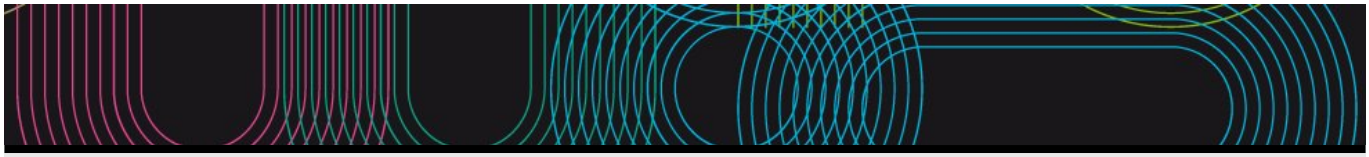

IDENTIFYING DATA				
Analytical Chemistry III: Electroanalytical Methods and Separations				
Subject	Analytical Chemistry III: Electroanalytical Methods and Separations			
Code	V11G201V01302			
Study programme	Grado en Química			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Mandatory	3rd	1st
Teaching language	#EnglishFriendly Spanish Galician English			
Department				
Coordinator	González Romero, Elisa			
Lecturers	Costas Rodríguez, Marta González Romero, Elisa			
E-mail	eromero@uvigo.es			
Web				
General description	Give knowledge of the analysis of compound (organic and inorganic, ions, atoms and molecules) of environmental interest, clinical, biomedical, in the food and pharmaceutical industries, in laboratories quality control, etc, by means of the main Electrometric Techniques of analysis and Classical Separation methods. Inside the process/analytical procedure, will take into account the conditions for the direct measurement and those other situations in which it would be necessary the previous separation of the analyte and/or interferences of the matrix (treatment of sample). It will give a wide and current vision of the versatility of these techniques like tool to resolve problems in the areas of application mentioned, already was carried out the analysis in the chemical laboratories (involves transport and storage of the sample) or directly in the place of sample collection (analysis in situ or decentralised), because of its advantages of miniaturisation and, therefore, of portability, its easy handle and its rapidity of answer (methods of screening). With all this, pretends that the student can acquire the sufficient skill, in the first place, in the handle of the sources of bibliographic documentation and, second, in the set up and maintenance of teams, so that it can apply the analytical methodology in the resolution of real problems. Matter of the program English Friendly: the international students will be able to follow the classes without difficulty then , so much the visual material (presentations in PowerPoint) like the bibliography recommended, presents in English, in addition to having to his disposal another material of support for the follow-up of the matter in English and to be able to request to the professors any another material or additional bibliographic references in this language. They will attend the interventions in class, the tutorial and the realisation of the proofs and evaluations also in English. Matter Offered for the Elderly Program; to the students of this program that select this matter, will facilitate them material of support in Spanish (books of text, monographs, articles, etc) so that they can follow fluently the contents, in addition to having of the bibliography recommended.			

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
B5	Ability to adapt to new situations and to make decisions
C6	Know the basics and tools for resolution of analytical problems and characterization of chemical substances
C13	Know the principles and applications of electrochemistry
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	Training and Learning Results			
Identify and distinguish properly the different steps of the analytical process	A3			D1
Know and apply the main systems of sampling, storage and treatment of samples for electroanalytical purposes	A1		C13	D1
Describe and explain the fundamentals and the analytical applications of separation techniques (no chromatographic ones) in the treatment of sample and the electroanalysis in the determination	A3		C13	D1
Purchase critical trial to evaluate and select the ideal technique, so much electroanalytical as of separation, to resolve a real analytical problem, taking into account to the analyte, to the type of sample and the analytical quality that demands to the results.	A1	B5	C13 C26	D1
Differentiate, choose and correctly handle the instrumentation involved in electroanalysis and the material used in non-chromatographic separations	A1	B5	C13 C26	D1
Acquire skills to plan and develop an analysis method, as well as to calibrate, measure and interpret the results obtained when solving, experimentally, the analytical problem that is proposed and successfully evaluate / defend any situation, simulated or real, that arises at the laboratory.	A3	B5	C26	D1
Acquire skills to discuss and defend the choice of an analysis method in different situations and its validation.	A3	B5	C13 C26	D1
Correctly carry out calculations in the preparation of solutions, in the calibration and in the evaluation of the results and recognize errors.	A1 A3	B5	C6 C26	D1
Collect information to prepare, argue and present reports.	A1	B5		D1
Handle chemicals correctly, assess risks and manage the waste produced in the lab.	A3	B5		D1

