Teaching Guide					
Identifying Data					2020/21
Subject (*)	Polymers in Sustainable Energy Development			Code	770523015
Study programme	Mestrado Universitario en Eficiencia e Aproveitamento Enerxético				
Descriptors					
Cycle	Period		Year	Type	Credits
Official Master's Degree	2nd four-month period		First	Optional	3
Language	SpanishGalicianEnglish				
Teaching method	Face-to-face				
Prerequisites					
Department	Física e Ciencias da TerraQuímica				
Coordinador	Abad López, María José		E-mail	maria.jose.abad@udc.es	
Lecturers	Abad López, María José Ares Pernas, Ana Isabel González Rodríguez, María Victoria		E-mail	maria.jose.abad@udc.es ana.ares@udc.es victoria.gonzalez.rodriguez@udc.es	
Web					
General description	Provide basic knowledge and discuss the role that conductive polymers as active materials in devices capable of producing, storing or saving clean energy can play.				

Contingency plan	1. Modifications to the Contents No changes are foreseen in the subject contents. 2. Methodologies *Maintained teaching methodologies Supervised project: Each student will do a supervised work about one of the proposed topics. At the end of the project, they have to submit a written report and give an oral presentation to the classmates and teachers. *Teaching methodologies that are modified Guest lecture/ keynote speech: Oral presentation by videoconference using TEAMS. In addition, the Moodle forum will be used to promote student participation. Supervised project: The oral presentation will be realized by videoconference using TEAMS. Laboratory practices: The laboratory practices will move to online format. Teachers will provide students videos, instructions and other necessary materials. Virtual tutoring will be available (by Teams), Moodle forums or other non-presential formats to attend to students' questions. 3. Mechanisms for personalized attention to students Tools: Email (via UDC mail or moodle). Videoconference or chat byTEAMS Timing: The doubts and questions can be made by e-mail (asynchronous communication) or by videoconference (synchronous communication) according to the student's preference or the topic to be discussed. The schedule for the personalized attention will be flexible, agreeing with the student the date and moment that better adapts to his/her needs. The questions sent by email or Moodle will be replied in a maximum period of 24 hours. This is valid from Monday to Friday, on teaching days. 4. Modifications in the evaluation There are no changes in the assessment provided by the GADU *Evaluation observations: REQUIREMENTS TO PASS THE SUBJECT IN THE FIRST OPPORTUNITY: 1.To attend and participate regularly in class activities. 2. To submit and present the supervised work on the date indicated. 3. To do and submit all the laboratory practices on the date indicated. 3. To obtain a minimum total score of 5 out of 10. REQUIREMENTS TO PASS THE SUBJECT IN THE SECOND OPPORTUNITY: 1.To pass the exam (minimum 50% of the maximum score) 2.To do and submit on time the additional work/practices

3. To obtain a minimum total score of 5 out of 10.

5. Modifications of the bibliography or webgraphy

There are no changes. Students will have presentations and additional materials in Moodle. In addition, students will have access to the online bibliographic resources of the UDC library where they can find books and specialized scientific literature to perform their work.

Study programme competences / results	
Code	Study programme competences / results
A12	Capacidad para la toma de decisiones en un entorno tecnológico donde los materiales se utilicen en aplicaciones de eficiencia
B1	Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
B3	Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
B9	Extraer, interpretar y procesar información, procedente de diferentes fuentes, para su empleo en el estudio y análisis.
B14	Aplicar conocimientos de ciencias y tecnologías avanzadas a la práctica profesional o investigadora de la eficiencia
B16	Valorar la aplicación de tecnologías emergentes en el ámbito de la energía y el medio ambiente.
C1	Adquirir la terminología y nomenclatura científico-técnica para exponer argumentos y fundamentar conclusiones.
C4	Desarrollar el pensamiento crítico

Learning outcomes			
Learning outcomes	Study programme competences / results		
Capacity for decision -making in a technological environment where materials are used in applications efficiency	AJ12		
That the students can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study .		BC1	
Knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas , often in a research context .		BC3	
Extract , interpret and process information from different sources , for use in the study and analysis .		BC9	
Apply knowledge of science and advanced technologies to professional practice or research efficiency		BC14	
Assess the application of emerging technologies in the field of energy and the environment .		BC16	
Acquire scientific and technical terminology and nomenclature to present arguments and justify conclusions.			CC1
Develop critical thinking			CC4

Contents	
Topic	Sub-topic
1. Introduction to conductive polymers	1.1 . Polymers and environment 1.2 . Intrinsically conducting polymers 1.3 . Conducting composites
2. Polymers in harvesting energy	2.1 . Harvesting energy concept 2.2 . Polymers in thermoelectricity 2.3 . Polymers in piezoelectricity
3. Conducting polymers in light emitting diodes and solar cells	3.1. Basis 3.2. Devices 3.3. Applications
4. Conducting polymers in electrochromic devices	4.1. Basis 4.2. Devices 4.3. Applications
5. Conducting polymers in batteries	5.1. Basis 5.2. Devices 5.3. Applications

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours

Guest lecture / keynote speech	B3 B14 C1 C4	9	0	9
Supervised projects	A12 B3 B1 B9 B16 C1 C4	1	51	52
Laboratory practice	B3 B1 B9 C1 C4	12	1	13
Personalized attention		1	0	1
(*)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	Oral presentation supported by audiovisual media with the inclusion of some questions for students, to provide knowledge and to facilitate learning.
Supervised projects	Methodology is designed to promote autonomous learning of students in different environments (academic or more professional environment) under the guidance of a teacher. It refers mainly to learning "how to do things." In this option, students must assume the responsibility for their own learning.
Laboratory practice	This methodology allows that students learn effectively doing practical activities, such as demonstrations, exercises, lab work and researches

