



Teaching Guide				
Identifying Data				2017/18
Subject (*)	Industrial Processes and Sustainability	Code	610509104	
Study programme	Mestrado Universitario en Investigación Química e Química Industrial (Plan 2017)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	Yearly	First	Obligatoria	3
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Blas Varela, Andrés M. de	E-mail	andres.blas@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	<p>This subject is key in the Obligatory Training 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.</p> <p>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.</p>			

Study programme competences / results	
Code	Study programme competences / results
A1	Define concepts, principles, theories and specialized facts of different areas of chemistry.
A2	Suggest alternatives for solving complex chemical problems 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.
B3	Students should be able to integrate knowledge and handle complexity, and formulate judgments based on information that was incomplete or limited, include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgments.
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
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
C2	CT2 - Traballar en equipo e adaptarse a equipos multidisciplinares.
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		
Coñecemento das materias primas empregadas na industria química e os seus procesos de extracción.	AC1 AC2 AC5 AC6 AC9	BC2 BC3 BC4 BC5 BC7 BC8 BC10	CC3 CC4
Coñecemento de procesos industriais de produtos químicos inorgánicos.	AC1 AC2 AC4 AC5 AC6 AC9	BC1 BC2 BC3 BC4 BC5 BC7 BC8 BC10 BC12	
Coñecemento de procesos industriais de produtos químicos orgánicos.	AC1 AC4 AC5 AC6	BC1 BC2 BC3 BC4 BC5 BC7 BC8 BC10	
Toma de conciencia da necesidade de control ambiental de procesos e produtos químicos.	AC2 AC5 AC6	BC2 BC3 BC4 BC5 BC7 BC8 BC9 BC10 BC11 BC12	CC1 CC2



Coñecemento de tecnoloxías emerxentes en procesos de sínteses que minimizan tempos de reacción, emprego de disolventes orgánicos en reaccións e procesos de separación e purificación, uso de reactivos inmovilizados e reaccións en fluxo continuo.	AC5 AC6 AC9	BC1 BC2 BC3 BC4 BC7 BC8 BC9 BC10 BC11 BC12	CC3 CC4
Coñecemento dos métodos sintéticos industriais que empregan procesos catalizados por metais de transición.	AC9	BC1 BC2 BC3 BC4 BC5 BC7 BC10 BC12	CC1 CC3 CC4

Contents	
Topic	Sub-topic
Tema 1. Principios e conceptos da química sostible	1. Introdución. 2. Definición de química sostible. 3. Química sostible e desenvolvemento. 4. Os 12 principios da química sostible. 5. Economía atómica. Definición e exemplos. 6. Toxicidade. Medida da toxicidade. 7. Residuos na industria química. Técnicas de minimización de residuos. Tratamento de residuos. 8. Diseño eficaz de reactivos para a súa fácil degradación. 9. Eficacia medioambiental.
Tema 2. Química Industrial: Principais materias primas e procesos	1. A industria química e sustentabilidade. (medio ambiente, enerxía e esgotamento de recursos). a. Industria e Medio ambiente. b. Utilización da enerxía. 2. Un pouco de Historia. O papel do desenvolvemento tecnolóxico, da lexislación e dos sistemas de garantía de calidade. a. Era preindustrial. b. As revolucións Industriais. c. Situación actual. i. Fenómenos globais. Destrución da capa de ozono, quecemento global. ii. Fenómenos locais. Episodios locais de contaminación: Smog tipo Londres, Smog tipo os Anxos, enfermidade Itai, Minamata, Seveso, Bophal, Aznalcollar. 3. Algunhas Industrias importantes: Industria petroquímica, Industria metalúrxica, Industria dos fertilizantes, Outras industrias químicas, Materiais de construción, Xeración de enerxía, Transporte... Problemática asociada á produción e o uso dos produtos elaborados. Formas de combater a contaminación, unha visión verde.