Contents	
Topic	
UNIT 1.- Electroanalysis in the measurement step. Fundamentals of electrometric methods.	Redox and electrochemical chemical reactions. Interface electrode / dissolution. Transportation phenomena. Electrolysis and model of stationary diffusion. Classification of electrometric techniques. Instrumentation: basic components in potentiometric systems, conductimetric and potentiostatic / galvanostatic.
UNIT 2.- Electrodes and cells.	Working, reference and auxiliary electrodes. Working Electrodes: ISE, ISFET, solids (metallic and carbon), liquids (Hg), screen-printed electrodes (SPE) and modified. Supporting electrolytes and solvents. Cell configuration in electroanalysis and equivalent circuit. Calibration, the role of blank in electroanalysis and calculation of analytical parameters. Direct measurement and measurement after sample treatment: separation and derivatization in electroanalysis. Validation.
UNIT 3.- Conductimetry and potentiometry.	Conductometric analysis. Potentiometric analysis. Conductometric and potentiometric titrations. Analytical applications
UNIT 4.- Electroanalysis in dynamic systems I.	Coulombimetry, chronocoulombimetry and coulometric titrations. Analytical applications. Chronoamperometry and amperometry.Linear sweep voltammetry (LSV) and cyclic (CV). Processes of electrode for organic and inorganic compounds and criteria. Analytical applications.
UNIT 5.- Electroanalysis in dynamic systems II.	Pulse techniques: normal pulse voltammetry (NPV), differential pulse(DPV), square wave (SWV). Alternate current techniques (AC). Stripping techniques. Hybrid techniques and couplings. Analytical applications. Reflections and comparative study with others analytical techniques.
UNIT 6.- Fundamentals and aims of the separations in analytical chemistry.	Treatment of sample by digestion. Preparation of the sample: purification and pre-concentration. Studies of recovery.
UNIT 7.- Non-chromatographic Separations.	Precipitation, Leaching, Volatilisation and Distillation (lyophilisation, Kjeldhal, Willard-Winter), Electrodeposition and stripping.
UNIT 8.- Extraction	Liquid-liquid extraction, S-L extraction (Soxhlet, Assisted Extraction by Ultrasonic, microwave and accelerated-ASE), microextraction and solid phase extraction (SPE).
LABORATORY EXPERIMENTS	Experiments related to the contents in electroanalysis and non-chromatographic separations, applying the analytical process and including the evaluation and data processing, as well as the delivery of reports.

Planning

	Class hours	Hours outside the classroom	Total hours
Lecturing	24	18	42
Seminars	12	4	16
Laboratory practical	26	14	40
Workshops	0	6	6
Objective questions exam	1	8	9
Essay questions exam	2	12	14
Report of practices, practicum and external practices	0	12	12
Laboratory practice	1	10	11
*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.			

Methodologies

	Description
Lecturing	The master classes (55 min) aim to give a global and real vision of electroanalysis, both from organic and inorganic compounds, by direct measurement or prior separation of the analyte. Each one of the topics will be documented with scientific articles, the contents of which will serve to establish and expand the knowledge acquired in the theoretical classes, and with representative examples of the fundamental concepts that are collected in each topic. The teaching-learning methodology will be centered on the student, so the classes will be aimed at motivating / encouraging a high participation on the part of these in the classroom. Therefore, the classes will be developed in a very interactive with the students, using the didactic material for their development online, as well as the most appropriate bibliography. The use of ICTs (MooVi and My Moodle) will be the resource that allows the student to communicate with the teacher (in addition to e-mail and the tutorials) and their peers, at the same time being the source of information of immediate access for them. In the tele-teaching platform, they will be able to find the basic information and documentation on the subject being taught, the schedule of activities, the exercises proposals, practice guide, workshop planning and qualifications.
Seminars	After the lectures, the seminars will be dedicated to solving problems / exercises, in which it is intended to strengthen the level of understanding of the students in the topic under study. These problems / exercises, in principle, are worked on in class in small groups, then there is a general debate on them and later the student will have to solve them individually. The seminars aim to reinforce knowledge acquired in the theoretical classes. There will also be a discussion of practical cases and work scientists related to the contents of the subject.
Laboratory practical	The practical laboratory classes play a fundamental role in teaching the subject. On the one hand, they are essential for understanding the theories and concepts taught in the lessons; and on the other, they allow the student to be trained in the handling of analytical methodology, as well as norms and rules of scientific work, both at the level of group and individual work, including report writing. Ultimately, these are procedural objectives. The use of ICTs (MooVi and My Moodle) will be the resource that allows the student to communicate with the teacher and their colleagues, at the same time being the source of information of immediate access for them. In the tele-teaching platform, you will be able to find basic information and documentation on the subject that is taught, the agenda of activities, the proposed exercises, the practice guide, the workshop planning and qualifications.
Workshops	They would be part of the seminars and laboratory practices in which students must solve by themselves, under the teacher's supervision but with greater autonomy, assumptions real practicals of electrochemical processes, detection and determination of compounds of interest (pollutants, drugs, biomolecules, etc.) and design analytical strategies. Both in the seminars and workshops will monitor the personal work that is being carried out by the student at all times. Discussions will be held that will serve to solve problems real, as well as to expose complementary concepts, addressed or not in other subjects, but necessary in the approach to this problem. This task will be subject to the evolution of the student in the learning process.

