COURSE DATA

Data Subject	
Code	34230
Name	Analytical chemistry III
Cycle	Grade
ECTS Credits	6.0
Academic year	2018 - 2019

Study (s)

Degree	Center	Acad. year	Period
1110 - Degree in Chemistry	Faculty of Chemistry	3	First term

Subject-matter

Degree	Subject-matter	Character
1110 - Degree in Chemistry	6 - Analytical Chemistry	Obligatory

Coordination

Name	Department
MEDINA HERNANDEZ, MARIA JOSE	310 - Analytical Chemistry

SUMMARY

On this course students complete their overview of the various types of instrumental analytical techniques by analysing electro-analytical, separation and coupled techniques. The course provides students with a solid foundation for selecting analytical methods using the techniques they have studied both in previous academic years and in this one and for addressing univariate, bivariate and multivariate data processing with the most common statistical techniques and the independence and critical spirit that is afforded by satisfactory knowledge of the fundamentals of this sub-discipline.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

1934 - Double Degree Program in Chemistry-Chemical Engineering :

1110 - Degree in Chemistry :

1929 - Double Degree Program in Physics and Chemistry :

R4-OBLIGATION TO HAVE SUCCESSFULLY COMPLETED THE COURSE

34183 - General Chemistry I

34184 - General Chemistry II

34183 - General Chemistry I

34184 - General Chemistry II

34183 - General Chemistry I

34184 - General Chemistry II

Other requirements

To successfully complete this course, students should have acquired knowledge from previous courses. In particular, they should have a basic understanding of the analytic process and analytical chemistry as well as knowledge of the chemistry of solutions, spectroscopic techniques, univariate data management (calibration), and significant features of the analytical methods.

COMPETENCES (RD 1393/2007) // LEARNING OUTCOMES (RD 822/2021)

1108 - Degree in Chemistry

- Develop capacity for analysis, synthesis and critical thinking.
- Show inductive and deductive reasoning ability.
- Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.
- Solve problems effectively.
- Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.
- Demonstrate ability to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences and using information technology, as appropriate.
- Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.
- Learn autonomously.
- Acquire a permanent sensitivity to quality, the environment, sustainable development and the prevention of occupational hazards.
- Demonstrate knowledge of the main aspects of chemical terminology, nomenclature, conventions and units.

- Interpret the variation of the characteristic properties of chemical elements according to the periodic table.
- Demonstrate knowledge of the main types of chemical reaction and their main characteristics.
- Demonstrate knowledge of the principles of thermodynamics and kinetics and their applications in chemistry.
- Demonstrate knowledge of the principles, procedures and techniques for the determination, separation, identification and characterisation of chemical compounds.
- Show knowledge of the metrology of chemical processes including quality management.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.
- Solve qualitative and quantitative problems following previously developed models.
- Recognise and analyse new problems and plan strategies to solve them.
- Evaluate, interpret and synthesise chemical data and information.
- Handle chemicals safely.
- Handle the instrumentation used in the different areas of chemistry.
- Interpret data from observations and measurements in the laboratory in terms of their significance and the theories that underpin them.
- Evaluate the risks in the use of chemicals and laboratory procedures.
- Relate theory and experimentation.
- Recognise and evaluate chemical processes in daily life.
- Understand the qualitative and quantitative aspects of chemical problems.
- Develop sustainable and environmentally friendly methods.
- Relate chemistry with other disciplines.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.
- Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.
- Have basic skills in the use of information and communication technology and properly manage the information obtained.

LEARNING OUTCOMES (RD 1393/2007) // NO CONTENT (RD 822/2021)

The learning outcomes for this course, which are contained in the Degree document under Analytical Chemistry, are:

1. To have the theoretical and practical knowledge needed to plan, apply and manage the most suitable analytical method for tackling environmental, health, industrial, food or any other problem related to chemical substances.

2. To demonstrate the principles, procedures and main instrumental technologies used in chemistry for the determination, separation, identification, characterization and behaviour of chemical compounds.

3. To clearly explain phenomena and processes related to Analytical Chemistry.

4. To understand and rigorously use bibliographical information and technology related to chemical analytical processes.

5. To understand and be able to use the various forms of measurement for studying chemical processes and instrumental technologies used to determine the behaviour of chemical species.

