Universitat de les Illes Balears

Teaching guide

Academic year	2016-17
Subject	11280 - Structural and Microstructural Characterization of Materials
Group	Group 1, 1S
Teaching guide	A
Language	English

Subject identification

Subject	11280 - Structural and Microstructural Characterization of Materials
Credits	0.72 de presencials (18 hours) 2.28 de no presencials (57 hours) 3 de totals (75 hours).
Group	Group 1, 1S (Campus Extens)
Teaching period	First semester
Teaching language	English

Professors

Lecturers	**Horari d'atenció als alumnes**					
	Starting time	**Finishing time**	**Day**	**Start date**	**Finish date**	**Office**
Joan Cifre Bauzà joan.cifre@uib.es	You need to book a date with the professor in order to attend a tutorial.					
Jaime Pons Morro jaume.pons@uib.es	13:30	15:30	Wednesday	12/09/2016	24/07/2017	F-308 3r pis Ed. Mateu Orfila i Rotger
	13:30	15:30	Monday	12/09/2016	24/07/2017	F-308 3r pis Ed. Mateu Orfila i Rotger
Fernando Hierro Riu ferran.hierro@uib.es	You need to book a date with the professor in order to attend a tutorial.					

Contextualisation

This subject is included in the *Materials Physics Speciality* of the *Master's degree on Advanced Physics and Applied Mathematics* at UIB. The subject is also included in the *Chemistry and Physics of Materials Speciality* of the *Master's degree on Chemical Science and Technology*.

Together with the subject *11280-Characterization of Physical Properties of Materials,* they contain the main education on experimental techniques for general characterization of materials offered in this Master's degree.

The course develops de basic theory of x-ray, electron or neutron diffraction by crystals. The main x-ray diffraction techniques are reviewed, with special focus on the powder method and x-ray diffractometer. This is completed with a general introduction to electron microscopy: SEM, TEM and EDX microanalysis.

This subject is complemented with the course *11296 - Transmission Electron Microscopy*, which gives a deeper approach to this particular technique.

The academic and research background of the lecturers fit perfectly with the topic of the subject. Jaume Pons received his PhD in Physics in 1992 and performed a post-doc stay at the Centre d'Etudes de Chimie Metallurgique - CNRS (France) in 1993 for specialization in High Resolution TEM. He became Associate Professor in 1994 and Professor of Applied Physics in 2011. He has, then, a large teaching experience both at undergraduate and graduate levels (Master's degree and PhD program courses). His research activity has always been in the Physics of Materials research group. He is an experienced user of electron microscopy and

Date of publication: 11/11/2016

diffraction techniques since their PhD work. During these years, more than 100 scientific papers published by this author in indexed international journals have included results obtained by TEM and diffraction techniques.

Drs. Fernando Hierro Riu and Joan Cifre Bauza are highest level technicians at the Scientific and Technical Facilities Service of the UIB. Dr. F. Hierro is the head of the Optical and Electron Microscopy Area since 1988, whereas Dr. J. Cifre is the head of the X-ray Diffraction Area since 1995. They have a wide experience in the use and maintenance of these equipments.

Requirements

Essential requirements

Degree in Sciences or Engineering

Recommendable

It is recommended that the students' undergraduate background includes some course in Solid State Physics or Chemistry.

Skills

Specific

* • EFM2 - Knowledge of the working principles and possibilities of techniques for thermal and mechanical analysis of materials, as well as structural and microstructural characterization. Use of the techniques and correct analysis and interpretation of the results..
* • CE1 - Students must possess the learning skills that enable them to combine specialized knowledge in Astrophysics and Relativity, Geophysical Fluids, Materials Physics, Quantum Systems or Applied Mathematics, with the versatility that provides an open training curriculum..
* • CE2 - Students must possess the ability to use and adapt mathematical models to describe physical phenomena of different nature..
* • CE3 - To acquire edge-line knowledge in the international scientific research context and demonstrate a full comprehension of theoretical and practical aspects, together with the scientific methodology.