Personalized assistance

Methodologies	Description
Lecturing	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.
Seminars	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.

Laboratory practical	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.
Workshops	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.

Tests	**Description**
Report of practices, practicum and external practices	The tutoring program is configured as a study support element, where the student will have personalized academic assistance that results in a better use of the training and knowledge provided by the subject. In addition to face-to-face tutorials and / or via email, student work, individually or in groups, will also be tutored at through the MooVi Platform or through the remote campus.

Assessment

	Description	Qualification	Training and Learning Results
Seminars	PRACTICAL CASES: application of techniques in the RESOLUTION OF environmental, clinical, food industry PROBLEMS, etc. There will be a personalized follow-up of the student and evaluable by the teacher, considering the degree of participation by the students in the practical cases that arise in the seminar classes for the resolution of analytical problems in different fields of application. The ability to resolve questions and issues that arise related to the topic will be taken into account, both in the way of presenting them (ability to synthesize, explain and transmit the information) and in defending them vehemently.	10	A1 B5 C6 D1 A3 C13 C26
Laboratory practical	EXPERIMENTAL IN THE LABORATORY The teachers involved will carry out personalized monitoring of the experimental work carried out by the student in the laboratory sessions, their progress, autonomy, attitude, aptitude and skills developed, as well as their ability to work in a group. It is important to indicate that it is MANDATORY AND ESSENTIAL to attend ALL laboratory sessions and pass the activity to qualify for approval in the matter. Logically, the laboratory practices will be suspended for students who do not complete or fail this activity. A minimum grade of 4/10 must be achieved to qualify for the pass of the subject.	15	A1 B5 C6 D1 A3 C13 C26
Workshops	Resolution of PRACTICAL ASSUMPTIONS (design of experiments, laboratory introduction) A personalized monitoring of the student will be carried out and the way of defending/presenting the information will be evaluated, endorsed by the reliable bibliographic search (ability to search, value, classify and select information), as well as the ability to structure, synthesize, criticize and interrelate the contents for the resolution of the practical case or case raised.	5	A1 B5 C6 D1 A3 C13 C26
Objective questions exam	There will be a short test of objective questions on the topics covered in seminars/workshops that may include theoretical-practical questions/problems or multiple choice. This test serves, at the same time, for the student to assess and evaluate their study methodology. In order to compensate with the rest of the evaluation, a total final grade of 4/10 must be achieved (and a minimum grade of 4/10 in each part of the test). The day and time, as well as the classroom, will be public and the information will be included in the academic program of the center, previously approved by the Faculty Board.	10	A1 B5 C6 D1 A3 C13 C26

Essay questions exam	It corresponds to the official test (ordinary and/or extraordinary calls) and MANDATORY for all enrolled students. It is made up of three parts: theoretical (5%), theoretical-practical (15%) and problems (15%) that integrates the development of an analytical procedure and/or resolution of a practical case. In order to compensate with the rest of the evaluation, a total final grade of 4/10 must be achieved (and a minimum grade of 4/10 in each part of the test). The day and time, as well as the classroom, will be public and the information will be included in the academic program of the center, previously approved by the Faculty Board. OBSERVATION: If there are several teachers involved in the subject (in theory/seminars), the grade that the student must obtain in the part taught and evaluable by each teacher will have to be greater than or equal to 3.5/10, being the necessary requirement for the overall weighting of the exam to take place. Not reaching this qualification, the final result is fail.	40	A1 B5 C6 D1 A3 C13 C26
Report of practices, practicum and external practices	Upon the teacher's indication, the work team will prepare the practical reports (limited number of pages), which will reflect the work done in the laboratory by the team. Two models will be followed: scientific and technical. The fact of adjusting to the norms, the title proposal, layout, discussion of results, ability to synthesize the conclusions, etc. will be valued. The scientific articles/technical reports handled in the practices will serve as a model. Taking as a model does not mean PLAGIARIASING, which will be penalized with a ZERO in the qualification of the reports. These reports, whether scientific or technical, must be delivered within the established period and will be corrected by the professor. A minimum grade of 4/10 must be achieved to qualify for the pass of the subject.	10	A1 B5 C6 D1 A3 C13 C26
Laboratory practice	A laboratory test will be practiced, at an individual level, which will allow the evaluation of the competencies and skills acquired by the student during the laboratory sessions. Said test will be carried out at the end of the laboratory sessions and is mandatory, and a minimum grade of 4/10 must be achieved to opt for the subject's approval.	10	A1 B5 C6 D1 A3 C13 C26

