Universitat Autònoma de Barcelona

2019/2020

Analytical Chemistry

Code: 103282
ECTS Credits: 5

Degree	Type	Year	Semester
2501922 Nanoscience and Nanotechnology	OB	3	2

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

Having completed the subject of Chemical Reactivity, 1st year Degree in Nanoscience and Nanotechnology

Objectives and Contextualisation

In this subject, students must acquire the basic knowledge of Analytical Chemistry and Chemical Analysis. The subject is structured in five blocks of homogeneous content but of different duration and amplitude.

Block 1: The objective of Analytical Chemistry, the analytical process and, above all, the different methods of calibration, as well as a basic statistic for its correct use and interpretation of results are introduced. An introduction to the sampling is also made

Block 2: Introduction to chromatography. Basic principles; gas chromatography; high performance liquid chromatography(HPLC).

Block 3: Introduction to analytical spectroscopy. Special emphasis will be placed on molecular analysis techniques, but also the most common techniques of atomic analysis will be introduced. As an example of qualitative analysis, the principles and applications of infrared spectroscopy will be described

Block 4: Brief introduction to classical methods of wet analysis

Block 5: Introduction to electrochemical analysis, especially the potentiometric and the basic principles of amperometry.

In blocks 2, 3 and 5 the objective is to establish the working concepts and methodologies, so that the student can apply them and in the future expand them if necessary but, in addition, some examples of application of nanocomposites will be mentioned.

Competences

- Apply the concepts, principles, theories and fundamental facts of nanoscience and nanotechnology to solve problems of a quantitative or qualitative nature in the field of nanoscience and nanotechnology.
- Be ethically committed.
- Communicate orally and in writing in ones own language.

- Demonstrate knowledge of the concepts, principles, theories and fundamental facts related with nanoscience and nanotechnology.
- Handle the standard instruments and materials of physical, chemical and biological testing laboratories for the study and analysis of phenomena on a nanoscale.
- Interpret the data obtained by means of experimental measures, including the use of computer tools, identify and understand their meanings in relation to appropriate chemical, physical or biological theories.
- Learn autonomously.
- Manage the organisation and planning of tasks.
- Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
- Propose creative ideas and solutions.
- Reason in a critical manner
- Recognise and analyse physical, chemical and biological problems in the field of nanoscience and nanotechnology and propose answers or suitable studies for their resolution, including when necessary the use of bibliographic sources.
- Recognise the terms used in the fields of physics, chemistry, biology, nanoscience and nanotechnology in the English language and use English effectively in writing and orally in all areas of work.
- Resolve problems and make decisions.
- Show sensitivity for environmental issues.
- Work correctly with the formulas, chemical equations and magnitudes used in chemistry.
- Work on the synthesis, characterisation and study of the properties of materials on a nanoscale from previously established procedures.

Learning Outcomes

1. Analyse situations and problems in the field of physics and chemistry, and propose experimental responses or studies using bibliographic sources.
2. Be ethically committed.
3. Classify electroanalytical and optical analysis methods, and how they are used.
4. Communicate orally and in writing in ones own language.
5. Correctly handle glass and another types of material usually found in a synthesis and characterisation laboratory.
6. Correctly use computer tools to calculate, graphically represent and interpret the data obtained, as well as its quality.
7. Correctly use the necessary computer tools to resolve, expose and interpret an analytical problem.
8. Critically evaluate experimental results and deduce their meaning.
9. Describe standard analytical methods based on acid-base equilibriums, complex formation, redox and precipitation.
10. Describe the principles involved in electrochemical and optical analysis methods.
11. Design simple experiments for the study of simple chemical and physical systems.
12. Employ information and communication technology in the documentation of cases and problems.
13. Identify the most important analytical separation techniques.
14. Identify the statistical methods for the treatment of the results of analyses to obtain information on their quality.
15. Interpret analysis results and assess their quality, relating them to the previous information on the sample.
16. Interpret basic chemistry texts and bibliographies in English.
17. Interpret the data obtained from experimental measurements to characterise a chemical compound or a material.
18. Interpret the results obtained from analytical problems.
19. Justify the results obtained in the laboratory from chemical compound synthesis, separation, purification and characterisation processes on the basis of knowledge of their structure and properties.
20. Learn autonomously.
21. Manage the organisation and planning of tasks.
22. Obtain, manage, analyse, synthesise and present information, including the use of digital and computerised media.
23. Perform basic synthesis, separation and purification procedures in a chemistry laboratory

24. Perform basic synthesis, separation and purification procedures in a synthesis and characterisation laboratory.
25. Plan the right strategy in the different stages of the analytical procedure to solve the problems being addressed.
26. Present brief reports on the subject in English.
27. Propose creative ideas and solutions.
28. Reason in a critical manner
29. Recognise the stages of the analytical procedure in chemical analysis.
30. Recognise the terms relative to physics and materials.
31. Recognise, analyse and resolve electrochemical problems (batteries).
32. Relate experimental data with the physical and chemical properties and/or analysis of the systems that are the object of study.
33. Resolve exercises and problems related with chemical separations using different bibliographic sources and simulation programs.
34. Resolve problems and make decisions.
35. Select appropriate laboratory material for an analytical determination.
36. Show sensitivity for environmental issues.
37. Use data processors to produce reports.
38. Work correctly with the formulas, chemical equations and magnitudes used in chemistry.

Content

Introduction and data processing

Unit 1. Objective of Analytical Chemistry. Analytical process. Classification of analytical methods

Unit 2. Statistical evaluation of analytical data. Experimental error. Propagation of error. Significance tests: t and F. Univariate calibration methods: regression line. Introduction to multivariable calibration.