6. To recognize and appreciate the behaviour of chemical substances for our daily lives.

7. To use technical information to choose the best method for solving a real problem.

9. To demonstrate knowledge of sustainable analytical methods.

10. To have the theoretical and practical knowledge needed to manage chemical residues and safety procedures in the laboratory.

11. To clearly explain experimental phenomena using the theories that support them.

13. To skilfully treat errors, handle error propagation of the magnitudes measured in the laboratory, and manage computer programs for processing experimental information.

14. To demonstrate interpersonal skills also from the gender perspective.

15. To demonstrate sensitivity to environmental issues.

16. To demonstrate the ability to rigorously manage information.

17. To demonstrate leadership ability also from the gender perspective.

18. To effectively perform his or her tasks as a member of a team also from the gender perspective.

19. To solve problems rigorously.

These learning outcomes should ensure that on successful completion of Analytical Chemistry III students will be able to:

• Identify the basic criteria for choosing an instrumental analytical technique, or separation technique in this case, including selecting the working and detection conditions.

• Describe and interpret the experimental method to follow for the analysis using the analytical techniques studied.

• Identify the most common types of interference with the analytical techniques studied as well as the procedures for correcting them.

• Provide representative examples of the applications of the analytical techniques studied.

• Given a specific example of an application or a published article on an analytical method applied to a specific sample, justify its use, discuss its analytical characteristics, reasonably explain the steps to follow, and indicate how to perform the calculations.

• Perform the calculations needed to solve analytical problems using the analytical techniques studied, correctly expressing the results and explaining the conclusions drawn.

• Treat the data using univariate, bivariate and multivariate statistical techniques, expressing the results graphically and numerically and interpreting them correctly.

• Demonstrate an ethical and responsible conduct in the exercise of their professional work, values that are transmitted by teachers and researchers of the University, as a generator and transmitter of scientific knowledge.

DESCRIPTION OF CONTENTS

1. Introduction to Electroanalytical Methods

Electrochemical cells. Potentials of cell and electrode. Electrode reactions. Polarization. Transport mechanisms. Thermodynamic and kinetic aspects. Reversibility. Classification of electroanalytical methods.

2. Potentiometry

Reference electrodes. Types of Indicator electrodes. Potential. Membrane electrodes. Direct potentiometric measurements. pH measurement. Measuring cell. Selective electrodes. Calibration. Potentiometric titrations.

3. Voltamperometry

Working electrodes. Basic instrumentation. Classification of voltammetric methods. Qualitative and quantitative aspects. Polarography. The polarographic wave, the diffusion current, the Ilkovic equation. Limitations. Pulse voltammetry. Parameters. Advantages. Stripping voltammetry. Classification. Stages. Comparison of voltammetric methods. Amperometric titrations.

4. Introduction to Separation Techniques

Concept of analytical separation and classification of separation techniques. Liquid-liquid extraction. Characteristics of common solvents. Theory of liquid-liquid extraction: partition constant, capacity factor and distribution ratio. Numerical problems of extraction. Solid-phase extraction: concept and classification (liquid-solid, solid-solid and gas-solid). SPE as a preconcentration technique. Bonded phases. Common phases and phase distribution in normal, reverse and HILIC. Common phases in ion exchange and retention.

5. Analytical Separation Techniques

The concept of chromatography and the classification of chromatographic techniques. Elution modes. The main parameters in zonal elution chromatography: geometric, operational, and characteristic of the solutes. Introduction to two theories of chromatography. Equilibrium theory, the Craig machine. The concept of HETP. Dynamic theory and the rate equation. Experimental measurement of efficiency. Resolution and the selectivity factor. The relationship between resolution and retention. General characteristics of the detectors used in chromatography: measuring the LOD from background noise. Linear dynamic range, limits, qualitative and quantitative variables. Quantitative methods.

6. Gas Chromatography

Introduction and outline of the gas chromatograph. Scope and derivatizations common in GC. Sample injection with and without direct derivation and on-column injection. PTV injectors. Common stationary phases. Properties. Types of columns. Capillary columns. Selection criteria. Flame ionization detector (FID). Flame photometric detector. NPD detectors and PSD. Electron capture detector. Elution temperature. Identification in gas chromatography.

