Teaching Guide				
Identifying Data				2021/22
Subject (*)	Advanced Atomic Techniques and Sensors		Code	610509127
Study programme	Mestrado Universitario en Investigación Química e Química Industrial (Plan 2020)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Optional	3
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Departamento profesorado másterQuímica			
Coordinador	Moreda Piñeiro, Jorge	E-mail	jorge.moreda@udc.es	
Lecturers	Moreda Piñeiro, Jorge	E-mail	jorge.moreda@udc.es	
Web	master-universitario-investigacion-quimica-quimica-industrial/20202021/tecnicas-atomicas-avanzadas-sensores-17772-17018-3-98955			
General description	This subject will address the following objectives: 1. Complete acquisition of the different advanced atomic spectroscopic techniques, both in theoretical aspects and in their practical application. 2. Complete acquisition of the different hybrid techniques used in metallomics and metalloproteomics, both in theoretical aspects and in their application. 3. Complete acquisition of the different types of optical, electrochemical, thermal and mass sensors, theoretical aspects and application examples			

Contingency plan	Methodology: Due to the uncertainty generated by the health crisis of COVID 19, three possible teaching scenarios are proposed for the 2020/2021 academic year: SCENARIO 1: adapted normality Teaching will be face-to-face, except for some tutoring that could be done practically. The delivery of reports, assignments and exercises by the student will be in person and in paper format, and in some cases as digital material and non-face-to-face delivery (virtual classroom, webmail, etc.). SCENARIO 2: distancing (partial restriction on attendance) Face-to-face and non-face-to-face teaching will be combined, in the second case preferably using digital support such as the Microsoft computer platform or other equivalents, as well as the virtual classroom, combining synchronous and asynchronous mechanisms. The presentation and delivery of reports, assignments and exercises by the student will be done preferably digitally and not in person (virtual classroom, webmail, etc.). SCENARIO 3: closure of facilities Students will receive all teaching by telematic means, combining synchronous and asynchronous mechanisms, mainly using the Microsoft computer platform and the USC virtual campus, and therefore at no time will they access the faculty. Laboratory practices will be replaced by alternative non-contact activities including videos or demonstrations of these, examples, case resolution using simulated data, etc. The delivery of works and tests will not be in person or in paper format, but will be done by digital telematic means. Depending on the evolution of the health crisis of COVID 19, 3 scenarios are differentiated SCENARIO 1: adapted normality The evaluation will consist of two parts: a) Continuous assessment with a weight of 40%, corresponding to seminars, tutorials, exercises delivered to the teacher. b) Final exam of the subject: 60% The final exam will be face-to-face. SCENARIO 2: distancing (partial restriction on attendance) The evaluation will be performed as in scenario 1. The final exam will preferably be face-to-face SCENARIO 3: closure of facilities The assessment will be carried out as in scenarios 1 and 2, except that the final exam will not necessarily be face-to-face. In any of the three scenarios, in the case of not passing the continuous assessment, a final exam with a weight of 100% will be performed. The second opportunity, in any of the 3 scenarios, will be to take a final exam with a weight of 100% (face-to-face in the case of scenario 1, non-face-to-face in 3, and preferably non-face-to-face in 2).

Study programme competences	
Code	Study programme competences
A2	Suggest alternatives for solving complex chemical problems related to the different areas of chemistry.
A3	Innovate in the methods of synthesis and chemical analysis related to the different areas of chemistry
A6	Design processes involving the treatment or disposal of hazardous chemicals
A7	Operate with advanced instrumentation for chemical analysis and structural determination.
A9	Promote innovation and entrepreneurship in the chemical industry and in research.

B2	Students should apply their knowledge and ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
B4	Students should be able to communicate their conclusions, and the knowledge and the reasons that support them to specialists and non-specialists in a clear and unambiguous manner
B5	Students must possess learning skills to allow them to continue studying in a way that will have to be largely self-directed or autonomous.
B7	Identify information from scientific literature by using appropriate channels and integrate such information to raise and contextualize a research topic
B9	Demonstrate ability to analyze, describe, organize, plan and manage projects
B10	Use of scientific terminology in English to explain the experimental results in the context of the chemical profession
C1	CT1 - Elaborar, escribir e defender publicamente informes de carácter científico e técnico
C3	CT3 - Traballar con autonomía e eficiencia na práctica diaria da investigación ou da actividade profesional.
C4	CT4 - Apreciar o valor da calidade e mellora continua, actuando con rigor, responsabilidade e ética profesional.

Learning outcomes			
Learning outcomes	Study programme competences		
Acquisition (theoretical aspects and application) of the several hybrid techniques used in matallomics and metalloproteomics	AC2 AC7 AC9	BC2 BC5 BC7	CC3
Acquisition (theoretical aspects and application) of advanced atomic spectroscopic techniques both in theoretical aspects and in their practical application	AC2 AC7 AC9	BC2 BC4 BC5 BC7	CC1
Acquisition (theoretical aspects and application) of several types of optical, electrochemical, thermal and mass sensors	AC2 AC3 AC6 AC7 AC9	BC2 BC4 BC9 BC10	CC4

