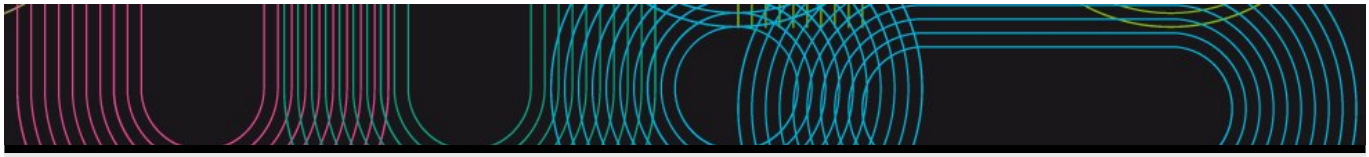

IDENTIFYING DATA				
Analytical Chemistry II: Optical Methods of Analysis				
Subject	Analytical Chemistry II: Optical Methods of Analysis			
Code	V11G201V01207			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Bendicho Hernández, José Carlos			
Lecturers	Bendicho Hernández, José Carlos Pena Pereira, Francisco Javier Pérez Cid, Benita			
E-mail	bendicho@uvigo.gal			
Web				
General description	English Friendly subject: International students may request from the teachers: a) materials and bibliographic references in English, b) tutoring sessions in English, c) exams and assessments in English. Description of the course: the optical methods of analysis (analytical spectroscopy), constitute a powerful and versatile tool in the chemical laboratories, resolving problems in areas of interest such as food, environment, industry or biomedicine. In this subject, students will learn the fundamentals, instrumentation and applications of the main optical methods of analysis that rely on phenomena such as absorption, emission, fluorescence, scattering, etc.			

Training and Learning Results	
Code	
A1	Students can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study
A3	Students have the ability to gather and interpret relevant data (usually within their field of study) to inform judgments that include reflection on relevant social, scientific or ethical issues
B4	Ability for analysis and synthesis
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C26	Perform correctly usual procedures in the laboratory, including the use of standard chemical instrumentation for synthetic and analytical work
D1	Ability to solve problems

Expected results from this subject			
Expected results from this subject			Training and Learning Results
Choose the suitable instrumental analytical technique in function of the analyte to be determined and the characteristics of the sample.			C6
Define, calculate and interpret the different quality parameters of an analytical method.		B4	C6
Explain the fundamentals of the main optical methods of analysis and describe their relevant applications in the laboratories.	A1		C6
Describe the interaction processes of the electromagnetic radiation with the matter, classify the optical methods and recognise the differences between the molecular and atomic spectrometry.			C6
Distinguish the instrumentation of the modern spectroscopy techniques and their different components.			C6

Select the suitable calibration method for any analytical problem posed and compute the experimental data to obtain the function of calibration.			C26	D1
Apply the optical methods of analysis for the resolution of problems in different working areas.	A1 A3		C26	
Carry out correct mathematical calculations in the problem solving of the optical methods of analysis.	A1 A3	B4	C26	D1

Contents	
Topic	
SUBJECT 1. Introduction to instrumental analytical methods.	Classification of the instrumental analytical methods. Quality parameters of an instrumental method: Validation. Methods of calibration in instrumental analysis: external calibration, standard addition and internal standard. Characteristics of the calibration curves. Fitting and statistical parameters of calibration lines.
SUBJECT 2. Optical methods of analysis: generalities.	Electromagnetic spectrum. Phenomena of interaction between the electromagnetic radiation and the matter. Classification of the optical methods of analysis. Instrumental components and representative configurations of the different instruments. Signals and noise.
SUBJECT 3. UV-vis molecular absorption spectroscopy	Fundamentals of the UV-vis molecular absorption spectroscopy. Basic concepts. Lambert-Beer Law. Deviations of the Lambert-Beer law. Absorbent species. Types of instruments. Analytical methodology and applications.
SUBJECT 4. Luminescent techniques.	Fundamentals. Mechanisms of molecular deactivation. Fluorescence and Phosphorescence. Factors influencing the luminescence. Quenching of the fluorescence. Chemiluminescence and Bioluminescence. Instrumentation. Analytical methodology and applications.
SUBJECT 5. Infrared and Raman spectroscopy.	Fundamentals. Modes of molecular vibration. Infrared spectrum and molecular structure. Raman spectroscopy. Origin of the Raman spectra. Instrumentation. Methodology. Applications in qualitative, quantitative and structural analysis.
SUBJECT 6. Atomic absorption spectroscopy.	Fundamentals. Origin of atomic spectra. Flame atomizer. Atomization processes in flames. Graphite furnace atomizer. Thermal programs. Interferences. Instrumentation. Background correctors. Methods of vapor generation. Analytical methodology and applications. Atomic fluorescence spectrometry.
SUBJECT 7. Atomic emission spectroscopy and atomic mass spectrometry.	Fundamentals of atomic emission spectroscopy. Excitation sources and temperature effect. Flame emission spectrometry (flame photometry). Arc and spark emission spectrometry. Inductively-coupled plasma atomic emission spectrometry. Plasma source mass spectrometry. Comparative analytical characteristics of the main techniques for trace inorganic analysis.

