FACULTAD DE
CIENCIAS QUÍMICAS

ENVIRONMENTAL ANALYTICAL CHEMISTRY

COURSE GUIDE

BSc Chemistry

Academic Year 2025-2026

UNIVERSIDAD
COMPLUTENSE
MADRID

I.- IDENTIFICATION

COURSE NAME:	**Environmental Analytical Chemistry**
CREDITS (ECTS):	**6**
CHARACTER:	**Optative**
SUBJECT:	**Analytical Chemistry**
MODULE:	**Fundamental**
UNDERGRADUATE DEGREE:	**Bachelor's Degree (BS) in Chemistry**
SEMESTER/TERM:	**First semester (fourth year)**
DEPARTMENT/S:	**Analytical Chemistry**

LECTURERS:

Grupo A (English)		
Theory **Seminar** **Tutoríal**	**Profesora:** **Departamento:** **Despacho:** **e-mail:**	YOLANDA MADRID ALBARRÁN Química Analítica QA-405 ymadrid@ucm.es
Grupo B		
Theory **Seminar** **Tutorial**	**Lecturer:** **Department:** **Office Number:** **e-mail:**	Mª MILAGROS GÓMEZ GÓMEZ Química Analítica QB-436 mmgomez@ucm.es

II.- OBJECTIVES

■ GENERAL OBJECTIVE

The main aim of this course is that students acquire the criteria to apply analytical methodologies to solve environmental problems and to control environmental pollution. It is intended that the student learn how to perform the analysis of environmental samples in its different steps, including sampling and sample treatment, analysis and interpretation of the results obtained.

■ SPECIFIC OBJECTIVES

- Learn the role that Analytical Chemistry plays in solving environmental problems.
- Learn the characteristics of the main types of environmental samples, the analytes of interest present in these samples and the concentration levels at which they can be found.

- Introduce the basic aspects of the environmental analysis applied to atmospheric, water, soil and sediment samples.
- Promote the criteria of the student to select the best analytical methodology to be applied to specific cases related to environmental analysis.

III.- BACKGROUND KNOWLEDGE AND RECOMMENDATIONS

■ BACKGROUND KNOWLEDGE:

It is advisable to have previous knowledge on Analytical Chemistry, Instrumental Analysis, Applied Statistics and Data Treatment.

■ RECOMMENDATIONS:

It is advisable to have successfully completed the following subjects: *Analytical Chemistry I, Analytical Chemistry II and Analytical Chemistry III.*

IV.- CONTENTS

■ BRIEF DESCRIPTION:

Role of Analytical Chemistry in solving environmental problems. Environmental samples, analytes and concentration levels. Speciation: Importance of the chemical species and their environmental impact. Analysis of atmospheric samples: Atmospheric contaminants, sampling techniques, analytical techniques, analysis of gases and atmospheric particles, current legislation and most relevant applications. Analysis of water samples: physical-chemical parameters of the water; analysis of trace organic and inorganic substances; persistent and emerging pollutants, sampling, analytical techniques current legislation and most relevant applications. Analysis of soil and sludge samples: Physical-chemical characteristics of the soils; chemical and instrumental methods in soil and sludge analysis; contamination, origin and analysis of contaminants.

.■ SYLLABUS:

Unit 1. Introduction. Analytical Chemistry and Environment

Role of Analytical Chemistry in solving environmental problems. Methodology and particularities of environmental analysis (environmental sampling, sample treatment analytical methods, trace analysis).

Unit 2. Analysis of atmospheric samples

Physicochemical structure of the atmosphere. Atmospheric pollutants. Analysis of particles and aerosols. Analysis of gaseous pollutants. Examples.

Unit 3. Water analysis.

Characteristics and chemical composition of waters. Sampling. Determination of main physical-chemical parameters of water. Analysis of major components. Determination of trace contaminants

Unit 4. Soil and sediment analysis.

Structure and physical-chemical characteristics of soils. Chemical composition of the soil. Sources of soil contaminants .Sampling and sample treatment

Unit 5. Speciation

Importance of the chemical species and their impact in the environment. Examples. Anaytical methodology for speciation analysis. Hyphenated techniques

Seminars. The students will prepare procedures for the analysis of different environmental samples and analytes. These procedures will be orally presented and discussed with the class.

V.- COMPETENCES

- **CG1-MA1:** Recognize chemical processes in daily life
- **CG3-MA1:** Demonstrate knowledge and skills with the aim of being further applied in specialized areas of Analytical Chemistry or in multidisciplinary areas.
- **CG4-MA1:** Express correctly the acquired knowledge in Analytical Chemistry in a scientific language to be clearly understood in multidisciplinary areas.
- **CG7-MA1:** Apply the acquired theoretical and practical knowledge in solving analytical problems with criteria to select the more appropriate to the problem.
- **CG8-MA1:** Correctly evaluate studies and research performed in the field of Analytical Chemistry
- **CG13-MA1:** Develop good scientific measurement and experimentation practices.

