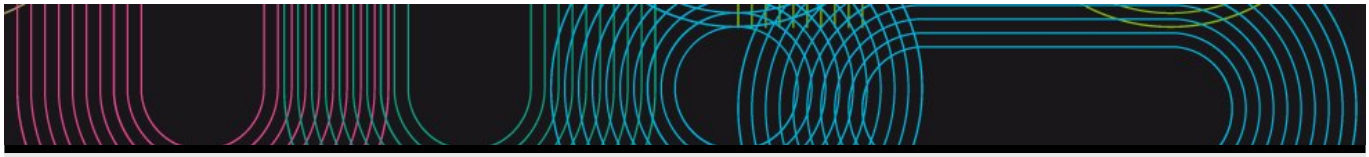

IDENTIFYING DATA				
Analytical Chemistry II: Optical Methods of Analysis				
Subject	Analytical Chemistry II: Optical Methods of Analysis			
Code	V11G201V01207			
Study programme	(*)Grao en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	2nd	2nd
Teaching language	#EnglishFriendly Spanish Galician			
Department				
Coordinator	Bendicho Hernández, José Carlos			
Lecturers	Bendicho Hernández, José Carlos Pérez Cid, Benita			
E-mail	bendicho@uvigo.es			
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.			

Competencies	
Code	
A2	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

Learning outcomes			
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.	A2	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.	A2 A3		C26	
Carry out correct mathematical calculations in the problem solving of the optical methods of analysis.	A2 A3	B4	C26	D1

Contents

Topic	
SUBJECT 1. Introduction to instrumental analytical techniques.	Classification of the instrumental techniques of analysis. 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	Fundamentals. Sources of excitation. Flame atomic emission spectrometry (Flame photometry). Spectrometry of emission in arc and spark. Inductively-coupled plasma atomic emission spectrometry. Inductively-coupled plasma-Mass spectrometry. Instrumentation. Interferences. Analytical methodology and applications.
SUBJECT 8. X-ray Spectroscopy.	Fundamentals. Origin of the X-ray spectra. Interaction between the radiation of the X-ray region and matter: absorption, emission, fluorescence and diffraction. Spectroscopy of X-ray fluorescence. Instrumentation. Analytical methodology and applications.

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 students to reinforce the learning of the subjects explained during the masterclasses. Teaching tools to carry out in these sessions will comprise the resolution of mathematical problems, theoretical-practical exercises, worksheets for solving calibration problem, discussion of practical cases related with the optical methods of analysis and published in educational journals of chemistry, etc. The teacher will regularly propose to students different problems/exercises/questionnaires for their resolution (deliverable exercises).

Laboratory practical	In the practical lab, the student will learn the handling of characteristic instruments used in atomic and molecular spectrometries, acquiring skills in the diferent stages of method development such as the preparation of samples and standards, optimisation of instrumental parameters, calibration, etc. For this purpose, the teacher will provide in advance to the students the scripts where the theoretical fundamentals, aims of the practice, instrumentation, reagents and operative procedure will be briefly described. The student will elaborate a laboratory notebook in which all the operations made will be reflected, including the experimental data obtained and the conclusions reached.
Lecturing	The teacher will explain the contents of the program from the material provided to the student through the Moodle on-line learning platform. In the masterclasses, the teacher will explain the fundamentals of the subject that will be complemented by means of the bibliography recommended. At the end of each subject, the teacher will propose a multiple choice question examination that will have to be individually resolved by each student.

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 the sessions of laboratory practices a follow-up of the experimental work made by students (attitude and practical skills) will be performed. It is important to indicate that the attendance to all the lab sessions is compulsory. The non-attendance, even if it is excused, will penalize the mark (in case of unexcused absences, students should attend practical sessions of other groups to accomplish the practice). If the number of absences is upper to the 25 % of the programmed lab sessions, it will involve that students will not pass the course.	10	A3 B4 C6 C26 D1
Essay questions exam	A SHORT EXAM (mid-course exam) roughly to half of the course. The attendance to this exam disables students to obtain the mark of non presented. The short exam will consist of multiple choice questions, short answer questions and exercises. This exam will released contents if passed. Students that do not surpass the exam will have to repeate the exam of this part in the overall examination. The date of this examination will be approved by the Faculty board.	30	A2 B4 C6 D1
Essay questions exam	COMPULSORY OVERALL EXAM. It will consist of on an exam related to the second part of the subject contents. This exam will include multiple choice questions, short answer questions and exercises. It will be necessary to obtain a minimum mark of 3 out of 10 in this exam so that it can added to the marks of the remaining assessment items. If the short exam is not passed, students will have to pass an exam of all subjects. In this case, the exam will represent the 60 % of the final mark. The date of this exam will be approved by the Faculty board.	30	A2 B4 C6 D1
Report of practices, practicum and external practices	Student will elaborate a practice lab notebook in which the experimental work carried out in the lab sessions will be reflected (Preparation of standards, calibration of instruments, operation procedures, observations, results, etc.). The evaluation will consider both formal issues and quality of the results.	10	A3 B4 C26
Objective questions exam	At the end of each subject of the theoretical program, the student will perform a self-evaluation test (multiple choice questions) with the end to strengthen the understanding of the contents.	10	C6