Planning			
	Class hours	Hours outside the classroom	Total hours
Problem solving	24	24	48
Laboratory practical	14	3	17
Lecturing	24	31	55
Essay questions exam	2	4	6
Essay questions exam	0	8	8
Report of practices, practicum and external practices	0	4	4
Objective questions exam	0	8	8
Problem and/or exercise solving	0	4	4
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies	
	Description
Problem solving	Problem solving will allow to reinforce the learning of theoretical contents explained during the masterclasses. Activities in these classes may comprise solving of numerical problems, handling of spreadsheets for calibration exercises, discussion of practical cases related with the optical methods of analysis and published in educational journals, etc. The teacher will propose different problems/exercises/questionnaires that will be solved by students and delivered for their evaluation.

Laboratory practical	In the lab sessions, student will learn to operate with the different instruments corresponding to atomic and molecular spectrometries, acquiring skills in the different stages of method development such as the preparation of standards, optimisation of instrumental parameters, calibration, etc. For this purpose, the teacher will provide the student with the scripts describing the theoretical foundations, objectives, instrumentation, reagents and operation procedure. Students will elaborate a lab notebook during the development of the hands-on experiments, in which they will reflect all the operations made, experimental data, calculations and conclusions reached. Those students that have overcome lab practices in the academic years 21-22 and 22-23 will not need to repeate them. In this case, the mark obtained in lab practices will be kept.
Lecturing	The teacher will explain in masterclasses the theoretical contents of the program with the support of slides provided through the learning platform moovi. Several questionnaires will be proposed to students for their self-evaluation.

Personalized assistance

Methodologies	Description
Lecturing	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Problem solving	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Laboratory practical	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.
Tests	**Description**
Report of practices, practicum and external practices	The teacher will resolve the doubts on any activity proposed (masterclasses, laboratory practices, problems/exercises solving) in a personalised way. To this end, the teacher will inform students of the available tutorial schedule in the presentation of the subject.

Assessment

	Description	Qualification	Training and Learning Results
Laboratory practical	In lab sessions, a follow-up experimental work carried out by the student will be monitored (attitude and practical skills acquired) will be performed. Attendance at all laboratory sessions is compulsory (it is not possible to overcome the course without doing the practical sessions).	10	A3 B4 C6 C26 D1
Essay questions exam	1st Examination: exam (subjects 1,2,3) of 2 hours of duration carried out approximately in the middle of the term and included in the course schedule. The test will have two parts, one of numerical problems/exercises and the other of multiple-choice questions.	30	A1 B4 C6 D1
Essay questions exam	2nd Examination: exam (subjects 4,5,6,7) of 2 hours of duration, to be held on a date approved by the Faculty Board, corresponding to the end of the term. The examination will have two parts, one of numerical problems/exercises and the other of multiple-choice questions.	30	A1 B4 C6 D1
Report of practices, practicum and external practices	Students will elaborate a lab report in which the experimental work will be reflected (preparation of standards, calibration of instruments, operation procedures, observations, results, etc.). The assessment will consider both formal issues and quality of the results.	10	A3 B4 C26
Objective questions exam	At the end of the subjects corresponding to the theoretical program, students will perform a self-evaluation test (multiple choice questions) so as to strengthen the understanding of the contents.	10	C6
Problem and/or exercise solving	Students will solve similar problems/exercises to those included in the problem/exercise sheets (deliverables). Likewise, deliverables of questionnaires posed in the discussion of different case studies will be requested. It will be necessary to accomplish a minimum number of deliverables established by the teacher so that the mark of this activity can be added to the rest of the assessment items.	10	A1 A3 B4 C6 D1

Other comments on the Evaluation

Continuous assessment mode:

Considerations on the evaluation of the practical subjects:-Lab practices (hands-on work follow-up): lack of attendance, even if justified, will penalise the mark. A number of absences of more than 25% of the laboratory sessions will mean failing the

lab practices. A minimum mark of 4 out of 10 will be required to be added to the rest of the evaluation elements. The completion of the lab practices and the lab report is essential to pass the course both in the continuous assessment mode and in the global assessment mode (non-continuous).-Lab report: it will be necessary to obtain a minimum grade of 4 points out of 10 in the Lab Report in order to be added to the rest of the evaluation elements.