Other comments on the Evaluation

1.-The ***EVALUACIÃ*N continuous** *harÃ taking into account the *calificaciÃ*n of the distinct activities/test that they describe in this section (see Ã*tems of *evaluaciÃ*n up). It is **indispensable to reach a *calificaciÃ*n of 5/10 in each one of split them/activities/test that *evalÃ*an to SURPASS the matter**. *AdemÃ*s, beÃ necessary to reach a *calificaciÃ*n ***mÃ*nima of 4/10 in each one of these activities/test proposed to OPT To THE APPROVED of the matter**. In **case of not achieving the note *mÃ*nima** demanded in any of the activities/test, supposes the ***calificaciÃ*n of SUSPENSE** in the matter; the ***calificaciÃ*n that appearÃ in the record beÃ the note *ponderada *mÃ*s high reached**, reflecting aceÃ the *calificaciÃ*n *mÃ*s faithful and real of the activities/test made by the student (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023,*TÃ*tulo V. Of the *calificaciÃ*n of the student, *Art. 31.2.).

The ASSISTANCE To THE *PRÃ*CTICAS And To THE SEMINARS/WORKSHOPS, aceÃ like **the development and the *realizaciÃ*n of the activities/test associated** (see Ã*tems of *evaluaciÃ*n), **is COMPULSORY for ALL THE STUDENTS ENROLLED**, receive to the *evaluaciÃ*n continuous or global. **The *prÃ*cticas, the reports and the seminars/workshops are not recoverable** in the second neither successive announcements. The **ABSENCE in the *prÃ*cticas and/or seminars/workshops, aceÃ like the does not deliver of the reports in group, are not recoverable** in the second neither successive announcements, preventing *tambiÃ*n surpass the *evaluaciÃ*n global (in the case of the students that had opted by this way of *evaluaciÃ*n).

THE DELIVERY OF THE REPORTS OF *PRÃ*CTICAS, inside the term established by the *profesorado, is **COMPULSORY**. All the reports happenÃ*n by programs *anti-plagiarism and only allowÃ a *mÃ*ximo of 10% of similarity. The ***detecciÃ*n of plagiarism** with an upper similarity to 10% *tendrÃ like consequence the **SUSPENSE in the activity, with a *calificaciÃ*n of ZERO** and without *opciÃ*n to recover (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023,*TÃ*tulo VII. Of the use of half *ilÃ*citos, *Art. 40.).

The *calificaciÃ*n obtained in the distinct activities/test of *evaluaciÃ*n compulsory, whenever it reach the *mÃ*nimo of 4/10, *mantendrÃ for the announcement of July, by what in this announcement the student presentÃ only to the parts that have not surpassed in the first announcement.

2.- ***EVALUACIÃ*N GLOBAL:** to the *calificaciÃ*n definite of this proof moveÃ*n the qualifications obtained in the activities of *carÃ*cter compulsory and developed in the *prÃ*cticas of laboratory and in the seminars/workshops. **The student that wish to receive to the *evaluaciÃ*n global, have toÃ deliver to the coordinator of the matter**, **IN THE TERM OF TWO WEEKSfrom the start of the teaching**, a writing **signed in which it certify that opts by said *evaluaciÃ*n global**, what him preventÃ go back to the *evaluaciÃ*n continuous.

3.-Regarding the *realizaciÃ*n of the proofs or any official examination of the subject, is **COMPULSORY to carry achieve to be able to access to the classroom: *DNI/*NIF or *carnet to drive, SIMPLE CALCULATOR (no programmable or *electrÃ*nica) and 2 BOWLÃ*GRAFOS BLUE**. No allowÃ the use of an extraneous calculator. Therefore, no allowÃ the access to the classroom with the following UNAUTHORISED material: correctors (*tipex),*lapiceros, *TELÃ*FONO MÃVILE, INTELLIGENT CLOCK Or ANY ANOTHER DEVICE *ELECTRÃNICO, coats, hunters, *parcas, sweatshirts marsupials, scarves and similar, etc.