Personalized attention	
Methodologies	**Description**
Laboratory practice Supervised projects	Each student must perform autonomously a work. The teacher will guide them by individual tutoring. The students will do three sessions of lab work where they will work concepts related to the energy efficiency in conducting polymers.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Laboratory practice	B3 B1 B9 C1 C4	The student will perform three laboratory practices related to energy efficiency of conductive polymers .The skills acquired in the laboratory and the report submitted will be evaluated .	30
Supervised projects	A12 B3 B1 B9 B16 C1 C4	Students will do individual work on a topic related to conductive polymers to be delivered and presented to other students . Both will be evaluated.	70

Assessment comments

Students who accumulate more than 20% of unjustified absences, who have not carried out all the laboratory practices (without justified cause) or who have not submitted the supervised work are excluded from the continuous evaluation process. They will be qualified as NOT ATTEND at the first opportunity. REQUIREMENTS TO PASS THE SUBJECT AT THE FIRST OPPORTUNITY : 1.Attend and participate regularly in class activities. 2.Submit and present the supervised work on the date indicated.3. To do and submit all the laboratory practices on the indicated dates.3. Obtain a minimun total score of 5 out of 10. Students with recognition of partial time dedication and academic exemption from attendance, must communicate it to the teachers at the beginning of the term and justify them adequately. In this case, teachers will be given appropriate instructions to ensure that the students follow the subject without problems, by replacing the classroom teching methodologies with other individual works with the same score. Translated with www.DeepL.com/Translator (free version) At the second opportunity, the student will have to pass an objective test or exam (in classroom or online) that may have different types of questions (multiple choice, sorting, short answer, discrimination, completion and/or association). In addition, students will be asked to perform an additional work/laboratory practices. The rating will be 50% the objective test (exam), 30% the laboratory practices and 20% additional work/practices. REQUIREMENTS TO PASS THE SUBJECT AT THE SECOND OPPORTUNITY : 1.To pass the exam (minimum 50% of the maximum score) 2.To do and submit on time the additional work/practices 3. Obtain a minimun total score of 5 out of 10.

Sources of information	
Basic	- Hideki Shirakawa (). The Discovery of Polyacetylene Film: The Dawning of an Era of Conducting Polymers. Angew. Chem. Int. Ed. 2001, 40, 2574 - 2580 - Alan G. MacDiarmid (). ªSynthetic Metalsº: A Novel Role for Organic Polymers. Angew. Chem. Int. Ed. 2001, 40, 2581 - 2590 - Alan J. Heeger (). Semiconducting and Metallic Polymers: The Fourth Generation of Polymeric Materials. Angew. Chem. Int. Ed. 2001, 40, 2591 - 2611 - Olga Bubnova and Xavier Crispin (). Towards polymer-based organic thermoelectric generators. Energy & Environmental Science 2012, 5, 9345-9362 - Javier Padilla Martínez; Rafael Garcia Valverde; Antonio Jesús Fernández Romero y Antonio Urbina Yer (). Polímeros conductores. Su papel en un desarrollo energético sostenible. Editorial Reverté - Sambhu Bhadraa; Dipak Khastgir; Nikhil K. Singhaa and Joong Hee Lee (). Progress in preparation, processing and applications of polyaniline. Progress in Polymer Science 34 (2009) 783?810 - Yong Dua, Shirley Z. Shenb, Kefeng Caia, Philip S. Casey (). Research progress on polymer?inorganic thermoelectric nanocomposite materials. Progress in Polymer Science 37 (2012) 820? 841 - Petr Novák; Klaus Müller; K. S. V. Santhanam and Otto Haas (). Electrochemically Active Polymers for Rechargeable Batteries. Chem. Rev. 1997, 97, 207-281 - Pierre M. Beaujuge and John R. Reynolds (). Color Control in ?-Conjugated Organic Polymers for Use in Electrochromic Devices. Chem. Rev. 2010, 110, 268?320 - Yasuhiko Shirota and Hiroshi Kageyama (). Charge Carrier Transporting Molecular Materials and Their Applications in Devices. Chem. Rev. 2007, 107, 953-1010 - K. Walzer, B. Maennig, M. Pfeiffer, and K. Leo (). Highly Efficient Organic Devices Based on Electrically Doped Transport Layers. Chem. Rev. 2007, 107, 1233-1271
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 Sustainability Environment, Person and Gender Equality:1. The delivery of the works (supervised work / reports of practices) that are carried out in this matter will be done in the following way: 1.1. It will be delivered in virtual format and / or computer support 1.2. In the case of having to print something on paper, it will be made on recycled and double-sided paper. Drafts will not be printed, only the final version.2. It must make a sustainable use of resources and the prevention of negative impacts on the natural environment. It will be encouraged that the materials that are discarded in the matter (papers, plastics) are thrown in the respective containers enabled in the streets for such purpose.3. It will try to convey to students the importance of ethical principles related to the values ??of sustainability so that they apply not only in the classroom, but in personal and professional behaviors.4. The gender perspective must be incorporated in this subject, so the works delivered by the students and the material prepared by the teacher must use non-sexist language.5. It will facilitate the full integration of students who for physical, sensory, psychic or sociocultural reasons, experience difficulties to an adequate, equal and profitable access to university life.