Universitat Autònoma de Barcelona

2019/2020

Industrial and Environmental Monitoring

Code: 102498
ECTS Credits: 6

Degree	Type	Year	Semester
2502444 Chemistry	OT	4	0

Contact

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Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: Yes

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

INSTRUMENTATION

1. The Analytical Procedure. Instrumentation associated to the different stages. Sampling. Unitary operations of the sample pretreatment. Fundamental concepts of instrumental measurement techniques. Acquisition and Processing of Signals.
2. Simplification of the analytical procedure applied to the process monitoring: Automation vs Integration of stages of the analytical procedure. Selection of the methodology.

3. Automation of the Analytical Procedure. Classification of automatic methods. Robotized Analyzers. Basic principles and applications. Automatic discrete analyzers. Basic principles and Applications.
4. Automation of the Analytical Procedure by means of Continuous Flow Analyzers. Principles and Applications.
5. Integration of the Analytical Procedure. Sensor concept. Types of Sensors. Optical sensors. Electrochemical sensors. Biosensors. Gas sensors
6. Miniaturization of analytical instrumentation. Integrated analytical microsystems. Technologies of manufacturing. Continuous in-situ monitoring of industrial and environmental parameters.
7. Qualitative vs quantitative aspects of the analytical problems in industrial and environmental fields. Methods of screening. Methods of Total Index and Binary Response. Environmental Quality indicators.
8. Remote Monitoring. Conceptual development. Geographic Information Systems (GIS). Global Positioning Systems (GPS). Observation platforms. Associated analytical instrumentation. Applications.
9. Monitoring of Industrial Processes. Process Analytical Chemistry (PAC): historical perspective. Process analyzers vs Laboratory analyzers. Process-analyzer interface. Analytical technologies. Processes analytical chemistry based on spectroscopic methods: theory, technology and implementation. Processing of Information.

APPLICATIONS

1. Monitoring of water resources. Types of contamination. Types of monitoring. Sampling. Discrete and continuous monitoring: Physical, chemical and biological parameters. Analytical Instrumentation. Water quality control networks.
2. Atmospheric monitoring. Types and characteristics of atmospheric pollutants. Sampling. Monitoring techniques and associated instrumentation. Networks of manual and automatic atmospheric quality control.
3. Soil pollution. Sampling and representativeness. Speciation. Sequential extraction. in-situ instrumental techniques of analysis. Conical perforator
4. Industrial Process Control. Case studies in the agri-food, pharmaceutical industry, petrochemical, etc.

Methodology

Theory classes, seminars and Laboratory Practices / Field Trips

The exhibition model (masterclass) will be combined with audiovisual support and training activities that can be carried out in groups or individually. In the master classes, the teacher will offer a global vision of the treated topic emphasizing on the associated key concepts for its adequate comprehension and will answer to the eventual doubts or questions.

The student has to complement the knowledge acquired during the theoretical classes with the help of both the material that the professor can provide through the virtual campus as the recommended bibliography.

For some selected topics will be held seminars where students collaborate individually or collectively with the teacher both in their preparation and in their subsequent presentation in class. The activities are designed to acquire the specific competences as well as to develop the transversal competences.

In order to favour the achievement of the proposed learning objectives, training activities will be introduced aimed at promoting cooperative learning and student participation

Thus, students associated in groups will select at the beginning of the course a topic related to the application of analytical tools in obtaining environmental and industrial information and will develop it as throughout the semester.

Periodic tutorials will be held to discuss the seminar preparation as well as some sessions directed to the resolution of problems. At the end of the semester, there will be a set of classes dedicated to the oral presentation and defense of the work done by the different groups before the whole class and its general discussion and evaluation. These seminars seek to deepen both theoretical and applied aspects of treaties in the theoretical classes.

Experimental field practices will be carried out to visualize the importance of the environmental and industrial monitoring systems in the control and minimization of the impact of the anthropogenic activities in the natural environment as well as, as far as possible, some laboratory sessions aimed at identifying the basic problems to solve in the design of the analytical instrumentation used.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures and seminars	32	1.28	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	8	0.32	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	38	1.52	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

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

a) Middle term test (individual assessment), including the 1st part of the subject. 15% of the final mark.

b) Final term test (individual assessment), including the whole subject. 45% 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.

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) is requested in the average of the controls and the cooperative and collaborative activities.

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
Middle Term	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

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