Universitat Autònoma de Barcelona

2023/2024

Industrial and Environmental Monitoring

Code: 102498
ECTS Credits: 6

Degree	Type	Year	Semester
2502444 Chemistry	OT	4	2

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

Antonio Calvo Lopez

Prerequisites

There are no prerequisites

Objectives and Contextualisation

The course aims to complement and extend the basic knowledge of students in the field of Analytical Chemistry, as a science that generates quality chemical information (qualitative and quantitative) for the resolution of industrial and environmental monitoring problems. This information must incorporate next to the numerical data relative to the composition, the temporal and spatial vector that characterizes the information relative to dynamic systems in evolution.

With this objective, special importance will be given to everything related to the simplification of the analytical procedures using approximations based on the automation and interconnection of the different stages that they are composed; the reduction and integration of these stages through improvements in the selectivity of the measurements or their subsequent chemometric data treatment and, finally, the miniaturization of the instrumentation to facilitate its use outside of the environment of conventional laboratories.

The knowledge acquired in this course is fundamental to understand the importance of instrumental analysis methods for the acquisition of analytical information relevant to a management and rational exploitation of natural resources that allows their preservation and maintenance by limiting the impact of anthropogenic activities on ecosystems.

Likewise, it will show how the instrumental methods of analysis are also a basic tool for the optimization of industrial production processes and the reduction of their environmental impact, improving the quality of the products obtained, minimizing both the consumption of raw materials and the residual generation.

This course will also show the importance of multidisciplinary knowledge for the resolution of complex environmental and industrial problems. The design of analytical tools capable of providing in-situ information in real time will require understanding and addressing the learning of other areas of knowledge, showing the eminently multidisciplinarynature of Analytical Chemistry field.

The objectives of this course are:

1. Describe and deepen the fundamentals concepts and the instrumentation associated with the main instrumental techniques of analysis.

2. Describe and deepen the different analytical methodologies applicable to obtain information in real time in the field.

3. Apply the acquired knowledge to solve problems of environmental (control of natural processes and pollution by anthropogenic activities) and industrial (optimization of production and minimization of environmental impact) monitoring

Competences

- "Interpret data obtained by means of experimental measures, including the use of IT tools; identify their meaning and relate the data with appropriate chemistry, physics or biology theories."
- Adapt to new situations.
- Apply knowledge of chemistry to problem solving of a quantitative or qualitative nature in familiar and professional fields.
- Be ethically committed.
- Communicate orally and in writing in one's own language.
- Evaluate the health risks and environmental and socioeconomic impact associated to chemical substances and the chemistry industry.
- Have numerical calculation skills.
- Lead and coordinate work groups.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Manage, analyse and synthesise information.
- Obtain information, including by digital means.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse chemical problems and propose suitable answers or studies to resolve them.
- Resolve problems and make decisions.
- Show an understanding of the basic concepts, principles, theories and facts of the different areas of chemistry.
- Show sensitivity for environmental issues.
- Use IT to treat and present information.
- Use the English language properly in the field of chemistry.
- Work in a team and show concern for interpersonal relations at work.

Learning Outcomes

1. Adapt to new situations.
2. Apply the analytical information obtained from the optimisation of industrial processes to improve their competitiveness and reduce environmental impact.
3. Be ethically committed.
4. Communicate orally and in writing in one's own language.