SPECIFIC:

- **CE7-MAQA4**: Recognize the importance of Analytical Chemistry in the evaluation of environmental contamination, recognizing the types of environmental samples, analytes, and concentration levels.
- **CE7-MAQA5:** Apply the most usual analytical methodologies for the analysis of organic and inorganic pollutants in air, water, soil and biota, and in particular with regard to speciation as a tool to assess the environmental impact of the chemical species

TRANSVERSALS

- **CT1-MA1:** Preparing and writing scientifical and technical analytical reports.
- **CT2-MA1:** Teamwork cooperation
- **CT3-MA1:** Learn to make decisions to solve practical problems**CT4-MA1:** Select the most suitable methodology to solve any analytical problem.
- **CT5-MA1:** Use any bibliography source
- **CT5-MA2:** To manage chemical information, chemical literature, and specialized databases in the Analytical Chemistry field

- **CT8-MA1:** Communicate using the most common audiovisual media.
- **CT11-MA1:** Autonomous learning development
- **CT12-MA1:** To develop sensitivity to environmental issues related to Analytical Chemistry

VI.- LEARNING RESULTS

Once this course has finished, the student must be able to:

- Identify the main areas of knowledge involved in the study of the Environment.
- Define the main concepts related to Environmental Chemistry
- Explain technical and legal concepts related to the limits of the presence of compounds in the Environment.
- Describe sampling, sample storage and sample treatment procedures related to environmental analysis.
- Describe the physical-chemical structure of the atmosphere and its chemical composition.
- Identify the sources and transport of atmospheric contaminants.
- Describe analytical methods for determining particulate and gases.
- Classify natural waters and describe their main physical and chemical characteristics, according to their origin.
- Describe the main water sampling procedures, as well as the devices used for this purpose.
- Define the general physical-chemical parameters used to establish water quality and determine them.
- Propose procedures for the analysis of organic and metals in waters at trace level
- Describe the physical-chemical structure of the geosphere, in general, and of the soil in particular.
- Identify the origin, causes and effects of contaminants on the soil.
- Determine the content of the main nutrients in soils for agricultural use as well as some contaminants usually present in soil.
- Use concepts such as bioavailability, environmental mobility, and bioaccumulation.
- Assess the importance of chemical species being present in the environment in different chemical forms.
- Classify the main hyphenated techniques for the analysis of chemical species.

VII. – WORKING HOURS DISTRIBUTED BY ACTIVITY

Activiy	Attendance (hours)	Self-study (hours)	Credits
Lectures	35	65	4,0
Seminars	10	10	0,8
Tutorials/Guided work	2	8	0,4
Laboratory			-
Written assignments and exams preparation	5	15	0,8
Total	**52**	**98**	**6**

VIII.- METHODOLOGY

The teaching practice will follow a mixed methodology based on cooperative learning, collaborative learning, and self-learning. The training activities will be carried out through theoretical classes (lectures), seminars, resolution of theoretical-practical cases and problems, and preparation and presentation of work in directed tutorials. In the **lectures** the content of the unit will be made known to the student. At the beginning of each unit, the content and main objectives of the topic under study will be clearly stated. At the end of each unit, exercises/problems that illustrate the contents developed in the lectures will be proposed. To make it easier to follow up the lectures, the student will be provided with some teaching material used by the teacher, either in photocopies or on the Virtual Campus. The lectures will be given using the blackboard and various audio-visual resources. In the **seminar classes**, problems and theoretical-practical cases related to the topics developed in the theory classes will be explained and the participation of the students will be encouraged, previously providing them with a list of case-problems **Tutorial**s will be used to discuss with the teacher the proposed problems and questions related to the course curriculum, as well as specific practical examples. **The tutorials** will be carried out with small groups, in which the problems and questions proposed by the professor related to the subject's agenda will be discussed, as well as specific practical cases.
The tool **Campus Virtual** will be used to allow fluid communication between teachers and students and as an instrument to make available to students the material that will be used in lectures and seminars.

IX.- BIBLIOGRAPHY

- **BASIC:**

  - R. N. Reeve. "*Introduction to Environmental Analysis*". John Wiley & Sons, LTD. Chichester. 2002.
  - N. Radojevic; V. N. Bahkin "*Practical Environmental Analysis*". RSC. 2006.

