Subject Guide

1. Information about the subject

SUBJECT	Analytical Chemistry II	**CODE**	GQUIMI01-3-009
EDUCATIONAL OFFER	Bachelor´s Degree in Chemistry	**CENTER**	Facultad de Química
TYPE	Compulsory	**N° TOTAL CREDITS**	6.0
PERIOD	First Semester	**LANGUAGE**	Spanish

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LECTURERS	**EMAIL**	
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2. Context

"Analytical Chemistry II" is taught in the third year of the Chemistry Degree. It belongs to the Fundamental module (Analytical Chemistry) and introduces students within the field of high sensitive and selective analytical techniques and methods (based in optical spectrometry, electrochemistry and mass spectrometry) essential in Chemistry studies. "Analytical Chemistry II" provides the students with basic and applied knowledge related with modern analytical techniques. Also, it gives the criteria to select the most adequate techniques to solve particular analytical problems and to correctly interpret the results.

The techniques and fundamentals presented in this course are crucial for the basic academic formation, allowing the student a better understanding of other subjects within the third year (e.g. "Experimentation in Organic Chemistry I", or "Physical Chemistry II" and "Physical Chemistry III"). Also, it is very important for subjects of the fourth year. In fact, it is mandatory to have passed this "Analytical Chemistry II" to get enrolled in "Experimentation in Analytical Chemistry II" (fourth year).

Teachers belong to the Analytical Chemistry area of the Department of Physical and Analytical Chemistry. Lectures will be given by María Teresa Fernández and Rosario Pereiro. Seminars and Group tutorial sessions will be given by Rosario Pereiro, María Teresa Fernández and Beatriz Fernández.

3. Requirements

It is recommendable for the student to be familiarized with the units system, with mathematical calculations (logarithms, exponentials, use of calculators, etc) and with the basic principles of Analytical Chemistry; i.e. to have passed General Chemistry, Mathematics and Physics of the first year and "Analytical Chemistry I" and "Experimentation in Analytical Chemistry I" (second year). Actually, registration in "Analytical Chemistry II" requires "Analytical Chemistry I" passed.

4. Competencies and learning results

The **General Competencies** to be pursued in this course are those collected in the VERIFICA Memory of this Degree as CG-1, CG-2, CG-7, CG-8, CG-9, CG-11, CG-12, CG-17, CG-18.

The **Specific Competencies** to be pursued are CE-6, CE-13, CE-14, CE-15, CE-18, CE-19, CE-20, CE-22, CE-24, CE-30, CE-34, CE-35.

The expected **Learning Outcomes** are the following:

- Knowledge and understanding of the different basic principles of optical and electrochemical instrumental techniques (CE-13, CE-14, CE-15, CE-19).

- Knowledge about how basic analytical instruments work (CE-13, CE-14, CE-15).
- Development of capabilities for assimilation and critical analysis of chemical information (CG-1, CG-8).
- Ability to process analytical data and to extract analytical information (qualitative and quantitative) from data (CE-6, CE-14, CE-15, CE-18, CE-20, CE-22, CE-24, CE-30, CE-34, CE-35).

5. Contents

- **UNIT 1. LINEAR SWEEP VOLTAMMETRY (LSV) AND CYCLIC VOLTAMMETRY (CV)**

  Introduction. Theoretical considerations. Basic parameters. Characterisation of electrode processes. Reactions coupled to electron transfer processes. Analytical applications.

- **UNIT 2. PULSE AND ALTERNATING CURRENT VOLTAMMETRY**

  Introduction. Normal and differential pulse voltammetry (NPV and DPV): theoretical considerations and analytical applications. Alternating current voltammetry (ACV): theoretical considerations and analytical applications. Square-wave voltammetry (SWV): theoretical considerations and analytical applications.

- **UNIT 3. PROCESSES OF PRECONCENTRATION AT ELECTRODES**

  Introduction. Electrodes. Classification. Electrodic preconcentration: possible processes. Stripping voltammetry. Adsorptive sptripping voltammetry. Potentiometric stripping. Analytical applications.

- **UNIT 4. COULOMETRY**

  Introduction. Direct coulommetry: a) at constant intensity, b) at constant potential. Applications. Coulometric titrations: fundamentals, types and analytical applications.

- **UNIT 5. INFRARED SPECTROSCOPY**

  Infrared absorption. Vibrational state of a molecule. Rotational transitions. Rotational/vibrational transitions. Types of molecular vibrations. Mechanical model for vibration in diatomic molecules. Infrared spectrum. Basic instrumentation. Dispersive IR spectrophotometers. Interferometers. Fourier analysis. FTIR spectrophotometers. IR microscopy. Relevant applications.

- **UNIT 6. FLAMELESS ATOMIC ABSORPTION SPECTROMETRY**

  Atomic absorption spectroscopy with electrothermal atomization. Characteristics of graphite furnaces. Types of atomizers. Atomization mechanisms in the graphite furnace. Interferences. Techniques for hydride and cold vapour generation. Basic instrumentation. Methodologies and analytical performance characteristics. Relevant applications.

- **UNIT 7. ATOMIC EMISSION SPECTROMETRY WITH PLASMA SOURCES.**

  Plasmas as excitation sources. Analytical plasma: definition and characterization. Plasma generation: types of plasmas. The inductively coupled plasma (ICP). Basic instrumentation. Analytical performance characteristics.

