

**1. General information****Course:** INSTRUMENTAL ANALYSIS II**Type:** CORE COURSE**Degree:** 398 - UNDERGRADUATE DEGREE PROGRAMME IN CHEMISTRY**Center:** 1 - FACULTY OF SCIENCE AND CHEMICAL TECHNOLOGY**Year:** 3**Main language:** Spanish**Use of additional languages:****Web site:****Code:** 57316**ECTS credits:** 6**Academic year:** 2020-21**Group(s):** 20 23**Duration:** First semester**Second language:** English**English Friendly:** Y**Bilingual:** N**Lecturer:** GREGORIO CASTAÑEDA PEÑALVO - Group(s): 20 23

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2. Pre-Requisites

There are not previous requirement established. Nevertheless it is strongly recommended the following:

- 1.- To have coursed the following subjects: Fundamentos de Química Analítica and Análisis Volumétrico y Gravimétrico of 2nd course.
- 2.- To know fundamentals of Chemometrics, analytical calibration including.
- 3.- To have coursed Análisis Instrumental I of 2nd course.

3. Justification in the curriculum, relation to other subjects and to the profession

Análisis Instrumental II is a part of the 18 ECTS credits grouped subject ANÁLISIS INSTRUMENTAL. The latter is mandatory in the Chemistry career and Analisis Instrumental II has 6 ECTS credits and belongs to the third course. The other two subjects belonging to Analisis Instrumental are Analisis Instrumental I that is studied in the second course and Métodos Instrumentales de Separación that is studied in the third course.

When Analisis Instrumental II is studied, the student has already coursed the subjects of Fundamentos de Química Analítica, Análisis Volumétrico y Gravimétrico and Analisis Instrumental I, where the fundamentals of Analytical Chemistry, the Analytical Process and Instrumental Analysis have been cimentado which provides basic competencias and knowledge in order to para afrontar la presente asignatura con garantías de éxito.

In second course, there are also other subjects such as Química Física, than enforce the concepts of spectroscopy, and quantic chemistry which are most needed in Analisis Instrumental.

Analisis Instrumental II meets its continuity with the third subject of Analisis Instrumental: Métodos Instrumentales de Separación. Besides, , en un enfoque aplicado y real de la vida cotidiana con la asignatura optativa de Química Analítica Aplicada.

In Análisis Instrumental II it is studied after the introduction, the fundamentals, instrumentation and applications of the main electroanalytical techniques. The most important techniques considered are the potentiometric and amperometric ones, as well as the voltamperometric. Conductimetry titrations is also studied. Besides, an introduction to mass spectrometry and other instrumental analytical techniques, such as flow injection analysis, are studied too.

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

| Code | Description |
|------|--|
| E05 | Know the chemical elements and their compounds, their forms of obtaining, structure, properties and reactivity, as well as the main techniques for their analysis |
| E06 | Know the structural properties of chemical compounds, including stereochemistry, as well as the main structural research techniques |
| E14 | Know and know how to apply the metrology of chemical processes, including quality management |
| E15 | Know how to handle the standard chemical instrumentation and be able to elaborate and manage standardized procedures of work in the laboratory and chemical industry |
| E16 | Plan, design and develop projects and experiments |
| | Develop the ability to relate to each other the different specialties of Chemistry, as well as this one with other disciplines |

| | |
|-----|---|
| E17 | (interdisciplinary character) |
| G02 | Be able to gather and interpret data, information and relevant results, obtain conclusions and issue reasoned reports on scientific, technological or other problems that require the use of chemical tools |
| G03 | Know how to apply the theoretical-practical knowledge acquired in the different professional contexts of Chemistry |
| G04 | Know how to communicate, orally and in writing, the knowledge, procedures and results of chemistry, both specialized and non-specialized |
| T04 | Ethical commitment and professional ethics |
| T05 | Organization and planning capacity |
| T06 | Ability to approach decision making |
| T10 | Ability to use specific software for chemistry at user level |
| T11 | Ability to obtain bibliographic information, including Internet resources |

5. Objectives or Learning Outcomes

Course learning outcomes

Description

Acquire skills for planning, writing and validating work protocols in the laboratory

Acquire critical judgment in the selection of the most appropriate analytical methodology according to the usual standards

Train the student to tackle an analytical problem, search and select the most relevant bibliography, synthesize it by extracting its most important parts, and expose and explain it in public

Train the student to be sensitive to the ethical exercise of the profession, becoming aware of the social responsibility of their reports and their impact on decision making

