Teaching Guide					
Identifying Data					2022/23
Subject (*)	Industrial Processes and Sustainability			Code	610509104
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		Obligatory	3
Language	SpanishGalicianEnglish				
Teaching method	Face-to-face				
Prerequisites					
Department	Química				
Coordinador	Martinez Cebeira, Montserrat		E-mail	monserrat.martinez.cebeira@udc.es	
Lecturers	Blas Varela, Andrés M. de Martinez Cebeira, Montserrat		E-mail	andres.blas@udc.es monserrat.martinez.cebeira@udc.es	
Web					
General description	This subject is key in the ObligatoryTraining Module in Advanced Chemistry, because it serves as an introduction to the specialty of Chemistry and Industrial Economics and provides basic concepts in relation to the processes of the chemical industry and sustainability that should be known by all students who attend Any specialty of this master. The subject is of interest both for students who are going to develop a teaching-research career and those who work in the company. The great impact and impact of chemistry on the quality of life of our society is indisputable. The industrial sector has adopted the approaches of chemistry as a fundamental need, betting on technological innovation in the production processes. This subject contributes to the training of young scientists and technologists in the area of ??basic industrial chemistry, enabling them to incorporate their concepts and methodologies into the design and development of sustainable processes, both in research and industrial production, As well as to perform a critical analysis on the degree of compliance of the postulates of Sustainable Chemistry in different types of chemical processes.				

Study programme competences / results	
Code	Study programme competences / results
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
A4	Apply materials and biomolecules in innovative fields of industry and chemical engineering.
A5	Properly assess risks and environmental and socioeconomic impacts associated with special chemicals
A6	Design processes involving the treatment or disposal of hazardous chemicals
A9	Promote innovation and entrepreneurship in the chemical industry and in research.
B1	Possess knowledge and understanding to provide a basis or opportunity for originality in developing and / or applying ideas, often within a research context
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.
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
B8	Evaluate responsibility in the management of information and knowledge in the field of Industrial Chemistry and Chemical Research
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
B11	Apply correctly the new technologies to gather and organize the information to solve problems in the professional activity.
B12	Being able to work in a team and adapt to multidisciplinary teams.
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 / results		
Knowledge of industrial processes of inorganic chemical products.	AC3 AC5 AC6 AC9	BC2 BC5 BC8	CC4
Awareness of the need for environmental control of chemical processes and products.	AC2 AC3 AC4 AC5 AC6	BC1	
Knowledge of the raw materials used in the chemical industry and their extraction processes.	AC6	BC7 BC10	
Knowledge of industrial processes of organic chemical products.	AC2 AC3 AC4	BC5	
Knowledge of the principles and postulates of sustainable chemistry, its main methods and applications in industrial processes.		BC7 BC9 BC11 BC12	CC1 CC3
Knowledge of industrial synthetic methods that use processes catalyzed by transition metals.	AC2 AC3	BC1 BC5	CC3
Knowledge of emerging technologies in synthesis processes that minimize reaction times, use of organic solvents in reactions and separation and purification processes, use of immobilized reagents and continuous flow reactions.	AC2 AC3	BC5 BC7	

Contents	
Topic	Sub-topic
Topic 1. Principles and concepts of sustainable chemistry	1. Introduction. 2. Definition of sustainable chemistry. 3. Sustainable chemistry and development. 4. The 12 principles of sustainable chemistry. 5. Atomic economy. Definition and examples. 6. Toxicity. Measurement of toxicity. 7. Waste in the chemical industry. Waste minimization techniques. Waste treatment. 8. Efficient reagent design for easy degradation. 9. Environmental efficiency.
Topic 2. Industrial Chemistry: Main raw materials and processes	1. The chemical industry and sustainability. A little history. 2. Environment, energy and resource depletion. 3. Some Important Industries: 4. Other issues related to the sustainability of the chemical industry.