- **UNIT 8. X-RAY SPECTROMETRY FOR CHEMICAL ANALYSIS**

  Introduction: origin of the x-ray spectra. X-ray spectra: continuum spectrum and lines spectrum. X-ray interaction with matter. X-ray absorption. General method for x-ray fluorescence analysis. X-ray excitation sources. Separation of fluorescent lines: analyser. X-ray detector. Wavelength dispersive spectrometers and energy dispersive spectrometers. Analytical applications of x-ray fluorescence. Sample preparation. Microanalysis methods: electron microprobe and scanning electron microscopy.

- **UNIT 9. ELEMENTAL AND MOLECULAR MASS SPECTROMETRY**

Mass spectrometry fundamentals. Classification of mass atomic techniques: the ICP-MS. Basic instrumentation in ICP-MS. Mass spectra and spectral interferences in ICP-MS. Analytical performance characteristics and relevant applications. Molecular mass spectra. Basic components of instruments for molecular mass spectrometry. Coupled spectrometers. Relevant applications of molecular mass spectrometry.

6. Methodology and working plan

The contents of this course will be presented using three different types of in-class activities:

1. **Lectures**: The course content will be presented by the teacher. At the beginning of each unit, the main objectives of the unit under study will be commented and at the end, some questions that allow correlating all the acquired knowledge will be posed. With the aim of following the lectures in an adequate way, students will have previously the material employed by the teacher (e.g. in the *Campus Virtual* platform). The explanation of each unit will be done by using the blackboard and/or Power Point presentations.
2. **Seminars**: Calculations related to the units and contents that were commented in the lectures will be discussed. Active participation will be favoured. Numerical problems will be given previously (at least two days in advance) to the students.
3. **Group tutorial sessions** (mandatory). Questions and problems related to the different units will be discussed in these sessions. Students will have with suffficiently time in advance (at least two days) the questions and exercises that should be dealt with individually, or collectively, before the tutorial session. In the tutorial session the student will present the solved exercises and the teacher will clarify doubts and problems that students have found in the resolution of the proposed tasks.The general objective of these activities is that students know the utility of instrumental analytical methodologies that were studied along the course as well as their real application in e.g. environmental, technological, industrial, clinical, forensic or food fields. Also, they will visit the “Servicios Científico-Técnicos” of the University as well as different research groups of the Department of Physical and Analytical Chemistry (Analytical Chemistry area). With this activity they will have the chance of evaluating the importance of the available analytical instrumentation and the problems it solves. At the end of these visits the students will have to answer questions posed by the teacher and they will work in groups.

The *Campus Virtual* will be used and will allow fluent communication between students and teachers. It is the basic tool employed by teachers for giving material to students. The course has 6 credits that correspond to 150 hours of student work. The distribution of this work is shown in the following table:

SESSIONS		**Hours**	**%**
In class	Lectures	46	30.67
	Seminars	7	4.67
	Group tutorials	4	2.67
	Evaluation	3	2
Out of class	Individual work	90	60
	Total	**150**	**100**

7. Evaluation of the student's learning results

Ordinary evaluation will consist of:

1. **Written test**. The maximum mark will be 10 points, being 5 points the minimun required to pass. The mark obtained will be 90% of the final grade. The test will take 3 hours and will have a theoretical part (60% of the mark) and a practical one (numerical questions, 40% of the mark). The minimum mark that allows compensation of each part is 4.5. The written exam will take place in the official examination period established for the Chemistry Degree.
2. **Group tutorial sessions.** They will be marked from 0 to 10 points, and they will account for the 10% of the final mark.

In extraordinary examinations, evaluation will consist only of a written test, that is 100% of the final mark. In this test, it will be required to obtain 5 points over 10 for passing the course. The test will take 3 hours and will have a theroretical part (60% of the mark) and a practical one (numerical questions, 40% of the mark). The minimum mark

that allows compensation of each part is 4.5. The written exam will take place in the official examination period established for the Chemistry Degree.

8. Resources, bibliography and complementary documentation

Power-Point presentations will be used in lectures and seminars. Material will be available either in *Campus Virtual* or at the class, where the teacher will give it to the students. The same happens with auxiliary materials such as publications, practices, calculations…

Some bibliography related to the different units is listed below:

- *Quantitative Chemical Analysis*, D. Harris, 8ª Edición, W.H. Freeman and Company, 2010.
- *Principles of Instrumental Analysis,* 6th Edition. D.A.Skoog, F.J.Holler, S.R.Crouch; ISBN-13:978-0495012016.

- *Analytical Electrochemistry*, 2nd edition, J. Wang, Wiley-VCH, 2000.
- *Electroanalytical Methods, Guide to Experiments and Applications*, F.Scholz, Springer, 2002.
- *Electrochemical Methods. Fundamentals and Applications*; A. J. Bard, L. R. Faulkner; 2nd Edition, J. Wiley & Sons, New York, 2001.

Complementary texts are:

- *Chemical Analysis. Modern Instrumentation, Methods and Techniques*. 2nd Edition; F. Rouessac, A. Rouessac. Wiley, 2007
- *Laboratory Techniques in Electroanalytical Chemistry*, 2nd Edition , P.T.Kissinger, W.R.Heineman, Marcel Dekker, 1996.