Considerations on the evaluation of the tests (intermediate and end of term test):
The part of multiple-choice questions and the part of numerical problems/exercises will have a weight of 50% each in the two tests. In order to be able to average the theory part and the problems/exercises part, a minimum of 3 points out of 10 must be obtained in either part.
-A minimum score of 4 points out of 10 must be achieved in the first examination in order for it to be averaged with the second one. Students who have not achieved a grade of at least 4 points out of 10 in the first examination and those who wish to raise their grade must take a recovery exam of the first part of the course (1 hour time) whose grade will replace the one obtained previously. This recovery test will take place on the date scheduled for the 2nd examination The average of the two exams must be at least 4 points out of 10 in order to be added to the rest of the evaluation elements. If this minimum score is not reached, only the weighted grade of both exams will appear in the student grading reports.

Qualification in the 1st edition of the call (May-June):

-Once the above criteria have been taken into account, passing the course is achieved with an overall mark of 5 points out of 10.The student's participation in any of the assessement items with the exception of problem solving and/or exercises (deliverables) and self-assessment tests disqualifies him/her from obtaining the grade of NOT PRESENTED. The overall qualification in the first edition of the call will be made up of the marks obtained in the problem solving classes (deliverables) (1 point), self-assessment tests (1 point), hands-on work follow-up (1 point), Lab report (1 point), 1st examination (3 points) and 2nd examination (3 points).

Qualification in the 2nd edition of the call (July):
The qualification in this edition will be made up of two components:
1. Grades obtained by the student during the course:
Only the marks obtained by the student during the course in the lab practices (1 point) and the Lab report (1 point) will be retained.
2. Final exam on the contents of the subject (8 points).
This exam will include numerical problems/exercises and multiple-choice questions. A minimum grade of 4 out of 10 points will be required in this exam in order to be added to the grade obtained in the practicals.

Global assessment mode (not continuous):

-Students who wish to take this option must notify the subject coordinator in writing within one month of the start of the term. It is compulsory to complete the Lab practices/Lab report and a global assessment examination in order to pass the course.
-Lab practices/Lab report (2 points): the same considerations established above for continuous assessment will apply.
-Global assessment examination (8 points): The exam will have two parts, one of numerical problems/exercises and the other of multiple-choice questions and will cover all the topics of the course, with the same considerations as those determined above for continuous assessment. Passing the subject requires an overall mark of 5 points out of 10.
The date of this exam will coincide with the date of the final exam of the four-month period established for continuous assessment.

Evaluation of students in the Integrated Cycle of the Seniors Programme:

-Compulsory attendance to 80% of the theoretical and practical classes and seminars.
-Accomplishement of a theoretical-practical work on a subject of the course.
-Accomplishement of the self-assessment tests programmed through the e-learning platform.

Sources of information
Basic Bibliography
D.A. Skoog, F.J. Holler, S.R. Crouch, **Principios de Análisis Instrumental**, 7ª edición, Cengage Learning Editores, 2018
A. Rios, M.C. Moreno, M. Simonet, **Técnicas espectroscópicas en química analítica**, Síntesis, 2012
L. Hernández, C. González, **Introducción al Análisis Instrumental**, Ariel, 2002
Complementary Bibliography
J.D. Ingle, S.R. Crouch, **Spectrochemical Analysis**, Wiley, 1988
J.N. Miller, J.C. Miller, **Estadística y Quimiometría para Química Analítica**, Prentice Hall, 2002
J.M. Fernández Solís, J. Pérez Iglesias, H.M. Seco Lago, **Estadística sencilla para estudiantes de ciencias**, Síntesis, 2012

J. Guiteras, R. Rubio, G. Fonrodona, **Curso experimental en Química Analítica**, Síntesis, 2003
J.M. Andrade y 5 autores más, **Problems of Instrumental Analysis: a hands-on guide**, World Scientific Publishing Europe, 2017

Recommendations

Subjects that continue the syllabus

Analytical Chemistry III: Electroanalytical Methods and Separations/V11G201V01302
Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306
Enhancement of Analytical Chemistry/V11G201V01406
Quality in Analytical Labs/V11G201V01407
Food, Agricultural and Environmental Analytical Chemistry/V11G201V01410

Subjects that it is recommended to have taken before

Physics: Physics I/V11G201V01102
Physics: Physics 2/V11G201V01107
Mathematics: Mathematics 1/V11G201V01103
Mathematics: Mathematics 2/V11G201V01108
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202