5. Critically evaluate the analytical methodologies used in the control of industrial and environmental processes, as well as their applicability in accordance with the type of information sought, the sample for analysis and the available means.
6. Define the concepts of integration and automation of analytical procedures as a tool for their simplification and critically evaluate the characteristics of the different types of automatic analysis systems.
7. Define the functions of chemical analysis in sustainable development, on an industrial and environmental level.
8. Describe the concept of the sensor as a tool for the integration of analytical procedures, and the basic principles of transduction and selective recognition.
9. Differentiate the diverse stages of the analytical process as a key element for the obtainment of information.
10. Discriminate between qualitative (screening) and quantitative analytical methods.
11. Distinguish the problems associated with the different types of analyte and sample matrices in the industrial and environmental fields (water system, atmosphere, soil).
12. Evaluate and interpret chemical data and information obtained by means of industrial and environmental monitoring.
13. Evaluate the results of the environmental monitoring process to control the evolution of the ecosystem and thus enable effective management of natural resources.
14. Have numerical calculation skills.
15. Identify the current demands for information in the industrial and environmental field, and new trends in chemical analysis in order to provide solutions to optimise processes.
16. Identify the main pollutant chemical agents, know their sources, and their distribution and interaction with the natural environment.
17. Lead and coordinate work groups.
18. Learn autonomously.
19. Manage the organisation and planning of tasks.
20. Manage, analyse and synthesise information.
21. Obtain information, including by digital means.
22. Plan a strategy to solve an analytical problem related with industry and environmental control, incorporating the time space vector in the information.
23. Propose creative ideas and solutions.
24. Reason in a critical manner
25. Recognise the basic chemistry used to interpret processes occurring in the natural environment.
26. Recognise the basics of the main instrumental analysis techniques in the industrial and environmental fields, in order to properly select the most appropriate in each case.
27. Recognise the different stages required to resolve an analytical process and obtain information.
28. Recognise the differential characteristics of process analysers and relate them to problems derived from the analyser-process interface.
29. Recognise the importance of miniaturising analytical instruments in the development of analytical methodologies that provide information on the space time vector.
30. Resolve examples of controlled follow-up with numerical and graphic tools.
31. Resolve problems and make decisions.
32. Select the suitable methodology for the integration/automation of the analytical procedure in each case.
33. Show sensitivity for environmental issues.
34. Summarise an article written in English in a reasonable time.
35. Use IT to treat and present information.
36. Use common English terminology for industrial chemistry, electrochemistry and corrosion, environmental chemistry, green chemistry, quality management, monitoring systems, and financial and business management.
37. Work in a team and show concern for interpersonal relations at work.

Content

INTRODUCTION

1. Analytical Chemistry and the Control of Environmental and Industrial Processes. The Total Analytical Process. Monitoring: Extraction of information from evolving processes. Spatial and temporal Vector. New trends and challenges in Industrial and Environmental Analytical Chemistry.

INSTRUMENTATION

2. The Analytical Procedure. Instrumentation associated with the different stages. Sampling. Unit operations of sample pretreatment. Fundamental concepts of instrumental measurement techniques. Signal Acquisition and Processing.

3. Simplification of the analytical procedure applied to the process monitoring: Automation vs Integration of stages of the analytical procedure. Selection of the methodology.

4. Automation of the Global Analytical Procedure. Classification of automatic methods. Robotized analyzers. Basic principles and applications. Automatic discrete analyzers. Basic principles and applications.

5. Automation of the Analytical Procedure using Continuous Flow Analyzers. Principles and applications.

6. Integration of the Analytical Procedure. Sensor concept. Types of Sensors. Optical sensors. Electrochemical sensors. Biosensors. Gas sensors.

7. Miniaturization of analytical instrumentation. Preponderant phenomena on a micro scale. Manufacturing technologies. Integrated analytical microsystems. On-site continuous monitoring of industrial and environmental parameters.

8. Screening Methods. Qualitative vs. quantitative aspects of problems in industrial and environmental analysis. Total Index and Binary Response Methods. Parameters Indicators of environmental quality.

9. Remote Monitoring. Conceptual development. Geographic Information Systems (GIS). Global Positioning Systems (GPS). Observation Platforms. Associated analytical instrumentation. Applications.

10. Monitoring of Industrial Processes. Process Analytical Chemistry (PAC): historical perspective. Process analyzers vs Laboratory analyzers. Process-analyzer interface. Analytical process technologies based on spectroscopic methods: theory, technology and implementation. Information processing.

APPLICATIONS

11. Monitoring of water resources. Types of pollution. Types of monitoring. Sampling. Discrete and continuous monitoring: Physical, chemical and biological parameters. Analytical Instrumentation. Water quality control networks.

12. Atmospheric monitoring. Types and characteristics of atmospheric pollutants. Sampling. Monitoring techniques and associated instrumentation. Networks for manual and automatic control of atmospheric quality.

13. Soil contamination. Sampling and representativeness. Speciation Sequential extraction. Instrumental techniques for in-situ measurement. Cone Penetrometer.

14. Industrial Process Control. Case studies in the agri-food, pharmaceutical, petrochemical and mining industry.

Methodology

Theory classes, seminars and Laboratory Practices / Field Trips

The exhibition model will be combined (master class), with audiovisual support, and training activities that can be carried out in groups or individually.

In the theoretical classes, the teacher will offer an overview of the topics covered and will focus on those key concepts that help the student to understand and acquire the basic knowledge of the subject, answering any doubts or questions that may arise.

To promote the achievement of the learning objectives set, training activities aimed at promoting cooperative learning and student participation will be introduced. For individual study and preparation of topics in depth, a basic and complementary bibliography will be indicated.

The activities are designed to acquire specific skills, as well as to develop transversal skills.

At the end of the semester, different seminars will also be held on selected applications in the field of industrial and environmental monitoring. These seminars are intended to delve deeper into aspects covered in theory classes. The works will be elaborated by a class group or by smaller groups and will be presented orally for discussion and evaluation among peers.