Understand the advantages, disadvantages, limitations and applications of the main instrumental methods of analysis

6. Units / Contents

Unit 1: Introduction to Electroanalytical Chemistry

Unit 2: Electrodes. Direct Potentiometry

Unit 3: Potentiometric and Amperometric Titrations

Unit 4: Voltammetry.Polarography

Unit 5: Modified electrodes

Unit 6: Mass spectrometry

Unit 7: Others instrumental analytical techniques

Unit 8: Laboratory sessions

ADDITIONAL COMMENTS, REMARKS

Theme 1. Introduction to Electroanalytical Chemistry. Electroanalytical cells. Influence of intensity on potentials. Intensity-Potential curves. Electroanalytical methods classification.

Theme 2. Electrodes. Direct Potentiometry. Introduction. Reference electrodes. Metal indicator electrodes .Membrane electrodes. Direct Potentiometry. Selective electrodes.

Theme 3. Potentiometric and Amperometric electrodes. Potentiometric titration types (null intensity, constant intensity) and analytical applications. Amperometric titration types and applications.

Theme 4. Voltammetry. Polarography. Fundamentals. Mercury drop electrode. Polarography features. Classic polarography, Fast polarography, Normal and differential pulse polarography. Analytical applications. Other voltamperometric techniques.

Theme 5. Modified electrodes. Introduction. Chemically modified electrode preparation. Analytical applications.

Tema 6. Mass spectrometry. Introduction. Fundamentals. Mass spectrometer components. Coupled and direct sample entry systems. Ionization types. Detectors. Analytical applications.

Theme 7. Other instrumental analytical techniques.

Theme 8. Laboratory sessions.

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] | Lectures | E05 E06 E15 E16 E17 T10 T11 | 1.08 | 27 | N | - | |
| Problem solving and/or case studies [ON-SITE] | Problem solving and exercises | E05 E14 G02 G03 T10 | 0.2 | 5 | N | - | |
| Other on-site activities [ON-SITE] | Group Work | E16 E17 G02 G03 G04 T10 T11 | 0.2 | 5 | N | - | |
| Progress test [ON-SITE] | Assessment tests | G02 G03 G04 T05 | 0.08 | 2 | Y | N | |
| Laboratory practice or sessions [ON-SITE] | Practical or hands-on activities | E14 E15 E16 G02 G03 T05 | 0.64 | 16 | Y | Y | |
| Practicum and practical activities | | E05 E14 E16 E17 G02 G03 | | | | | |

| | | | | | | |
|--|---------------------------|-------------------------------------|--------------------------------------|-----|---|---|
| report writing or preparation [OFF-SITE] | Guided or supervised work | G04 T10 T11 | 0.8 | 20 | N | - |
| Study and Exam Preparation [OFF-SITE] | Combination of methods | E17 G02 G03 T05 T06 T10 T11 | 2.8 | 70 | N | - |
| Group tutoring sessions [ON-SITE] | Case Studies | E05 E06 E16 E17 G02 G03 G04 T05 T06 | 0.08 | 2 | N | - |
| Final test [ON-SITE] | Assessment tests | G02 G03 G04 T05 | 0.12 | 3 | Y | N |
| 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 |
| Progress Tests | 85.00% | 0.00% | <p>THE EXAM IS A TEST IN WHICH EACH QUESTION HAS FOUR POSSIBLE ANSWERS AND ONLY ONE IS CORRECT. WRONG ANSWERED QUESTIONS DEDUCT (3 WRONG QUESTIONS EQUAL ONE CORRECT). THERE IS ONLY ONE CORRECT ANSWER.</p> <p>The test is divided in three parts. The first one evaluates the laboratory. It has questions in the proportion 9 out of 60. The second part evaluates the theoretical aspects. It has questions in a proportion 34 out of 60. The final part evaluates the problems. It has questions in a proportion 17 out of 60.</p> <p>If the progress exam is passed, it will not be necessary to do the final ordinary exam.</p> |
| Laboratory sessions | 15.00% | 15.00% | <p>The laboratory sessions are of compulsory attendance. It is not allowed to come late to the laboratory. Besides, the student behaviour should be adequate to the laboratory work. The student has also to set out the results of the laboratory practice once it is finished.</p> <p>A laboratory exam will be done together with the progress exam. This will consist of test questions.</p> |
| Final test | 0.00% | 85.00% | <p>THE EXAM IS A TEST IN WHICH EACH QUESTION HAS FOUR POSSIBLE ANSWERS AND ONLY ONE IS CORRECT. WRONG ANSWERED QUESTIONS DEDUCT (3 WRONG QUESTIONS EQUAL ONE CORRECT). THERE IS ONLY ONE CORRECT ANSWER.</p> <p>The test is divided in three parts. The first one evaluates the laboratory. It has questions in the proportion 9 out of 60. The second part evaluates the theoretical aspects. It has questions in a proportion 34 out of 60. The final part evaluates the problems. It has questions in a proportion 17 out of 60.</p> <p>If the progress exam is passed, it will not be necessary to do the final ordinary exam.</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:

This final ordinary exam will be done by the students that have not passed the progress exam.