Tema 3. Catálisis como unha ferramenta para a sustentabilidade de procesos químicos	<ol style="list-style-type: none"> <li>1. Introducción. Catálisis e química sustentable.</li> <li>2. Catálisis homoxénea e heteroxénea. Catalizadores soportados.</li> <li>3. Procesos catalíticos de relevancia industrial. <ol style="list-style-type: none"> <li>3.1. Catálisis aceda e básica.</li> <li>3.2. Hidroxenación catalítica.</li> <li>3.3. Oxidacións.</li> <li>3.4. Formación de ligazóns C-C.</li> </ol> </li> <li>4. Fotocatálisis.</li> <li>5. Organocatálisis.</li> <li>6. Biocatálisis.</li> </ol>
Tema 4. Reaccións en medios non convencionais	<ul style="list-style-type: none"> <li>- Química verde</li> <li>- Líquidos iónicos</li> <li>- Reaccións en auga</li> <li>- Reaccións en ausencia de disolvente</li> </ul>
Tema 5. Tecnoloxías innovadoras en sínteses	<ol style="list-style-type: none"> <li>1. Síntese Química asistida por Microondas.</li> <li>2. Reactores de fluxo.</li> <li>3. Tecnoloxías High throughput screening.</li> <li>4. Técnicas de deseño de experimentos (DOE).</li> </ol>
Tema 6. Aplicacións da química sustentable en procesos industriais.	Aplicacións da química sustentable en procesos industriais. "Case studies".

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student's personal work hours	Total hours
Guest lecture / keynote speech	A1 A2 A4 A5 A9 B1 B8	21	38	59
Seminar	A1 A4 A5 A6 A9 B1 B2 B3 B4 B5 B7 B9 B10 B11 B12 C1 C2 C3 C4	3.75	0	3.75
Mixed objective/subjective test	B2 B3 B4 B10	4	0	4
Oral presentation	A1 A5 B1 B2 B3 B4 B5 B7 B8 B9 B10 B11 C1 C3	0.25	0	0.25
Supervised projects	A1 A2 A5 A6 A9 B1 B2 B3 B4 B5 B7 B8 B9 B10 B11 B12 C1 C2 C3 C4	0	20	20
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	Clases presenciales teóricas. Clases expositivas (utilización de pizarra, ordenador, cañón), complementadas con las herramientas propias de la docencia virtual.
Seminar	Seminarios realizados con profesorado propio del Máster, o con profesionales invitados de la empresa, la administración o de otras universidades. Sesiones interactivas relacionadas con las distintas materias con debates e intercambio de opinións con los alumnos.



Mixed objective/subjective test	Realización de las diferentes pruebas para la verificación de la obtención tanto de conocimientos teóricos como prácticos y la adquisición de habilidades y actitudes
Oral presentation	Exposición oral de trabajos, informes, etc., incluyendo debate con profesores y alumnos, en especial de los trabajos tutelados realizados
Supervised projects	Resolución de ejercicios prácticos (problemas, cuestiones tipo test, interpretación y procesamiento de la información, evaluación de publicaciones científicas, etc.) Tutorías individuales o en grupo reducido. Utilización de programas informáticos especializados e internet. Soporte docente on-line (Campus Virtual). Estudio personal basado en las diferentes fuentes de información

**Personalized attention**

Methodologies	Description
Seminar Supervised projects Oral presentation	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.

**Assessment**

Methodologies	Competencies / Results	Description	Qualification
Guest lecture / keynote speech	A1 A2 A4 A5 A9 B1 B8	Avaliarase a asistencia e a participación activa na clase.	5
Seminar	A1 A4 A5 A6 A9 B1 B2 B3 B4 B5 B7 B9 B10 B11 B12 C1 C2 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
Supervised projects	A1 A2 A5 A6 A9 B1 B2 B3 B4 B5 B7 B8 B9 B10 B11 B12 C1 C2 C3 C4	Durante os seminarios poderanse expós estudos de casos concretos relacionados coa sustentabilidade dos procesos industriais, valorácese a presentación, unha procura e selección adecuada da información, o uso de fontes adecuadas, etc	15
Mixed objective/subjective test	B2 B3 B4 B10	Proba mixta na que o alumno debe de pór de manifesto os coñecementos e competencias adquiridos ao longo do curso.	65
Oral presentation	A1 A5 B1 B2 B3 B4 B5 B7 B8 B9 B10 B11 C1 C3	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

**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.

#### Sources of information

<b>Basic</b>	? 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.
<b>Complementary</b>	? 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. ? Páginas web de SUSCHEM y de la U.S. Environmental Protection Agency (EPA): <a href="http://www.suschem.org">http://www.suschem.org</a> <a href="http://www.suschem.org/technologies">http://www.suschem.org/technologies</a>

#### 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



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