Faculty of Experimental Sciences

GENERAL SPECIFICATIONS

CHEMISTRY DEGREE

Subject Data

Name:	
CRYSTALLOGRAPHY AND MINERALOGY	
English name:	
CRYSTALLOGRAPHY AND MINERALOGY	
Code:	**Type:**
757509110	Compulsory (in-person)

Hours:			
	Total	**In class**	**Out class**
Time distribution	150	60	90

ECTS:				
Standard group	**Small groups**			
	Classroom	**Lab**	**Practices**	**Computer classroom**
4.5		1.5		

Departments:	Knowledge areas:
Ciencias de la Tierra / Earth Sciences	Cristalografía y Mineralogía / Crystallography and mineralogy
Year:	**Semester**
1º	2º

TEACHING STAFF

Name:	E-mail:	Telephone
Rafael Pérez López	rafael.perez@dgeo.uhu.es	959219819

Others Data (Tutoring, schedule...)
Faculty of Experimental Sciences Office: P3- N2-14 Hours: 11:00-13-00 Mondays and Tuesdays, 16:00-18:00 h Wednesdays

SPECIFIC INFORMATION OF THE COURSE

1. Contents description:

1.1 In English:

Crystallography and Mineralogy constitutes an obligatory subject of the first year of the Degree in Chemistry, whose contents introduce the student to the general knowledge of crystalline materials and, particularly, of mineral raw materials.

1.2 In Spanish:

Cristalografía y Mineralogía constituyen conjuntamente una asignatura obligatoria de primer curso del Grado de Química, cuyos contenidos introducen al estudiante en el conocimiento general de los materiales cristalinos, y de las materias primas minerales en particular.

2. Background:

2.1 Situation within the Degree:

This subject facilitates the understanding and monitoring of some subjects of more advanced courses in the Degree in Chemistry, and offers greater solidity in the basic and applied training of the profession.

2.2 Recommendations

To take this course, it is convenient for students to review and update the general knowledge of Chemistry, Geology, Physics and Mathematics that they have acquired during their pre-university formation.

3. Objectives (as result of teaching):

By the end of the course, students should be able: (1) To have the capacity for structure analysis and study of the composition and properties of crystalline materials (particularly the minerals). (2) To identify symmetry operations and deduce the internal atomic order occurring in crystalline matter through stereographic projection of crystallographic models. (3) To know and understand the terminology, fundamental concepts and principles of mineral classification. (4) To use methodologies for the characterization of macroscopic properties and physic-mechanical properties for the identification of common minerals.

4. Skills to be acquired

4.1 Specific Skills:

C29: Conocer la estructura, composición y propiedades de los minerales.

C30: Conocer y describir los principales modelos de estructuras y sus características cristaloquímicas.

P2: Habilidad para llevar a cabo procedimientos estándares de laboratorio implicados en trabajos analíticos y sintéticos, en relación con sistemas orgánicos e inorgánicos.

P3: Habilidad para la observación, seguimiento y medida de propiedades, eventos o cambios químicos, y el registro sistemático y fiable de la documentación correspondiente.

P4: Habilidad para manejar instrumentación química estándar, como la que se utiliza para estudios estructurales y separaciones.

P5: Interpretación de datos procedentes de observaciones y medidas en el laboratorio en términos de su significación y de las teorías que la sustentan.

Q1: Capacidad para demostrar el conocimiento y comprensión de los hechos esenciales, conceptos, principios y teorías relacionadas con la química.

Q2: Capacidad de aplicar dichos conocimientos a la resolución de problemas cualitativos y cuantitativos según modelos previamente desarrollados.

Q3: Competencia para evaluar, interpretar y sintetizar datos e información química.

4.2 General, Basic or Transversal Skills:

CB1: Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel que, si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.

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.

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.

CB4: Que los estudiantes puedan transmitir información, ideas, problemas y soluciones a un público tanto especializado como no especializado.

CB5: Que los estudiantes hayan desarrollado aquellas habilidades de aprendizaje necesarias para emprender estudios posteriores con un alto grado de autonomía.