Unit 3. Validation of an analytical method. Accuracy. Precision. Sensitivity. Selectivity.

Introduction to chromatography.

Unit 4. Introduction. Classification of chromatographic techniques. Basic parameters.

Unit 5. Gas chromatography. Instrumentation. Types of columns Stationary phases. Mass detector coupling. Application examples

Unit 6. High resolution liquid chromatography. Instrumentation. Application examples

Taking and sample treatment

Unit 7. Sample taking. Sampling plan. Sampling statistics. Ingamells' equation. Sample preparation. Solid phase extraction (SPE).

Introduction to analytical spectroscopy

Unit 8. Electromagnetic spectrum. Interaction matter radiation. Classification of spectroscopic techniques. Law of Beer-Lambert.

Unit 9. Molecular spectroscopy. Classification. UV-Vis spectrophotometry. Luminescence. Optical sensors Immunoassays Infrared spectroscopy: application to qualitative analysis.

Unit 10. Atomic spectroscopy. Classification. Atomic absorption spectroscopy. Emission spectroscopy: flame and ICP

Classical chemical analysis

Unit 11. Quantitativity of a reaction. Conditional constants. Complexity volumes. Examples of applications

Introduction to electrochemical analysis:

Unit 12. Potentiometry. Indicator electrodes. Reference electrodes. Selective electrodes Sensors and biosensors.

Unit 13. Amperometry. Polarography Basic concept of the amperometric curve. Example amperometry: control of blood glucose.

Laboratory practices:

Three sessions:

In each laboratory session the student will perform a practice:

Determination of copper in brandy by atomic absorption spectrophotometry

Spectrophotometric determination of Fe (II) in a polyvitaminic tablet

Determination of caffeine in soluble coffee by HPLC

Methodology

ethodology:

The student will perform three types of activities: directed, autonomous and supervised.

1.- Directed activities: The attendance is obligatory and they are carried out in the presence of a teacher.

Theoretical classes: The teacher exposes the contents of the subject and responds to any doubts that the student may have.
Classes of problems: The knowledge acquired in the lectures and autonomous student activities, mainly through the study, are applied to the resolution of problems and exercises related to the contents of the subject.
Laboratory practices: Assume the realization of practical work related to the contents of the subject.

2.- Autonomous activities: With these activities the student alone, or in a group, must reach the competences of the subject. Within these activities we find the study, the resolution of problems, the writing of works, the reading of texts and the search of bibliography.

3.- Supervised activities: The student can request to the teaching staff of the subject tutorials of support for the assimilation of the exposed matter in the classes of theory and problems, and for the resolution of works of pursuit.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
laboratory practices	12	0.48	4, 11, 23, 24, 26, 21, 17, 16, 19, 5, 2, 36, 22, 25, 27, 28, 30, 32, 34, 35, 38, 6, 7, 37
resolution of numerical exercises	8	0.32	1, 8, 4, 11, 12, 26, 21, 17, 16, 36, 22, 25, 28, 30, 32, 33, 34, 38, 6, 7, 37
theory classes	25	1	1, 8, 3, 4, 9, 10, 26, 21, 14, 13, 16, 22, 30, 29, 31, 34, 6, 7, 37
Type: Supervised			

Bibliographic search	5	0.2	12
tutorials	4	0.16	
Type: Autonomous			
Resolution of numerical exercices	11	0.44	1, 11, 18, 31, 32, 33, 34, 38
study	48	1.92	1, 20, 8, 3, 9, 11, 12, 10, 21, 14, 13, 16, 22, 25, 28, 30, 29, 32
writting of works	6	0.24	4, 12, 26, 36, 27, 28, 7, 37

Assessment

The evaluation process is governed by the principle of continuous evaluation. It will consist in:

a) The realization of two midterm exams with contents of theory and problems. The weight of each partial exam will be the same and the total will represent 70% of the final grade. However, depending on the distribution of hours and material between partials, the proportion of each partial in the final grade may be modified, which will be indicated in the presentation of the subject. To average partials, a minimum score of 3.5 must be obtained in each one. The student who does not reach 3.5 in one (or both) partial, will have a recovery test. If the minimum score of 3.5 is not reached in the recovery exam, the subject will be considered suspended and the score of the recovery exam will be teh final grade.

b) Delivery of reports on seminars, work or solved problems: 15% final grade

c) Practical laboratory reports: 15% final grade

To be able to take a recovery exam, the student must have obtained a minimum overall grade of 3.5. In order to be present at the recovery, students must have presented at least 2/3 of the continuous assessment activities.

Attendance at laboratory practices is mandatory. In the case of non-compliance with safety regulations, a student may be expelled from the laboratory and suspend the practice of that day. In the case of serious or repeated non-compliance with safety regulations, the student may be expelled from the laboratory and suspend the subject.

To pass the subject, a minimum global grade of 5.0 must be obtained.

If approved by partial exams, the recovery exam can not be used to raise the grade.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory practices reports	15%	0	0	8, 23, 24, 15, 17, 19, 5, 36, 27, 35, 6, 37
Partial exams	70%	6	0.24	20, 3, 4, 9, 11, 10, 14, 13, 15, 18, 25, 28, 30, 29, 31, 32, 33, 34
Problems solving or presentation of written works	15%	0	0	1, 12, 26, 21, 16, 2, 22, 28, 33, 38, 7, 37

Bibliography

D.C. Harris, C.A. Lucy. Quantitative Chemical Analysis, 9th edition. Mac Millan Education 2016

D.S.Hage, J.R.Carr Analytical Chemistry and Quantitative Analysis, Pearson 2010

G.D. Christian, P. Dasgupta, K.A. Schug, Analytical Chemistry, 7th edition, Wiley International, 2014