UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2021/22
Subject (*)	Spectroscopy		Code	610G04017
Study programme	Grao en Nanociencia e Nanotecnoloxía			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	2nd four-month period	Second	Obligatory	6
Language	SpanishGalicianEnglish			
Teaching method	Face-to-face			
Prerequisites				
Department	Química			
Coordinador	Canle López, Moisés	E-mail	moises.canle@udc.es	
Lecturers	Canle López, Moisés Fernandez Perez, Maria Isabel	E-mail	moises.canle@udc.es isabel.fernandez.perez@udc.es	
Web	http://moodle.udc.es/			
General description	This subject tackles the foundations of the main technical spectroscopic and difractometric techniques for characterisation of nanomaterials and nanostrutures. It seeks the acquisition of the necessary basic knowledge, skills and competences associated to the understanding and application of the mentioned techniques.			
Contingency plan	1. Modifications to the contents No changes will be made 2. Methodologies All indications of the Faculty of Sciences will be followed, in agreement with potential contingency plans. *Teaching methodologies that are maintained Case studies (computes in the assessment) Oral Presentation (computes in the assessment) Proof of multiple answer (computes in the assessment) Personalised attention *Teaching methodologies that are modified Master class (would be taught through ICT) Case studies (would happen via ICT, computes in the assessment) Oral presentation (would happen via ICT, computes in the assessment) Examination (would happen via ICT, computes in the assessment) 3. Mechanisms for personalized attention to students Preferably in asinchronic mode: - e-mail, for queries, answering doubts and follow-up of the proposed activities - moodle: according to students' criteria - Teams: for master classes and seminars, excepcionally for queries and answering doubts. 4. Modifications in the evaluation No changes will be made 5. Modifications to the bibliography or webgraphy No changes will be made. Materials are available in moodle and/or in the corresponding Class Notebook (Office365) of the subject.			

Study programme competences	
Code	Study programme competences

A1	CE1 - Comprender los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología.
A2	CE2 - Aplicar los conceptos, principios, teorías y hechos fundamentales relacionados con la Nanociencia y Nanotecnología a la resolución de problemas de naturaleza cuantitativa o cualitativa.
A3	CE3 - Reconocer y analizar problemas físicos, químicos, matemáticos, biológicos en el ámbito de la Nanociencia y Nanotecnología, así como plantear respuestas o trabajos adecuados para su resolución, incluyendo el uso de fuentes bibliográficas.
A5	CE5 - Conocer los rasgos estructurales de los nanomateriales, incluyendo las principales técnicas para su identificación y caracterización
A7	CE7 - Interpretar los datos obtenidos mediante medidas experimentales y simulaciones, incluyendo el uso de herramientas informáticas, identificar su significado y relacionarlos con las teorías químicas, físicas o biológicas apropiadas.
B2	CB2 - Que los estudiantes sepan aplicar sus conocimientos a su trabajo o vocación de una forma profesional y posean las competencias que suelen demostrarse por medio de la elaboración y defensa de argumentos y la resolución de problemas dentro de su área de estudio
B3	CB3 - Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética
B6	CG1 - Aprender a aprender
B7	CG2 - Resolver problemas de forma efectiva.
C2	CT2 - Dominar la expresión y la comprensión de forma oral y escrita de un idioma extranjero
C3	CT3 - Utilizar las herramientas básicas de las tecnologías de la información y las comunicaciones (TIC) necesarias para el ejercicio de su profesión y para el aprendizaje a lo largo de su vida
C8	CT8 - Valorar la importancia que tiene la investigación, la innovación y el desarrollo tecnológico en el avance socioeconómico y cultural de la sociedad

Learning outcomes			
Learning outcomes	Study programme competences		
· To understand structural characteristics in nanoscience, as well as the main technical of structural characterisation.	A1 A2 A3	B2 B3	
· To understand, recognise and analyse new problems, and be able to plan strategies to solve them.	A5 A7	B7	C8
· To be able to interpret the data from observations and measurements in the laboratory.	A7	B2 B3 B6 B7	C3
· To be able to apply spectroscopic techniques as tools in identification of nanostructures and nanoparticles.	A2 A3 A5 A7	B2 B3	C2 C8

Contents	
Topic	Sub-topic
1. Introduction to spectroscopy.	Electromagnetic radiation and matter. Resonant and non resonant processes. Transition dipole moment. Spontaneous emission. Selection rules. Types of spectra. Population of energy levels. Lmbert-Beer Law. Factors that determine the shape and width of spectral bands. Principles of laser action.