The evaluation criteria will be the same as those for the progress exam.

Non-continuous evaluation:

This final ordinary exam will be done by the students that have not passed the progress exam.

The evaluation criteria will be the same as those for the progress exam.

Specifications for the resit/retake exam:

This extraordinary evaluation will consist of a written exam.

The evaluation criteria will be the same as those for the final ordinary exam

Specifications for the second resit / retake exam:

This second extraordinary evaluation will consist of a written exam.

The evaluation criteria will be the same as those for the final ordinary exam

| 9. Assignments, course calendar and important dates | |
|--|-------|
| Not related to the syllabus/contents | |
| Hours | hours |
| Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises] | 5 |
| Other on-site activities [PRESENCIAL][Group Work] | 5 |
| Progress test [PRESENCIAL][Assessment tests] | 2 |
| Study and Exam Preparation [AUTÓNOMA][Combination of methods] | 70 |
| Group tutoring sessions [PRESENCIAL][Case Studies] | 2 |
| Final test [PRESENCIAL][Assessment tests] | 3 |
| Unit 1 (de 8): Introduction to Electroanalytical Chemistry | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 10 |
| Unit 2 (de 8): Electrodes. Direct Potentiometry | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 3 |
| Unit 3 (de 8): Potentiometric and Amperometric Titrations | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 5 |
| Unit 4 (de 8): Voltammetry.Polarography | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 3 |
| Unit 5 (de 8): Modified electrodes | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 1 |
| Unit 6 (de 8): Mass spectrometry | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 3 |
| Unit 7 (de 8): Others instrumental analytical techniques | |
| Activities | Hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 2 |
| Unit 8 (de 8): Laboratory sessions | |
| Activities | Hours |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 16 |
| Practicum and practical activities report writing or preparation [AUTÓNOMA][Guided or supervised work] | 20 |
| Global activity | |
| Activities | hours |
| Class Attendance (theory) [PRESENCIAL][Lectures] | 27 |
| Progress test [PRESENCIAL][Assessment tests] | 2 |
| Practicum and practical activities report writing or preparation [AUTÓNOMA][Guided or supervised work] | 20 |
| Study and Exam Preparation [AUTÓNOMA][Combination of methods] | 70 |
| Group tutoring sessions [PRESENCIAL][Case Studies] | 2 |
| Laboratory practice or sessions [PRESENCIAL][Practical or hands-on activities] | 16 |
| Final test [PRESENCIAL][Assessment tests] | 3 |
| Problem solving and/or case studies [PRESENCIAL][Problem solving and exercises] | 5 |
| Other on-site activities [PRESENCIAL][Group Work] | 5 |
| Total horas: 150 | |

| 10. Bibliography and Sources | | | | | | |
|--|--|----------------------|------|---------------------|------|-------------|
| Author(s) | Title/Link | Publishing house | Citv | ISBN | Year | Description |
| Pablo Fernández López | Moodle UCLM | | | | | |
| Schwedt, Georg | The essential guide to analytical chemistry | John Wiley and Sons | | 0471899542 | 1999 | |
| Hernández Hernandez Lucas | Introducción al Análisis Instrumental | Ariel | | 84-344-8043-3 | 2002 | |
| Gary A. Mabbott | Electroanalytical Chemistry | Wiley | | 978-1-119-53858-5 | 2020 | |
| Douglas A. Skoog, F. James Holler, Stanley R. Crouch | PRINCIPLES OF INSTRUMENTAL ANALYSIS, 7th Edition | Cengage Learning-USA | | 978-1-30-57721-3 | 2017 | |
| Skoog Douglas A. | Fundamentos de Química Analítica | Reverté | | 84-291-7554-7 (v.1) | 2003 | |
| Rubinson Kenneth A. | Análisis Instrumental | Prentice Hall | | 84-205-2988-5 | 2004 | |