Experimental Laboratory Practices will be carried out aimed at the student tackling the resolution of real analytical problems after designing, constructing and evaluating the analytical instrumentation necessary to obtain the information. It is intended that the student identify the basic problems and solve them using the knowledge acquired in the subject.

Experimental Field Practices will also be carried out to visualize the importance of environmental and industrial monitoring systems in the control and minimization of the impact of anthropogenic activities on the natural environment.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Laboratory practices	12	0.48	1, 2, 18, 5, 13, 12, 4, 11, 19, 20, 17, 3, 33, 21, 22, 23, 24, 28, 27, 30, 31, 32, 14, 37, 35, 36
Lectures and seminars	34	1.36	1, 2, 18, 5, 13, 6, 7, 8, 10, 11, 16, 15, 3, 33, 22, 24, 26, 25, 29, 28, 27, 32
Type: Supervised			
Experimental in field practices	4	0.16	2, 18, 13, 12, 10, 11, 20, 3, 33, 21, 22, 24, 25, 30, 37
Tutorials	10	0.4	1, 18, 5, 13, 12, 11, 19, 20, 17, 3, 33, 21, 22, 23, 24, 28, 30, 31, 34, 14, 37, 35, 36
Type: Autonomous			
Exercices solving and seminar preparation	28	1.12	1, 2, 18, 5, 13, 12, 4, 6, 7, 8, 9, 10, 11, 19, 20, 16, 15, 17, 3, 33, 21, 22, 23, 24, 26, 25, 29, 28, 27, 31, 34, 32, 14, 37, 35, 36
Study	56	2.24	1, 2, 18, 5, 13, 12, 6, 7, 8, 9, 10, 11, 19, 20, 16, 15, 3, 33, 21, 22, 23, 24, 26, 25, 29, 28, 27, 30, 31, 34, 32, 14, 37, 35, 36

Assessment

Continuous Assesment

The competences of this course will be evaluated by means of:

A) Final term test (individual assessment), including the whole subject. 45 % of the final mark.

B) An evaluation of the work developed in the laboratory practices (in group). 15 % of the final mark.

C) Cooperative and collaborative activities (seminars, problems, evidences, etc.) and individual activities carried out inside and outside the classroom. They will have a weight of 40% of the final mark.

It will be considered a "not presented" in the course if the student does not appear to the laboratory practices or to the final mark.

To participate in the recovery exam, the students must have been previously evaluated in a set of activities whose weight must be equivalent to a minimum of two thirds of the total grade of the subject.

To pass the course, a minimum of 5 points (out of 10) are requested on the average of the different activities that are evaluated.

Unique Assesment

Students who have accepted the single evaluation modality must take a final test that will consist of an examination of the entire syllabus of the subject. This test will be held on the day that the students of the continuous evaluation take the control exam of the entire subject. The student's qualification will be:

Course grade = (Final exam grade · 85% + Lab grade · 15%)/100

If the final grade does not reach 5, the student has another opportunity to pass the subject by means of the second chance exam that will be held on the date set by the degree coordinator. In this test, you can recover 85% of the grade corresponding to the theory part.

The practical part is not recoverable

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final Term	45	2	0.08	1, 2, 18, 5, 13, 12, 4, 6, 7, 8, 9, 10, 11, 20, 16, 15, 3, 33, 22, 23, 24, 26, 25, 29, 28, 27, 30, 31, 32
Laboratory practices	15	2	0.08	1, 2, 18, 5, 13, 12, 4, 6, 7, 8, 9, 10, 11, 19, 20, 16, 15, 3, 33, 21, 22, 23, 24, 26, 25, 29, 28, 27, 30, 31, 34, 32, 14, 35, 36
Training activities and seminars	40	2	0.08	1, 2, 18, 5, 13, 12, 4, 6, 7, 8, 9, 10, 11, 19, 20, 16, 15, 17, 3, 33, 21, 22, 23, 24, 26, 25, 29, 28, 27, 30, 31, 34, 32, 14, 37, 35, 36

Bibliography

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11. Standard Methods for the Examination of Water and Wastewater. E.W. Rice, R.B. Baird, A.D. Eaton. Editorial: American Public Health Association; 23rd Revised edition. 2017. ISBN-10 : 087553287X.

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13. Marine Chemical Monitoring: Policies, Techniques and Metrological Principles. Philippe Quevauviller , Grayson, S. John Wiley & Sons. 2016. ISBN: 978-1-848-21740-9

Software

Microsoft Office

Acrobat Reader