Topic 3. Catalysis as a tool for the sustainability of chemical processes	1. Introduction. Catalysis and sustainable chemistry. 2. Homogeneous and heterogeneous catalysis. Supported catalysts. 3. Catalytic processes of industrial relevance. 3.1. Acid and base catalysis. 3.2. catalytic hydrogenation. 3.3. Oxidations. 3.4. formation of C-C bonds. 4. Photocatalysis. 5. Organocatalysis. 6. Biocatalysis.
Topic 4. Reactions in unconventional media	1. Green Chemistry 2. Ionic liquids 3. Reactions in water 4. Reactions in the absence of solvent
Topic 5. Innovative technologies in synthesis	1. Microwave Assisted Chemical Synthesis. 2. Flow reactors. 3. High throughput screening technologies. 4. Techniques of design of experiments (DOE).
Topic 6. Applications of sustainable chemistry in industrial processes.	? Applications of sustainable chemistry in industrial processes. ?Case studies?.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A2 A5 B1 B2 B5	17	27	44
Seminar	A4 A3 A6 B8 B11 C3 C4	3.75	0	3.75
Mixed objective/subjective test	A2 A3 A5	4	0	4
Oral presentation	B7 B9 B10 C1	0.25	0	0.25
Field trip	A9 B12	4	2	6
Supervised projects	B1 B5 B10 B11 C3 C4	0	15	15
Personalized attention		2	0	2
(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.				

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	Theoretical face-to-face classes. Lecture classes (use of blackboard, computer, cannon), complemented with the tools of virtual teaching.
Seminar	Seminars held with the Master's own teaching staff, or with invited professionals from the company, the administration or other universities. Interactive sessions related to the different subjects with debates and exchange of opinions with the students.
Mixed objective/subjective test	Carrying out the different tests to verify the achievement of both theoretical and practical knowledge and the acquisition of skills and attitudes.
Oral presentation	Oral presentation of works, reports, etc., including debate with professors and students, especially of the supervised works carried out.
Field trip	Visit to an industrial installation in which the students will have to analyze aspects related to the matter that they will have to capture in a report.

Supervised projects	Resolution of practical exercises (problems, multiple choice questions, interpretation and processing of information, evaluation of scientific publications, etc.) Individual or small group tutorials. Use of specialized computer programs and the Internet. Online teaching support (Virtual Campus). Personal study based on the different sources of information.

Personalized attention	
Methodologies	**Description**
Oral presentation Supervised projects Seminar	A personalized attention plays a fundamental role in the follow-up and support of the student both for the monitoring of the subject and in orientation during the preparation of the cases that are proposed for their study in the seminar sessions. Those students who take advantage of the regime of "recognition of part-time dedication and academic waiver of attendance exemption" according to UDC regulations will have specific attention that is specified in the following aspects: -The students will have at their own request and at times to be agreed, tutorial help for the preparation of the contents of the master class prior to the seminar class. -In the same way, and when requested, these students will receive complementary tutorial help for guidance and resolution of doubts. The student in this situation must speak with the responsible Teacher in the first week of the course to replace the face-to-face regimen with other qualifying activities.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Mixed objective/subjective test	A2 A3 A5	Proba mixta na que o alumno debe de pór de manifesto os coñecementos e competencias adquiridos ao longo do curso.	65
Oral presentation	B7 B9 B10 C1	Valorarase a capacidade de síntese, a capacidade para presentar e transmitir oralmente os aspectos máis importantes dos traballos realizados, con sentido crítico e usando de maneira adecuada a terminoloxía científica.	10
Field trip	A9 B12	Valorarase o contido do informe elaborado, tanto no seu formato e presentación como na capacidad para comprender e transmitir os aspectos da instalación onde se poda apreciar ou cos los que se podan relacionar os contidos da materia.	5
Supervised projects	B1 B5 B10 B11 C3 C4	Durante os seminarios poderanse expoñer estudos de casos concretos relacionados coa sustentabilidade dos procesos industriais, valorásese a presentación, unha procura e selección adecuada da información, o uso de fontes adecuadas, etc	10
Guest lecture / keynote speech	A2 A5 B1 B2 B5	Avaliarase a asistencia e a participación activa na clase.	5
Seminar	A4 A3 A6 B8 B11 C3 C4	Nos seminarios traballaranse aspectos prácticos relacionados cos temas teóricos e orientarase ao alumno para a realización dos traballos tutelados, estudo de casos, valorarase a iniciativa e a participación activa, espírito crítico e capacidade de debater co profesor e os compañeiros os temas propostos.	5

Assessment comments

Class attendance is mandatory. Repeating students will have the same attendance rate as those who study the subject for the first time.
Attendance at 80% of the classroom activities is a requirement to approve the subject.
The evaluation of the subject will be done by means of a final exam (65%) and assessment of attendance, participation, problem solving / practical cases, oral presentations and continuous evaluation of the student in class (35%) as specified in the following pulled apart.
Students who do not pass the subject will be able to perform an extraordinary exam, and the evaluation will be carried out following the same criteria as the first opportunity.

