chemistry I, Analytical Chemistry II and Analytical Chemistry III, and two laboratory courses taken in the second and third academic years of the Degree in Chemistry (Laboratory of Analytical Chemistry I and Laboratory of Analytical Chemistry II).

The course comprises sixteen laboratory sessions and four seminars. At the seminars, the students are introduced to the subject and taught how to search for information on official methods of analysis, sample treatments, and the treatment of the analytical results so that they can prepare a working procedure before beginning their experiments.

By working in the laboratory and analysing real samples, students will establish contact with the world of industry and analytical control laboratories. Students will also gain an awareness of the risks entailed by using the instrumentation and reagents and therefore of the importance of respecting the safety rules established in each case.

The course includes practical training that covers environmental analysis, food analysis, and industrial products as well as the use of optical methods of analysis, electroanalytical methods and the most common separation methods used in quality control laboratories.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

To successfully complete the course, students should have some prior knowledge of working in an Analytical Chemistry laboratory and a sound knowledge of the theoretical aspects of Analytical Chemistry, including instrumental techniques. They must therefore have passed Analytical Chemistry I, II and III and the two laboratory courses taught in the second and third academic years of the Degree (Laboratory of Analytical Chemistry I and Laboratory of Analytical Chemistry II).

OUTCOMES

1110 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Learn autonomously.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.

- Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.
- Recognise and analyse new problems and plan strategies to solve them.
- Handle chemicals safely.
- Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems.
- Handle the instrumentation used in the different areas of chemistry.
- Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.
- Evaluate the risks in the use of chemicals and laboratory procedures.
- Relate theory and experimentation.
- Understand the qualitative and quantitative aspects of chemical problems.
- Develop sustainable and environmentally friendly methods.
- Relate chemistry with other disciplines.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES

The previous section includes the competences contained in the document VERIFICA. This subject addresses part of the learning results of the matter Applied Instrumental Analysis Laboratory that allow to acquire specific knowledge of chemistry, cognitive skills and general skills recommended by the EUROPEAN CHEMISTRY THEMATIC NETWORK (ECTN) for the Chemistry Eurobachelor® Label. The following table lists the learning outcomes acquired in the subject Applied Instrumental Analysis Laboratory related to the competences of the degree in Chemistry.

SPECIFIC KNOWLEDGE OF CHEMISTRY

The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Applied Instrumental Analysis Laboratory that contemplate the learning outcomes EUROBACHELOR®
The principles and procedures used in chemical analysis and the characterisation of chemical compounds.	Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.(CE8) Show knowledge of the metrology of chemical processes including quality management..(CE10) Handle the instrumentation used in the different areas of chemistry.(CE19). Understand the qualitative and quantitative aspects of chemical problems..(CE24). Develop sustainable and environmentally friendly methods.(CE25)
COMPETENCES AND COGNITIVE SKILLS	
The learning process should allow the degree graduates to demonstrate:	

	Competences of the subject Applied Instrumental Analysis Laboratory that contemplate the learning outcomes EUROBACHELOR®
Ability to apply this knowledge and understanding to the solution of common qualitative and quantitative problems.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Competences for the evaluation, interpretation and synthesis of information and chemical data.	Evaluate, interpret and synthesise chemical data and information..(CE16). Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).
Ability to recognize and implement science and the practice of measurement.	Show knowledge of the metrology of chemical processes including quality management..(CE10) Interpret data from observations and

	measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20).
Ability to calculate and process data, related to information and chemistry data.	Solve qualitative and quantitative problems following previously developed models..(CE14). Recognise and analyse new problems and plan strategies to solve them..(CE15).
COMPETENCES AND COGNITIVE SKILLS RELATED TO THE PRACTICE OF CHEMISTRY	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Applied Instrumental Analysis Laboratory that contemplate the learning outcomes EUROBACHELOR®
Capabilities necessary to perform standard laboratory procedures as well as to use instrumentation in synthetic and analytical works, in both cases in relation to both organic and inorganic systems.	Carry out standard experimental procedures involved in synthetic and analytical work, in relation to organic and inorganic systems..(CE18). Relate theory and experimentation..(CE22). Understand the qualitative and

	quantitative aspects of chemical problems..(CE24).
Capacities to monitor, observe and measure the chemical properties, facts or changes, and perform their registration (collection) and documentation in a systematic and reliable way.	Handle the instrumentation used in the different areas of chemistry.(CE19). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Ability to interpret data derived from observations and laboratory measurements in terms of their relevance, and relate them to the appropriate theory.	Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them..(CE20). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24). Relate chemistry with other disciplines.(CE26).