The no allowed material and detected in the interior of the classroom during the *realizaciÃ*n of the proofs beÃ confiscated by the *profesorado and no *tendrÃ right to *devoluciÃ*n. *AdemÃ*s, the *incumplimiento of these norms, established by the *profesorado and known by the students with quite *antelaciÃ*n to the proofs and/or exÃ*menes when being published in the *GUÃTo EDUCATIONAL OF THE MATTER, considerÃ fraudulent behaviour and *tendrÃ consequences of Ã*ndole discipline (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, *TÃ*tulo VII. Of the use of half *ilÃ*citos, *Art. 41.)

The use of means or material *ilÃ*citos involveÃ the *finalizaciÃ*n of the proof and the immediate abandonment of the classroom, appearing a SUSPENSE in Records (certifying the fault in the file) and losing the rights to make ANY ACTIVITY, PROOF or EXAMINATION OF THE SUBJECT during the rest of the course. *TambiÃ*n NotifyÃ the fault committed to the managers of the Centre and of the *Dpto. So that they notify, to his time, to the upper authorities so that they take the timely measures (Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, *TÃ*tulo VII. Of the use of half *ilÃ*citos, *Art. 42.).

4.-All the activities that develop in the classroom or in the laboratories, the material of support (presentations), etc. *estÃ*n subject to the rights of the copyright and of image. The educational of the matter do not allow to be recorded, neither by *vÃ*deos neither by audios or any another format like the *pantallazos, during the development of the face-to-face classes or in the *telemÃ*ticas. What communicates for the timely effects by the possible consequences of Ã*ndole disciplinary that can produce .

NOTE: it recommends the reading of the document Regulation on *evaluaciÃ*n, the *calificaciÃ*n and the quality of the teaching and of the process of learning of the student, approved in the *claustro of 18 April 2023, that beÃ available in *MooVi to the start of the course.

***EVALUACIÃ*N OF THE STUDENTS OF THE PROGRAM OF GREATER**

1.- Assistance to the activities programmed 40%

2.- Follow-up of the activities made 30%

3.- The *anÃ*lisis home (sensors and devices *portÃ*tiles) 30%

Sources of information
Basic Bibliography
Hernández, L y González, C, **Introducción al análisis instrumental**, Ariel, 2002
Skoog, DA; Holler, FJ y Crouch, SR, **Principios de análisis instrumental**, 7, Cengage Learning Editores, 2018
Wang, J, **Analytical Electrochemistry**, 3, Wiley, 2006
Cela, R; Lorenzo, RA y Casais, MC, **Técnicas de separación en química analítica**, Síntesis, 2002
Complementary Bibliography
Monk, PMS, **Fundamentals of Electroanalytical Chemistry**, Wiley, 2001
Riley, T y Watson, A, **Polarography and other Voltammetric Methods**, Wiley, 1987
Kissinger, PT y Heineman, WR, **Laboratory Techniques in Electroanalytical Chemistry**, Marcel Dekker, INC, 1984
Valcárcel, M y Silva, M, **Teoría y práctica de la extracción líquido-líquido**, Alhambra, 1984
Miller, JM, **Separation Methods in Chemical Analysis**, Wiley, 1974

Recommendations
Subjects that continue the syllabus
Analytical Chemistry IV: Chromatographic and Affine Methods/V11G201V01306

Subjects that are recommended to be taken simultaneously

Chemical engineering/V11G201V01301
Inorganic Chemistry III: Coordination Chemistry/V11G201V01304
Organic Chemistry III: Concerted, Radical and Photochemical Reactions/V11G201V01305

Subjects that it is recommended to have taken before

Physics: Physics 2/V11G201V01107
Chemistry: Chemistry Lab I/V11G201V01105
Chemistry: Chemistry Lab II/V11G201V01110
Chemistry: Chemistry 1/V11G201V01104
Chemistry: Chemistry 2/V11G201V01109
Biochemistry/V11G201V01201
Analytical Chemistry I: Principles of Analytical Chemistry/V11G201V01202
Analytical Chemistry II: Optical Methods of Analysis/V11G201V01207
Physical chemistry I: Chemical thermodynamics/V11G201V01203
Physical Chemistry II: Surfaces and Colloids/V11G201V01208
Inorganic chemistry II/V11G201V01209
Organic chemistry I/V11G201V01205