COURSE DATA

Data Subject	
Code	34778
Name	Instrumental techniques of chemical analysis
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	School of Engineering	4	Second term

Subject-matter

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	23 - Optional subjects	Optional

Coordination

Name	Department
TORRES LAPASIO, JOSE RAMON	310 - Analytical Chemistry

SUMMARY

The subject “Instrumental Techniques of Chemical Analysis” is an optional character subject that is taught in the fourth year of the Bachelor's degree in Chemical Engineering during the spring semester. The curriculum consists of a total of 6 ECTS.

This course aims to provide students with the information needed to successfully address analytical problems related to the professional practice of chemical engineering. In this sense, the program focuses on the study of instrumental analysis techniques commonly used in industry, both for process control, quality of raw materials and manufactured goods and for environmental control.

After an overview of the so-called "analytical process" which provides general working methodology in Analytical Chemistry, a set of instrumental analysis techniques are studied indicating for each principles, basic instrumentation and variables of interest to focus, finally , in its application to solving analytical problems of interest in industry .

The course involves performing labs in which students carry out a series of determinations that allow them to put into practice the knowledge acquired. In addition, work in the laboratory is also pursuing

students to gain an awareness of the risks of the instrumentation used in each technique and therefore the importance of respecting the safety rules stated in each case. The contents of the subject are: Calibration and validation of methods, Molecular spectrometry, and Electrochemical and chromatographic methods.

Lectures will be carried out in Spanish and the laboratory classes, according to specified language in the subject file available on the degree website.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

Prior requirements or recommendations
In order to successfully address this course, students should have some previous knowledge of general chemistry already studied in Chemistry I and Chemistry II courses listed in the compulsory curriculum. Specifically, the concepts relating to the preparation and handling of solutions or calculation and expression of results, and the treatment of chemical equilibrium in various forms: acid-base, complexation, solubility and redox.

OUTCOMES

1401 - Degree in Chemical Engineering

- O1 - More comprehensive skills than those acquired in compulsory subjects.

LEARNING OUTCOMES

• Enter the basic criteria for choosing an instrumental analytical technique (O1).

• Explain the rationale for the different instrumental techniques studied (O1).

• Write and interpret the relationship between the analytical signal obtained in each of the techniques studied and the concentration of analyte (O1).

• Draw a diagram corresponding to the different analytical instrumentation techniques justifying the function of each of its components and their position on the instrumental design (O1).

• Describe the experimental methodology for conducting a determination by each of the techniques included in the program (O1).

• List the most common types of interference in the studied techniques and how to correct them (O1).

• Describe the different types of calibrated setting their differences and applicability (O1).

• Solve analytical problems based on the use of different types of calibration (O1).

• Perform the necessary calculations for solving analytical problems correctly expressing the result (O1).

• Apply statistical test data processing: rejection of anomalous results and comparison of results (O1).

• Quote representative examples of application of instrumental techniques studied and justify the proposed procedure in each case (O1).

• Use proper equipment for individual and collective protection in the laboratory (O1).

• Write analytical reports (O1).

• Proceed properly with the waste generated in the laboratory (O1).

• Justify the importance of the selection of waste and minimization of masses and volumes to reduce the environmental impact of the analytical methods (O1).

• Know how to apply the knowledge learned to help ensure inclusive, equitable and quality education and promote lifelong learning opportunities for all (SDG 4), to acquire a special sensitivity for sustainable water management (SDG 6), of raw materials and energy sources (SDG 7) as well as for sustainable development compatible with the environment (SDGs 11, 12, 13, 14 and 15), in addition to being able to design, select and/or develop products and efficient chemical processes (SDG 7) and that minimize their impact on the environment (SDGs 14 and 15), take advantage of alternative raw materials and generate less waste (SDG 11).

DESCRIPTION OF CONTENTS

1. Introduction to Analytical Chemistry

Objectives of Analytical Chemistry. Analytical Terminology. The analytical process: Steps thereof. Classification of instrumental methods of analysis.

2. Evaluation of results, calibration and validation of methods

Precision. Accuracy. Statistics for comparison of results. Calibration. Analytical characteristics of an analytical method. Validation.

3. Molecular Spectrometry (I)

Introduction. UV-Vis spectrophotometry absorption: Basis and instrumentation, analytical utility and applications.

4. Molecular Spectrometry (II)

Introduction. Fluorimetry: Basis and instrumentation, analytical utility, applications.

5. Polarimetry

Introduction. Polarimetry: Basis and instrumentation, analytical utility, applications.

6. Atomic spectroscopy

Introduction. Atomic spectroscopy with flame atomization. Atomic spectroscopy with electrothermal atomization. Other sources of atomization.

7. Electrochemical methods: Potenciometry

Introduction: Electrochemical cells' and redox potential. Potentiometry: Reference electrodes. Working electrodes. Ion selective electrodes. Analytical applications Nernst equation.