GENERAL COMPETENCES	
The learning process should allow the degree graduates to demonstrate:	
	Competences of the subject Applied Instrumental Analysis Laboratory that contemplate the learning outcomes EUROBACHELOR®
Ability to apply practical knowledge to solve problems related to qualitative and quantitative information.	Solve problems effectively..(CG4). Solve qualitative and quantitative problems following previously developed models..(CE14). Relate theory and experimentation..(CE22). Recognise and evaluate chemical processes in daily life..(CE23). Understand the qualitative and quantitative aspects of chemical problems..(CE24).
Calculation and arithmetic capabilities, including aspects such as analysis error, estimates of orders of magnitude, and correct use of the units.	Develop capacity for analysis, synthesis and critical thinking.. (CG1). Show inductive and deductive reasoning ability..(CG2). Solve problems effectively..CG4).

Planning and time management skills.	Develop capacity for analysis, synthesis and critical thinking. (CG1). Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation..(CG3). Solve problems effectively..CG4).
Interpersonal skills to interact with other people and get involved in team work.	Demonstrate ability to work in teams both in interdisciplinary teams and in an international context..(CG5). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional. (CG7). Demonstrate the ability to adapt to new situations..(CG9).
Ethical commitment to the European Code of Conduct: http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf	Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.(CG10). Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a

	professional. (CG7). Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration. (CB3).

These learning outcomes should ensure that on successful completion of Applied Instrumental Analysis Laboratory students will be able to:

- use personal and collective protective equipment in the laboratory appropriately.
- prepare laboratory notebooks containing the essential data for the work carried out.
- handle materials and basic analytical instrumentation and take measurements.
- link the observations made from using the analytical techniques to the corresponding theoretical background.
- develop procedures for preparing working solutions (sample, standards, reagents) in accordance with the sustainability parameters.
- apply various sample treatment procedures.
- use various calibration strategies.
- perform the calculations needed to transform the analytical signal into values of concentration or mass or into percentages.
- interpret and apply official methods of analysis.
- justify, on the basis of the experiments conducted, the methodological differences involved in solving analytical problems based on the type of analyte or its sample concentration, the physical state of the sample, the complexity of the matrix, etc.
- draft analytical reports, expressing quantities with their significant figures and corresponding units.
- interpret in analytical terms the results obtained in the treatment of data arrays from various kinds of problems.
- deal appropriately with the waste generated during practical classes.
- justify the importance of reducing the environmental impact of using the analytical methods by selecting the reagents, minimizing their mass and volume, and selective collection of wastes.
- Demonstrate an ethical and responsible conduct in the exercise of their professional work, values that are transmitted by teachers and researchers of the University, as a generator and transmitter of scientific knowledge.

Related to the Sustainable Development Goals (SDG's) in this course, students are expected to be able to apply the learned knowledge to ensure inclusive, equitable and quality education and promote learning opportunities throughout their life (SDG4), to acquire a special sensitivity for the sustainable management of water (SDG 6), raw materials and energy sources (SDG 7) as well as for sustainable and environmentally friendly development (SDGs 11, 12, 13, 14 and 15), in addition to being able to design,

select and/or develop efficient chemical products, processes and/or analytical methodologies (SDG 7) minimizing their environmental impact (SDG 14 and 15), take advantage of alternative raw materials and generate less waste (SDG 11).

DESCRIPTION OF CONTENTS

1. Analysis of Environmental Samples

In this thematic unit students attend a series of practical training sessions in which they use different instruments and sample treatment methods and apply official methods of analysis with the emphasis on solid samples. Parameters such as moisture, pH, conductivity, organic matter, phosphates and heavy metals in soil will be determined. The values obtained will be compared to the limits established by legislation for the various types of soil analysed.

2. Food and Industrial Analysis

In this thematic unit, official methods for controlling industrial products and food will be used and the results will be compared to the values reported in the legislation.
The importance of food analysis will be stressed since this sensitive sector is directly related to human health. Samples of oil, pasta, cocoa, juices, honey, will be analysed in order to establish their state of preservation, determine any toxic pollution and detect fraud.

3. Pharmaceutical and Clinical Analysis

In this thematic unit, official methods for controlling pharmaceutical products and parameters in a typical clinical laboratory analysis will be used.
Specifically, creatinine in urine will be determined by the Jaffe method.