7. High-Performance Liquid Chromatography

HPLC chromatograph. The manual injector and the automatic injector. Dual piston pump. Mixture modules at low and high pressures. Features. Columns: types and selection criteria. Detectors in liquid chromatography. Classification. Spectrophotometric detection. Classification of liquid chromatography according to the retention mechanism. Selecting the mobile and stationary phases (I): controlling the eluotropic strength. Selecting the mobile and stationary phases (II): controlling selectivity. Isocratic and gradient elution. Ion exchange equilibrium: selectivity coefficients. Conductivity detection. Indirect photometric detection. Selectivity of the response. Anionic suppression.

8. GC-MS and HPLC-MS Hybridization

Basic components of mass detectors. Sample-introduction systems. Ionization sources. Analysers. Detectors. Working modes and characteristics of the data. GC-MS hybridization. HPLC-MS hybridization. Common interfaces and scope.

9. Introduction to Chemometrics and Multivariate Exploratory Data Analysis

Objects and variables. Types of variables. The object-variable matrix and its transpose. Pre-processed data. The variance-covariance matrix. The correlation matrix. Classification of multivariate chemometric techniques. Cluster analysis. Principal component analysis (PCA).

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	51,00	100
Tutorials	9,00	100
Development of group work	13,00	0
Development of individual work	7,00	0
Study and independent work	18,00	0
Readings supplementary material	6,00	0
Preparation of evaluation activities	21,00	0
Preparing lectures	8,00	0
Preparation of practical classes and problem	8,00	0
Resolution of case studies	9,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

This course consists of:

• Whole-group lectures

Lectures will be combined with cooperative learning models. The instructor will provide an overview of the topic under study, explain the key concepts, and answer any questions that arise. To help students meet the learning objectives, activities to promote cooperative learning and student participation will be introduced. To encourage individual study and in-depth preparation of the topics, basic and complementary bibliographies will be provided.

The practical problem-solving sessions will apply the theoretical knowledge acquired. The lecturer will provide problem-type examples and present the information the students will need for learning to identify the essential features of the approach and the techniques needed to solve the problems.

• Tutorials with each subgroup

The lecturer will guide the student on all elements of the learning process regarding both general approaches and specific issues. In class students will solve problems, tackle other issues and conduct other work proposed by the lecturer. A selection of these activities will be corrected or presented. The lecturer will also provide other problems and issues for students to work on at home before correcting them in class.

Seminars and Conference

Seminars and Conference will focus on complementary aspects of their training in Analytical Chemistry. For this task, students attending the event and answer a questionnaire prepared by the instructor.

EVALUATION

Learning will be evaluated by taking into account all aspects outlined in the Methodology section of this course guide. Attendance and reply to a Seminar-Conference will be equivalent to a tutorial. The student activities are not recoverable. Students may submit a request in writing to be evaluated only by examination.

FIRST CALL

Final examination (70%) + student activities (30%)

The score on each of these two parts must be at least 4.5 in order to apply the average.

The minimum overall grade to pass the course is 5.0.

SECOND CALL

In the second call the final grade is obtained by applying the same criteria as in the first call.

REFERENCES

Basic

- SKOOG, D.A.; HOLLER, F.J. Y NIEMAN, T.A. Principios de Análisis Instrumental, 5ª Edición. Madrid: McGraw-Hill, 2001. ISBN 8448127757
- HARVEY, D. Química Analítica moderna. Madrid: McGraw-Hill, 2002.ISBN 9788448136352
- HARRIS, D.C. Análisis Químico Cuantitativo, 3ª Edición. Barcelona: Reverté, 2007. ISBN 9788429172249
- SKOOG, D.A.; WEST, D.M.; HOLLER, F.J. Y CROUCH, S.R. Fundamentos de Química Analítica, 8ª edición. Madrid: Thomson-Paraninfo, 2005. ISBN: 9788497323338
- MILLER, J.N. Y MILLER, J.C. Estadística y Quimiometría para Química Analítica. Madrid: Prentice Hall, Pearson Educación, 2002. ISBN 8420535141
- KELLNER, R.; MERMET, J.M.; OTTO, M.; VALCÁRCEL, M. Y WIDMER, H.M. Analytical Chemistry: a modern approach to analytical science, 2ª edición. Winheim: Wiley-VCH, 2004. ISBN 3527305904

- RAMIS, G. Y GARCÍA ALVAREZ-COQUE, M.C. Quimiometria. Madrid: Síntesis, 2001. ISBN 8477389047