Generic

* • CG1 - Sistematic comprehension of a field of knowledge and its related skills and research methods..
* • CB6 - Possess the knowledge and its understanding to provide the basis or opportunity to be original in developing and/or applying ideas, often within a research context..
* • CB7 - Students can apply the broader (or multidisciplinary) acquired knowledge and ability to solve problems in new or unfamiliar environments within contexts related to their field of study..
* • CB10 - Students gain the learning skills that enable them to continue studying in a way that will be largely self-directed or autonomous..

Date of publication: 11/11/2016

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

Theme content

-. Theme Content

1. X-ray Diffraction.

1. Introduction to diffraction

2. Bragg's law and Laue theory. Reciprocal lattice.

3 Diffracted intensity. Extinctions.

4. Laue Method.

5. Powder method. X-ray diffractometer.

6. Other methods

7. Indexation of x-ray diffractograms

2. Microstructural characterization of materials

1 Optical microscopy.

2 Electron microscopy. Basic principles. Wavelength and resolution improvement. Magnetic lenses.

3. Electron beam generation. Thermoionic gun. Field emission gun.

4. Interaction of the electron beam with matter. Origin of the different electron microscopy techniques.

5. Scanning electron microscopy. Working principles. Secondary electron and backscattered electron imaging.

6. Transmission Electron Microscopy: Basic principles. Electron diffraction. Diffraction contrast and phase contrast.

7. Microanalysis. Energy dispersive x-ray spectroscopy (XEDS). Basic principles. Detectors. Escape peaks. Absorption and fluorescence.

Teaching methodology

In-class work activities

Date of publication: 11/11/2016

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theory classes	Large group (G)	Master classes to introduce the theoretical basis of the course content.	10
Laboratory classes	Laboratory	Medium group (M)	Lab activity about equipments use. Most of this work will be peformed at the Scientific and Technical facilities Service of the UIB, under the lecturers supervision.	6
ECTS tutorials	Tutorials	Small group (P)	Resolution of practical cases with the students and doubt consulting.	1
Assessment	Oral presentation	Large group (G)	Oral presentation about a proposed theme	1

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Report	Preparation of a written report on a proposed topic.	32
Individual self-study	Study	Study of the concepts developed in the classes	25

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

Theory classes

Modality	Theory classes
Technique	Attitude scales **(non-retrievable)**
Description	Master classes to introduce the theoretical basis of the course content.
Assessment criteria	Attitude and participation in the classes

Final grade percentage: 5%

Date of publication: 11/11/2016

Laboratory

Modality	Laboratory classes
Technique	Attitude scales **(non-retrievable)**
Description	Lab activity about equipments use. Most of this work will be peformed at the Scientific and Technical facilities Service of the UIB, under the lecturers supervision.
Assessment criteria	Attitude and participation in the classes

Final grade percentage: 5%

Oral presentation

Modality	Assessment
Technique	Oral tests **(retrievable)**
Description	Oral presentation about a proposed theme
Assessment criteria	Oral presentation of the report

Final grade percentage: 45%

Report

Modality	Individual self-study
Technique	Papers and projects **(retrievable)**
Description	Preparation of a written report on a proposed topic.
Assessment criteria	Written report about a proposed topic

Final grade percentage: 45%

Resources, bibliography and additional documentation

Basic bibliography

B. E. Warren, X-Ray Diffraction, Dover Publications, 2003
E. Lifshin, Ed. X-ray characterization of materials. Wiley (1999).
D.B. Williams, C. B. Carter. Transmission Electron Microscopy : a textbook for materials science. Springer (2009).

Complementary bibliography

Marc de Graef , Michael E. McHenry. Structure of Materials. An Introduction to Crystallography, Diffraction and Symmetry
2nd Edition, Cambridge Univ. Press (2012)
M. de Graef. Introduction to Conventional Transmission Electron Microscopy. Cambridge Univ. Press (2003)
L. Reimer. Scanning electron microscopy : Physics of image formation and microanalysis. Springer-Verlag (1985)
S.J.B. Reed. Electron microprobe analysis, 2 nd . ed. Cambridge Univ. Press (1993).

Date of publication: 11/11/2016

T. Hahn ed., International Tables for Crystallography . Vol. A: Space-Group Symmetry. Kluwer Academic Pub., Dordrecht, (1995).

Date of publication: 11/11/2016