2. Vibrational spectroscopy.	Symmetry in Chemistry. Applications to Spectroscopy. IR spectroscopy Electron energy loss spectroscopy: EELS Raman spectroscopy
3. Electronic spectroscopy	UV-Vis spectroscopy Diffuse reflectance spectroscopy Luminescence: fluorescence, phosphorescence Surface plasmon resonance Size quantum effects
4. Photoelectron spectroscopy	UPS spectroscopy XPS spectroscopy Auger spectroscopy Other
5. Introduction to diffraction techniques	XR diffraction: XRD, SAXS XR fluorescence Electron diffraction: LEED Neutron diffraction
6. Electron microscopy	Scanning electron microscopy (SEM, SEM-EDS) Transmission electron microscopy (TEM) Atomic force microscopy (AFM)
7. Magnetic resonance techniques	Nuclear magnetic resonance: NMR, SS-NMR, MAS-NMR Electron and paramagnetic resonance: EPR
8. Other spectroscopies	Mössbauer spectroscopy Ionic spectrometry: RBS, SIMS Dielectric response spectroscopy

Planning				
Methodologies / tests	Competencies	Ordinary class hours	Student?s personal work hours	Total hours
Seminar	A2 A3 A7 B2 B3 B7 C3	8	16	24
Case study	A2 A3 A5 A7 B2 B3 B6 B7 C2 C3 C8	8	16	24
Mixed objective/subjective test	A1 A2 A5 A7 B2 B3 B7	4	0	4
Oral presentation	A7 A2 B2 B3 C3 C2	2	0	2
Guest lecture / keynote speech	A1 A2 A5 A7 B2 B3 C8	31	62	93
Personalized attention		3	0	3
(*)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	This activity is planned to be carried out in groups as reduced as possible, with the aim to deepen in a dynamic and argumentative way in the distinct topics. The success of this methodology depends on the active participation of the students.
Case study	This activity is designed so that the students work with real cases, debate in a dynamic way the possible alternatives for their resolution, with his pros and cons, given by diverse authors or at a professional level, and the reason for them.

Mixed objective/subjective test	Combination of different types of questions, tests and problems, brief answer or short essay, evaluating knowledge, capacity of reasoning and critical ability.
Oral presentation	Oral presentation of a case taken from the case studies activity, or a similar one proposed by the lecturer. The activity includes debate on the subject that is presented.
Guest lecture / keynote speech	Lectures with audiovisual or blackboard support in which the fundamental aspects of the subject are put forward, with possibility of participation of the students.

Personalized attention	
Methodologies	**Description**
Case study Oral presentation	It aims to guide to the students in the understanding of the problem posed and of the possible strategies to solve it. It will be jointly scheduled between lecturers and students, as needed. It will be carried out at lecturers' office. Will be distributed in 12 sessions of 15 min along the semester. The students with recognition of part time dedication and exemption of assistance will have to assist to at least a personal tutory for each seminar (=8 tutories) and one out of two case studies (=4 tutories), previously scheduled in agreement with the lecturers.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Case study	A2 A3 A5 A7 B2 B3 B6 B7 C2 C3 C8	Assessment includes: operational aspects, understanding strategies and methodologies used to solve cases, critical analysis of results.	20
Mixed objective/subjective test	A1 A2 A5 A7 B2 B3 B7	Final examination with two parts, one of a theoretical type (50%), including test questions, of short answer and/or essay, and another of problems solution (50 %), in which the ability to apply theoretical contents for problems solution will be assessed.	60
Oral presentation	A7 A2 B2 B3 C3 C2	Quality of the presented information. Abilities shown in the presentation. Capacity to defend the own presentation.	20