8. Amperometry and voltammetry

Current-potential curves. Amperometry. Voltammetry techniques. Stripping voltammetry. Analytical applications.

9. Chromatographic methods

Basis of chromatography: Various types. Column chromatography. Basic instrumentation. Chromatographic parameters. Bandwidth: Van-Deemter equation.

10. Gas chromatography

Introduction. Basic instrumentation. Experimental methodology. Analytical usefulness. Gas chromatography-mass spectrometry.

11. Liquid chromatography

Introduction: High-resolution liquid chromatography. Basic components of a HPLC. Partition chromatography: normal phase and reverse phase. Experimental methodology. Analytical usefulness and application areas.

12. Laboratory

Working methodology in Instrumental Analysis. Application of different instrumental techniques to determining substances of industrial or environmental interest.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	25,00	100
Classroom practices	20,00	100
Laboratory practices	15,00	100
Development of group work	15,00	0
Study and independent work	25,00	0
Readings supplementary material	10,00	0
Preparation of evaluation activities	25,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The course is structured around theory classes and problems, laboratory sessions and a series of seminars where students will solve exercises or discuss issues individually or in small groups.

In the theory sessions an overview of each topic will be featured. Teacher will insist in the key concepts and fostered student engagement by posing questions. In addition, the teacher will explain how problems-type address both its approach and its numerical solution in order to consolidate the concepts developed in theory (O1).

Seminars complement the lectures and in them, the role will go to students, working in groups, they will face problems and issues related to the concepts developed in the lectures (O1).

In the lab, students will work in pairs and before the experimental sessions, have the information necessary for the preparation of the experiences. Once completed the experience, students must prepare and submit an analytical report which shall contain experimental data, results and conclusions. Attendance at laboratory practice sessions is compulsory (O1).

EVALUATION

The evaluation will be carried out considering the different activities performed both in person and remotely. Specifically:

First assessment

The work done in seminars and in-class problem-solving will account for 15% of the final grade. This activity is not recoverable. (O1)

The score obtained in laboratory sessions will constitute 25% of the final score (minimum score to pass the course is 5.0). (O1)

A final exam will be conducted, which will contribute to 50% of the final score (minimum score of 4.0 required in both the theory and problem sections). (O1)

Finally, attendance and participation in class will be evaluated with the remaining 10%. This activity is not recoverable. (O1)

To pass the course, the final score must be higher than 5.0.

Alternatively, students can choose an evaluation system in which the weightage of the exam grade is 65% (minimum score of 5.0 required) (O1), while maintaining 25% for laboratory sessions (minimum score of 5.0). The remaining 10% can be obtained through the submission of a project (preferably a literature review) proposed by the professor (minimum grade of 5.0 required) (O1). In this case as well, the final grade must be higher than 5.0 to pass the course.

Students must indicate their choice of evaluation system within one month from the start of classes. By default, the continuous evaluation system will be applied. If the performance in seminars is not satisfactory, affected students may be transferred from the continuous evaluation modality to the exam plus literature work modality.

Second assessment

Students who have not achieved the minimum score indicated for the exam in the first assessment or for the laboratory sessions must take the corresponding exams. Regarding the laboratory sessions, an exam on laboratory-related questions will be conducted. Students who have not attended at least 80% of the hours for this activity or have failed the laboratory score must also take a practical exam and submit the corresponding report. (O1)

Furthermore, if the course is not passed in this second assessment, the score obtained in the laboratory sessions may be considered for enrollment in the following two academic years.

Finally, the early assessment will only be possible if the laboratory sessions were passed in the previous year.

The final score will be obtained according to the criteria specified for the alternative evaluation (non-continuous). A minimum score of 4.0 must be achieved in both theory and problems sections to average the remaining scores.

In any case, the evaluation system will be governed by the provisions established in the Reglament de Avaluació i Qualificació de la Universitat de València per a títols de Grau i Màster (http://links.uv.es/7S40pjF).

REFERENCES

Basic

- Análisis químico cuantitativo 3ªedición (6ª edición original), D.C.Harris, Editorial Reverté (2007)
- Química Analítica 6ª edición, G.C.Christian, McGraw-Hill, México (2009)
- Principios de Análisis Instrumental (6ª edición), D.A.Skoog, F.Holler, S.R.Crouch, Cengage Learning Editores, México (2008)

Additional

- Principios de Análisis Instrumental (6ª edición), D.A.Skoog, F.Holler, S.R.Crouch, Cengage Learning Editores, México (2008)
- Técnicas de separación en Química Analítica, R.Cela, R.A.Lorenzo y M.C.Casais, Síntesis, Madrid (2002)
- Técnicas analíticas de separación, M.Valcárcel Cases y M.Gómez Hens, Reverté, Barcelona (1988)
- Laboratorio de Análisis Instrumental, A.Maurí, M.Llobat y R.Herraez. Servei de Publicacions de la UV y editorial Reverté (2010)