Recommendations for evaluation

The student should review the theoretical concepts introduced in the different subjects using the reference manual and abstracts. It is fundamental to work the matter in a constant way, keeping the study of it "up to date". Those students who find important difficulties in working on the proposed activities should attend the teacher's tutoring hours, with the aim that the teacher can analyze the problem and help solve those difficulties.
The teacher will analyze with those students who do not successfully pass the assessment process in the regular exam, and so wish, the difficulties encountered in learning the contents of the subject. It will also provide you with additional material (questions, exercises, exams, etc.) to reinforce learning of the subject.
In the case of exceptional, objective and adequately justified circumstances, the Responsible Teacher could totally or partially exempt any member of the student body from attending the continuous assessment process. The students who are in this circumstance must pass a specific exam that leaves no doubts about the achievement of the competences of the subject.
The fraudulent performance of any exercise or test required of the student for the evaluation of the subject will be subject to disciplinary responsibilities, as set out in the Standards for Evaluation, Review and Claim of University Degree and Master's Qualifications (artigo 14) and UDC Student Statute (article 35, point 3).

Sources of information	
Basic	? Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford University Press: Oxford (UK), 2000. ? Mestres, R. Química Sostenible. Síntesis: Madrid. ? Lancaster, M. Green chemistry an introductory text. Royal Society of Chemistry: Cambridge (UK), 2010. ? J.R. Craig, D. J. Vaughan, B. J. Skinner " Recursos de la Tierra y el medio ambiente, 4ª Ed., PEARSON Educación Madrid 2012
Complementary	? Green Chemistry challenging perspectives. Tundo, P.; Anastas, P.; Eds. Oxford University Press: Oxford (UK), 2000. ? Baird, C. Química ambiental, 2 ed. Reverté: Barcelona. 2014 ? Rifkin, J. La tercera revolución industrial: cómo el poder lateral está transformando la energía, la economía y el mundo. Paidós: Barcelona, 2011. ? Sheldon, R. A.; Arends, I.; Henefeld, U. Green chemistry and catalysis. Wiley VCH: Weinheim, 2007. ? Sheldon, R. A., E Factors, green chemistry and catalysis: an odyssey. Chem. Commun. 2008, 3352-3365. ? Cabildo, M. P.; Cornago, P. Procesos de Bajo Impacto Ambiental. Química Verde. UNED: Madrid, 2006. ? Plechkova, N. V.; Seddon, K. R. Applications of Ionic Liquids in the Chemical Industry. Chem. Soc. Rev. 2008, 37, 123-150. ? Wasserscheid, P.; Welton, T. Ionic liquids in Synthesis. Wiley-VCH: Weinheim, Germany, 2002. ? Earle, M. J.; Seddon, K. R. Ionic Liquids: Green Solvents for the Future. Pure Appl. Chem. 2000, 72, 1391-1398. ? Microwaves in Organic Synthesis. André Loupy, Ed. First Ed, Wiley-VCH: 2002. ISBN: 3-527-30514-9. ? Fitzpatrick, D.E.; Battilocchio, C.; Ley, S.V. Enabling technologies for the future of chemical synthesis. ACS Central Science 2016, 2, 131 (y las referencias que se citan). ? Paciello, R. Chem. Rev. 2006, 106, 2912; Reetz, M. Angew. Chem. Int. Ed. 2008, 47, 2556 (y las referencias citadas en ellos). ? Lendrem, D.; Owen, M.; Godbert S. DOE (Design of Experiments) in Development Chemistry:? Potential Obstacles. Org. Proc. Res. Dev. 2001, 5, 324 (y las referencias citadas en el). ? Sustainable Industrial Processes. Cavani, F.; Centi, G.; Perathoner, S.; Trifiró, F.; Eds. Wiley-VCH: Weinheim, 2009. ISBN: 978-3-527-31552-9. - Craig, J.R., Vaughan, D.J., Skinner, B. J.: Recursos de la Tierra y el medio ambiente. Pearson Education: Madrid, 2012 ? Páginas web de SUSCHEM y de la U.S. Environmental Protection Agency (EPA): http://www.suschem.org http://www.suschem.org/technologies

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
Geen Campus Faculty of Sciences program to help achieve an immediate sustainable environment and comply with the following points of the "Environmental Declaration of Faculty of Sciences (2020)":-Point 8: Promote curricular greening, incorporating an environmental dimension as well as teaching and research activities.-Point 6 of the "Environmental Declaration of the Faculty of Sciences (2020)", the documentary works that are requested in this subject:(a) They will be requested mostly in virtual format and computer support(b) If done on paper:-Plastics will not be used-Double-sided prints will be made-Recycled paper will be used-The realization of drafts will be avoided

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.