Assessment comments
Trátase de avaliar a adquisición de coñecementos, a capacidade crítica, de síntese, de comparación, de elaboración, de aplicación e de orixinalidade do alumnado. Para un aproveitamento idóneo da materia, o alumnado debe asistir a todas as actividades presenciais. Primera oportunidade. Para que se teñan en conta as actividades de estudos de casos e da presentación oral é preciso obter unha cualificación mínima de 4.5/10 en cada unha das dúas partes da proba mixta. A cualificación final obtense aplicando as porcentaxes establecidas e as restricións previamente fixadas. Segunda oportunidade. Repetición da proba mixta, por considerarse irrepetibles as actividades relativas a estudo de casos e presentación oral, ao non ser xa posible o debate das mesmas con presencia de todo o alumnado. A cualificación final obtense aplicando as porcentaxes establecidas e as restricións previamente fixadas. En calqueira de ambas oportunidades, de no acadarse unha cualificación mínima de 4.5/10 en cada unha das partes da proba mixta, a asignatura figurará como suspensa ainda que a cualificación final, calculada segundo as porcentaxes correspondientes, sexa igual ou superior a 5/10. Nese caso, a cualificación final será 4.5/10. Matrículas de honra: no caso de que houbese varios estudantes con idéntica cualificación que poidan optar á MH, e o número de MH dispoñibles sexa inferior ao de estudantes, se lles convocará a unha proba escrita. Os estudantes avaliados na segunda oportunidade só poderán optar a MH se o número destas non foi cuberto na súa totalidade na primeira oportunidade. Cualificación de "non presentado": aplícase a estudantes que participaran en actividades avaliables que representen menos (

Sources of information

Basic	- Guozhong Cao (2004). Nanostructures & nanomaterials. London : Imperial College Press - Kurt W. Kolasinski (2012). Surface Science. Foundations of Catalysis and Nanoscience. Chichester : Wiley - Rolando M.A. Roque-Malherbe (2010). The Physical Chemistry of Materials. Boca Raton : CRC Press - Julio A. Gonzalo, José de Frutos, Jorge García (2002). Solid State Spectroscopies. Basic Principles and Applications. Singapore: World Scientific
Complementary	- S. Roy Morrison (1990). The Chemical Physics of Surfaces. London: Plenum Press - Arthur W. Adamson, Alice P. Gast (1997). Physical Chemistry of Surfaces. Chichester : Wiley - D.K. Chakrabarty, B. Viswanathan (2009). Heterogeneous Catalysis. Kent : New Age Science - Atkins, Peter W. (2014). Atkins' Physical Chemistry. Oxford : Oxford University Press - Luis Carballeira Ocaña, Ignacio Pérez Juste (2008). Problemas de Espectroscopía Molecular. Oleiros : Netbiblo - Levine, Ira N. (2004). Fisicoquímica. Madrid : McGrawhill - D. C. Harris (1989). Symmetry and spectroscopy an introduction to vibrational and electronic spectroscopy. New York : Dover - A. M. Ellis (2005). Electronic and photoelectron spectroscopy fundamentals and case studies.. Cambridge : Cambridge University Press - J. Keeler (2010). Understanding NMR spectroscopy. Chichester : John Wiley and Sons - Ooi, Li-ling (2010). Principles of x-ray crystallography. Oxford : Oxford University Press Materiais proporcionados ao longo do curso polos docentes.Materiais proporcionados ao longo do curso polos docentes.

Recommendations
Subjects that it is recommended to have taken before
Advanced Crystallography/610G04042 Fundamentals of Quantum Theory/610G04015 Physics: Electricity and Magnetism/610G04007 Chemistry: Structure and Bonding/610G04005 Physics: Mechanics and Waves/610G04002
Subjects that are recommended to be taken simultaneously
Synthesis and Preparation of Nanomaterials/610G04020 Instrumental Analysis/610G04014
Subjects that continue the syllabus
Techniques of Characterisation of Nanomaterials 2/610G04030 Techniques of Characterisation of Nanomaterials 1/610G04025 Surface Science/610G04021 Solid State/610G04022
Other comments
- Recoméndase revisar con asiduidade os conceptos teóricos introducidos nas leccións maxistrais, así como resolver simultáneamente as cuestións en exercicios que se irán propoñendo.- Desaconséllase estudar únicamente polos apuntes de clase. Aconséllase elaborar os propios materiais completando os apuntes.- Recoméndase fortemente facer uso das horas de titoría para aclarar dúbidas e profundizar nos coñecementos.- Programa Green Campus da Facultade de Ciencias. Para axudar a conseguir unha contorna inmediata sostible e cumprir co punto 6 da "Declaración Ambiental de la Facultad de Ciencias (2020)", os traballos desta materia solicitaránse en formato virtual e soporte informático.