4. Search and selection of the most appropriate analytical method

In this thematic unit, students will conduct a search of the analytical methods proposed in the scientific literature for the determination of a specific analyte in a sample provided by the teacher. In the first seminar of the subject, each one will be shown what sample and which analyte will have to analyze in order to have sufficient time to carry out the bibliographic search. Subsequently, and using the conditions described in the method sought, they will perform the determination in the laboratory.

WORKLOAD

ACTIVITY	Hours	% To be attended
Laboratory practices	48,00	100
Theory classes	12,00	100
Development of group work	13,00	0
Development of individual work	13,00	0
Study and independent work	23,00	0
Readings supplementary material	13,00	0
Preparation of evaluation activities	14,00	0
Preparation of practical classes and problem	14,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course will be taught using the following methods:

- Previous issues
- Practical classes
- Participatory classes
- Seminars
- Information searches

Before each laboratory session, a questionnaire will be answered with questions related to the practice that will be carried out. Those students who do not pass this questionnaire will not be able to enter the laboratory and therefore will not be able to carry out the practice of that session.

Before the beginning of each session the materials will be made available to the students via the virtual classroom. Each block of sessions will begin with a seminar.

As well as serving to present the subject, the aim of the seminars is teach students how to search for information on official methods of analysis, necessary sample treatments, and the treatment of analytical results so that they develop a work procedure before conducting their experiments.

In each block the skills needed to develop the subject will be introduced and the importance of developing the analytical report will be explained.

The course is structured as follows:

1. Preparation of the practical work.

Students prepare an outline of the formal method and the calculations needed to conduct the analysis. The lecturer will review the material prepared by the students before the practical work begins.

1. Experimental work.

Practical work is conducted in pairs. The work of the lecturer at this stage is to encourage a positive attitude from the students in their scientific work.

Regularly updating their laboratory notebook during their practical work is an important component of the students' laboratory work.

1. Treatment of results

Treatment of results is conducted in the laboratory. The aim of this stage is to develop students' analytical ability. Student should not only obtain the results in the laboratory but also analyse them and their previous calculations, expressing their results in the appropriate units and with significant figures.

1. Laboratory notebook and analytical reports.

Student must regularly update their laboratory notebooks. The lecturer will periodically review this laboratory notebook, and it will be evaluated by pairs through a rubric.

EVALUATION

To pass the course students must attend at least 90% of the seminars and laboratory sessions. The system of evaluation is as follows:

- Previous issues
- Written, oral or practical examinations.
- Evaluation of laboratory sessions will focus on the students' attitude and skills and the quality of their laboratory notebooks, results, papers, practice reports, and oral communication.

FIRST CALL

Students' grades are calculated from the average of the two above evaluations (30% for the examinations and 70% for the laboratory sessions and the previous questionnaires). To pass the course, students must obtain a minimum average of 5.0 and a minimum score of 4.5 points out of 10 on each section.

1. Examination (30%):

The student will sit an examination on topics related to their practical work.

1. Evaluation of the laboratory sessions (70%) based on:

- Preparation conducted prior to the laboratory session, by means of the realization of questionnaires (5%) and revision of the scheme and previous calculations of the laboratory notebook (5%).
- Work conducted in the laboratory (10%). A continuous assessment of the progress achieved and the work conducted during the practical sessions will be made taking into account the student's ability in the laboratory work, their interest and their attitude. In particular, progress made in implementing a proper experimental technique will be evaluated.
- Analysis of unknown samples (35%). During each practice session, students must analyse and make an analytical report of a sample problem of unknown composition and/or concentration. The quality of the results obtained is considered an accurate reflection of the quality of the experimental work conducted.
- Laboratory notebook (15%). The laboratory notebook must be developed in accordance with the lecturer's guidelines and it will be evaluated through the use of a rubric.

Attendance at all seminars and laboratory sessions is compulsory. In the case of excused absences, students can recover up to three sessions by attending other practical groups provided the teaching requirements of the laboratories allow. The marks awarded for any session not recovered in this way will be zero. Students will fail the course if they are absent from or fail to recover more than two laboratory sessions.

SECOND CALL

The second call will consist of a written examination and/or a practical examination in the laboratory to evaluate students' preparation for the practical sessions, their work conducted in the laboratory, their laboratory notebook and their analytical reports.

Students' grades will be calculated following the criteria applied for the first call.

NOTE: This course is excluded from the regulations on advance calls for completing graduate studies (Degree Committee agreement of 26/03/2015).

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