Contents	
Topic	Sub-topic
1. ATOMIC TECHNIQUES	(1) Electrothermal atomic absorption spectrometry. (2) Continuous source atomic absorption spectreometry. (3) Inductively coupled plasma atomic emisión spectrometry. (4) Inductively coupled plasma mass spectrometry. (5) Atomic fluorescence spectrometry. (6) Atomic X ray spectrometry.
2. ALTERNATIVE SAMPLING TECHNIQUES	(1) Solid sampling (2) Slurry sampling (3) Vapour generation techniques Cold vapour and covalent hydride generation). (4) Others solid sampling techniques (Laser ablation)
3. HYBRID TECHNIQUES IN THE ANALYSIS OF ORGANOMETALLIC COMPOUNDS AND METALOPROTEINS (METALLOMIC AND METALOPROTEOMIC)	(1) Liquid chromatography coupled with inductively coupled plasma atomic emission. (2) Liquid chromatography coupled with inductively coupled plasma mass spectrometry (3) Liquid chromatography coupled with atomic fluorescence spectrometry (4) Gas chromatography coupled with inductively coupled plasma mass spectrometry. (5) Capilar electrophoresis coupled with inductively coupled plasma mass spectrometry. (6) Filed flow fractionation coupled with inductively coupled plasma mass spectrometry
TEMA 4. SENSORES	(1) Concepts. (2) Types of sensors. (3) Electrochemical sensors. (4) Optical sensors. (5) Gas sensors. (6) Remote sensors

Planning

Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Seminar	A2 B2 B4 B9 B10 C4	7	14	21
Supervised projects	A2 A3 A9 B2 B4 B5 B7 B9 B10 C1 C3	2	8	10
Objective test	A2 A3 A6 A7	2	0	2
Guest lecture / keynote speech	A2 A3 A7	12	30	42
Personalized attention		0	0	0
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Seminar	Seminars given by Master's teachers, and professionals from companies, public administration and other universities Interactive sessions related to the different subjects with debates and exchange of opinions with students Resolution of practical exercises (problems, test questions, interpretation and processing of information, evaluation of scientific publications, etc.)
Supervised projects	Study based on different sources of information Oral presentation of papers, reports, etc., including discussion with teachers and students
Objective test	Carrying out the different tests for verifying the acquisition of both theoretical and practical knowledge and the acquisition of skills and attitudes
Guest lecture / keynote speech	Theoretical classes. Lectures (use of slate, computer, cannon), complemented with the tools of virtual teaching

Personalized attention	
Methodologies	Description
Guest lecture / keynote speech Seminar Supervised projects	The supervised works and problem solving will be carried out under the supervision of the teacher Doubts and work done, etc. will be reviewed by the teacher

Assessment			
Methodologies	Competencies	Description	Qualification
Seminar	A2 B2 B4 B9 B10 C4	Seminars will be evaluated through continuous evaluation of the student's work and the individual resolution of problems and cases	15
Supervised projects	A2 A3 A9 B2 B4 B5 B7 B9 B10 C1 C3	Spervised projects involve the realization of a memory and an exposition r	10
Objective test	A2 A3 A6 A7	Theoretical contents will be evaluated by means of a test that may include test with multiple choice, short questions and reasoned answer	75

Assessment comments

-The student must review the theoretical concepts introduced in the different topics, using the reference manual and the summaries. The degree of success in solving the proposed exercises provides a measure of the student's preparation to face the final exam of the subject. Those students who encounter significant difficulties when working on the proposed activities should attend the teacher's tutoring hours, with the aim that he can analyze the problem and help solve these difficulties.
-Competence assessment system: Final exam: CB7; CB9; CB10; Problem solving and case studies: CG2; CG4; CG5; Completion of work and written reports: CG2; CG4; CG5; Oral presentation (works, reports, problems and practical cases: CG2; CT1; CT3; CT4; Continuous evaluation of the student by means of questions and oral questions during the course: CB7; CB9; CT1
-Indication referring to plagiarism and the inappropriate use of technologies in the development of tasks or tests: "In cases of fraudulent performance of exercises or tests, the provisions of the Regulations for the evaluation of students' academic performance and the review of assessments"

Sources of information	
Basic	- Skoog, Holler, Nieman (2008). Principios de Análisis Instrumental. Ed. Thonsom-Paraninfo - R. Keller, J. M. Mermet, M. Otto, H. M. Widmer, (2004). Analytical Chemistry, . Ed. Wiley - C. Cámara, C. Pérez-Conde (2011). Análisis Químico de Trazas. Ed. Síntesis - B. Welz, M. Sperling (1999). Atomic Absorption Spectrometry. Ed. Wiley - B. Welz, H. Becker-Ross, S. Florek, U. Heitmann (2004). High Resolution Continuum Source AAS. Ed. Wiley - J. D?dina, D. L. Tsalev (1995). Hydride Generation Atomic Absorption Spectrometry. Ed. Wiley - R. Cornelis (2003). Handbook of Elemental Speciation I/II. Ed. Wiley - C. Pérez Conde (1996). Sensores Ópticos. Universidad de Valencia - S. Alegret, M. del Valle, A. Merkoçi (2004). Sensores electroquímicos. Universidad Autónoma de Barcelona
Complementary	

Recommendations
Subjects that it is recommended to have taken before
Subjects that are recommended to be taken simultaneously
Subjects that continue the syllabus
Other comments
Recommendations for evaluationThe student must review the theoretical concepts introduced in the different topics, using the reference manual and the summaries. The degree of success in solving the proposed exercises provides a measure of the student's preparation to face the final exam of the subject. Those students who have significant difficulties when working on the proposed activities should attend the teacher?s tutoring hours, so that the teacher can analyze the problem and help solve those difficulties. It is very important, when preparing for the exam, to solve some of the exercises that appear at the end of each of the chapters of the reference manual.Recommendations for recoveryThe teacher will analyze with those students who do not successfully pass the evaluation process and, if they so wish, the difficulties encountered in learning the contents of the subject. It will also provide them with additional material (questions, exercises, exams, etc.) to reinforce the learning of the subject? It is highly recommended to attend the exhibition classes from day one, as the different topics in the program are linked to each other.? It is important to keep the study ?up to date?.? After reading a topic, it is useful to summarize the important points, identifying the basic issues to remember and making sure you know both their meaning and the conditions under which they can be applied.