COMPLEMENTARY:

- C. Zhang. "Fundamentals of Environmental Sampling and Analysis". Wiley-Interscience. 2007.
- J. R Dean. "*Methods for environmental trace analysis*". John Wiley & Sons. West Sussex. 2003.
- F. W. Fifield; P. J. Haines (Eds.) "*Environmental Analytical Chemistry*". Blackie Acad. & Professional. 1997

X.- ASSESSMENT PROCEDURE

To access to the final evaluation, it is mandatory to participate in at least **70 % of the different activities proposed.** Attendance at supervised tutorials is mandatory.

The student's assessment will be determined in a weighted manner, according to the percentages shown in each of the aspects listed below. All grades will be based on the absolute score of 10 points in accordance with the scale established in RD 1125/2003. It will be necessary to reach a minimum score of 5 points out of 10 among all the activities to pass the course. This criterion will be maintained in all calls.
The qualifications of the activities planned for the evaluation of the course (exams, delivery of exercises, group work) will be communicated to the students sufficiently in advance before the completion of the final exam,
In any case, a period of seven days between the publication of the qualifications and the date of the final exam of the subject will be considered as minimum.

SELF-WORK, GUIDED ACTIVITIES 25 %

In this section, the theoretical and practical questions and problems proposed by the lecturer will be considered for grading throughout the course, both in scheduled tutorials and in non-presential activities.

Evaluated competences:

CG1-MA1, CG4-MA1, CG7-MA1, CG8-MA1, CG13-MA1, CE7-MAQA4, CT1-MA1, CT2-MA1, CT3-MA1, CT4-MA1, CT5-MA1, CT5-MA2, CT8-MA1, CT11-MA1, CT12-MA1

WRITTEN EXAMS 70%

Ordinary exam

The final exam will take place at the end of the first semester, on the date, time and place previously stablished by the academic authorities of the faculty. In this exam, the student must demonstrate the knowledge acquired throughout the semester by answering theoretical questions and theoretical-practical assumptions. The exam will include the scores assigned for each question or problem included in the exam. The exam represents the 70% of the final score of this course being necessary, that the student obtains a minimum score of **4.0 out of 10 points** for this activity to contribute to the overall score of the subject

Extraordinary exam

Those students who do not reach the minimum of 4.0 out of 10 points required in the final exam, or that the average of all the activities does not reach the score of 5 out of 10 points, will take an exam in the extraordinary call. For the final qualification of this extraordinary call, the same minimum qualification criteria and weighted average will be maintained as for the ordinary call.

Evaluated competences: CG3-MA1, CG4-MA1, CG7-MA1, CE7-MAQA5, CT3-MA1, CT11-MA1.

■ ACTIVE PARTICPATION 5%

The student's participation in presential lecture, seminars and tutorials will be considered.

ACTIVITIES SCHEDULE

TEMA	Activity	HOURS	GROUPS	BEGINNING	END
1. Introduction. Analytical Chemistry and Environment	Lectures	5	1	1st week	2nd week
	Seminar	1	1		
***2.* Analysis of atmospheric samples**	Lectures	7	1	3rd week	5th week
	Seminar	2	1		
3. Water analysis	Lectures	11	1	6th week	10th week
	Seminar	4	1		
	Tutorial*	1	2	To be assigned	
4. Soil and sediments analysis	Lectures	10	1	11st week	14th week
	Seminar	2	1		
5. Speciation	Lectures	2	1	15th week	15th week
	Seminar	1	1		
	Tutorial*	1	2	To be assigned	

* The weeks assigned for the scheduled tutorials will depend on the planning of the rest of the courses.

SUMMARY OF THE ACTIVITIES

Teaching activity	Associated competences	Lecturer activity	Student activity	Assessment procedure	P	NP	Total	C
Lectures	CG1, CG3, CG4, CG7, CG8, CG13, CE7-MAQA4, CE7-MAQA5, CT4, CT5, CT12.	Application of the theory to problem solving. Raising questions.	Participating in the questions posed by the teacher. Questions and doubts	Evaluation of the active participation in class regarding the theoretical concepts and resolution of practical exercises	35	65	100	5%
Seminars		Application of the theory to problem solving. Raising questions.	Exercises and questions solving. Questions and doubts.		10	10	20	
Tutorial/ personal activities	CG4, CG7, CG8, CG13, CE7-MAQA4, CE7-MAQA5, CT1, CT2, CT4, CT5, CT8, CT11, CT12.	Raising questions and problems.	Resolution of posed questions and problems. Active participation		2	8	10	25%
Laboratory	-	-	-	-				-
Exams/ Controls	CG3, CG4, CG7, CG13, CE7-MAQA4, CE7-MAQA5, CT3.	Design and exams correction. Student knowledge evaluation.	Exam preparation and execution.	Evaluation of the performed exams	5	15	20	70%
P : In-person; NP: Self-study; C: Evaluation								