Problem and/or exercise solving	Of each problem/exercise sheet, students will individually solve those selected by the teacher (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.	10	A2 B4 C6 A3	D1

Other comments on the Evaluation

May-June

The participation of the students in any of the asssessment items with the exception of problem and/or exercise solving (deliverables) will not entitle them to obtain the mark of NON PRESENTED. To pass the short exam (mid-course exam) as well as the overall exam, a balance in the marks of the multiple choice questions and that of problem/exercises will be required. The overall mark in the first opportunity of the call will be integrated by the marks obtained in problem/exercise solving (deliverables) (1 point), test of self-evaluation in masterclasses (1 point), lab practice follow-up (1 point), practice lab notebook (1 point), mid-course exam (3 points) and overall exam (3 or 6 points).

2ª Opportunity (July):

The mark in the second opportunity of the call will be integrated by two components:
1. Marks obtained by students during the academic course:
The marks obtained by students along the course in the lab practices (1 point) and practice lab notebook (1 point) will be maintained.
2. Overall exam of the contents of the subject (8 points).
This exam will include multiple choice questions and problem/exercices. A balance in the marks obtained in the multiple choice questions and that of problem/exercices will be required to pass the exam.

Sources of information

Basic Bibliography

D.A. Skoog, F.J. Holler, S.R. Crouch, **Principios de Análisis Instrumental**, 9786075266558, 7ª edición, Cengage Learning Editores, 2018

A. Rios, M.C. Moreno, M. Simonet, **Técnicas espectroscópicas en química analítica**, 978-84-995893-2-9, Síntesis, 2012

L. Hernández, C. González, **Introducción al Análisis Instrumental**, 84-344-8043-3, Ariel, 2002

Complementary Bibliography

J.D. Ingle, S.R. Crouch, **Spectrochemical Analysis**, 0-13-826900-9, Wiley, 1988

H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, **Métodos instrumentales de análisis**, 968-7270-83-7, Grupo Editorial Iberoamericana, 1991

J.N. Miller, J.C. Miller, **Estadística y Quimiometría para Química Analítica**, 84-205-3514-1, Prentice Hall, 2002

J.M. Fernández Solís, J. Pérez Iglesias, H.M. Seco Lago, **Estadística sencilla para estudiantes de ciencias**, 978-84-975681-5-9, Síntesis, 2012

J. Guiteras, R. Rubio, G. Fonrodona, **Curso experimental en Química Analítica**, 84-9756-072-8, Síntesis, 2003

J.M. Andrade y 5 autores más, **Problems of Instrumental Analysis: a hands-on guide**, 9781786341808, World Scientific Publishing Europe, 2017

Recommendations

Subjects that are recommended to be taken simultaneously

Structural Determination/V11G201V01206

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
Inorganic chemistry I/V11G201V01204

Contingency plan

Description

=== EXCEPTIONAL MEASURES SCHEDULED ===
In front of the uncertain and unpredictable evolution of the sanitary alert caused by the COVID-19, the University of Vigo establishes an extraordinary planning that will activate in the moment in that the administrations and the own institution determine it attending to criteria of security, health and responsibility, and guaranteeing the teaching in a no face-to-face stage or partially face-to-face. These already scheduled measures guarantee, in the moment that was prescriptive, the development of the teaching of a more agile and effective way when being known in advance (or with a wide anticipation) by the students and the teachers through the tool normalised and institutionalised of the educational guides.

=== ADAPTATION OF THE METHODOLOGIES ===
*Teaching Methodologies that will be kept
We will maintain the methodologies proposed in the teaching guide to reach the results of the learning, adapted to on-line or blended teaching, according to the guidelines provided by the Faculty. If necessary, the teaching in virtual mode through remote campus (synchronous teaching) or through the Moodle platform in FAITIC (asynchronous teaching) will be implemented. Likewise, the tutorial activity will be performed using appropriate telematic tools.

*Teaching methodologies that modify
See above section.

*Mechanism no face-to-face of attention to the students (tutorials)
Assistance to students will be provided using telematic tools (virtual office, skype, email, etc.).

*Modifications (if they proceed) of the contents to give
The contents will be the same.

*Additional bibliography to facilitate the self-learning
Bibliography recommendations in English to international students will be made. The teacher will adapt the teaching material available in the moodle platform to virtual teaching according to the different situations posed by the COVID-19.

*Other modifications

=== ADAPTATION OF THE EVALUATION ===
The evaluation will be kept according to guidelines scheduled in the teaching guide corresponding to this course (test, problem solving, etc.), using the available virtual assessment tools.

Proofs already made
Proof XX: [previous Weight 00%] [Weight Proposed 00%]
...

Pending proofs that keep
Proof XX: [previous Weight 00%] [Weight Proposed 00%]
...

Proofs that modify
[previous Proof] =&*gt; [new Proof]

New test

additional Information