CG1: Que los estudiantes hayan desarrollado y demostrado poseer habilidades de aprendizaje y

conocimientos procedentes de su campo de estudio, siendo capaces de aplicarlos en su trabajo, interpretando datos relevantes para emitir juicios de temas de diversa índole pudiendo transmitirlos a un público tanto especializado como no especializado.

5. Training Activities and Teaching Methods

5.1 Training Activities:

- Practical theoretical group.
- Laboratory teaching group.

5.2 Teaching Methods:

- Face-to-face classes related to the theoretical and practical contents (problems) of the subject, using teaching resources such as transparencies, computerized presentations and videos.
- Laboratory practices with small groups handling of experimental techniques, discussion of results, drawing conclusions, presentation of a final report.

5.3 Development and Justification:

During the lectures, the professor will explain the theoretical contents of Crystallography and Mineralogy. After each lesson, the sessions devoted to the supervised resolution of practical exercises or problems will be carried out also in the classroom. There the students will have the chance to solve some problems and doubts about theoretical contents under the supervision of the professor. Laboratory sessions will consist in exercises also supervised by the professor focused on the main two aspects of the subject: symmetry of crystalline solids and identification of minerals. The individual and group tutorials will be aimed to answer and solve any question of the students about the subject.

6. Detailed Contents

BLOCK I. MORPHOLOGICAL AND STRUCTURAL CRYSTALLOGRAPHY

Lesson 1: INTRODUCTION
Introduction to Crystallography and Mineralogy. Conceptual bases: Crystalline and amorphous solid state. Historical development and interactions with other disciplines. Interest and applications for Chemistry.

Lesson 2: LATTICE THEORY
Crystalline periodicity. Periodic models. Unit cell. The Bravais lattices. Lattice constants and notations. The fundamental laws of Morphological Crystallography.

Lesson 3: CRYSTALLINE SYMMETRY
Symmetry elements and operations. Point symmetry groups or crystal classes. Crystal forms. Translational symmetry groups: plane and space.

Lesson 4: X-RAY CRYSTALLOGRAPHY
X-ray spectra: continuous and characteristic. X-ray diffraction by a crystal lattice. Laüe's equations. Bragg's law. Powder diffractometer: foundations and applications.

BLOCK II. CRYSTAL AND MINERAL CHEMISTRY

Lesson 5: CRYSTAL CHEMISTRY
Crystal chemistry principles. Crystalline, paracrystalline and quasicrystalline structures. Relationship between ionic radii and coordination numbers. The Pauling's rules. Crystal packings and polyhedral sites. Crystal structure models.

Lesson 6: CRYSTAL DYNAMIC
The real crystal. Crystal imperfections or defects. Compositional variations: isomorphism and solid solutions. Structural variations: polymorphism and polymorphic transformations.

Lesson 7: CRYSTAL GROWTH AND MINERAL FORMATION
Nucleation and crystal growth. Atomic structure of crystalline surfaces. Crystal growth mechanisms. Crystal morphology as a genetic indicator. Geological processes in the formation of minerals.

BLOCK III. SYSTEMATIC AND APPLIED MINERALOGY

Lesson 8: SYSTEMATIC MINERALOGY
Mineral nomenclature and diversity. Mineral classification. Structure, composition and properties of the main minerals.

Lesson 9: APPLIED MINERALOGY
Applications and economic interest of minerals. Metal ores. Industrial minerals. Gemstones. Mineral raw materials for the chemical industry.

PRACTICAL EXERCISES OR PROBLEMS:

ACTIVITY 1: Study of periodic models and lattice notations.
ACTIVITY 2: Study of the stereographic projection of crystallographic solids.
ACTIVITY 3: Study of space groups.
ACTIVITY 4: Study by X-ray diffraction of crystalline solids.
ACTIVITY 5: Study of crystal chemistry in structure models.
ACTIVITY 6: Calculation of the formula of a mineral from its chemical analysis.
ACTIVITY 7: Visit to a mineral exhibition.

LABORATORY PRACTICES:

PRACTICE 1: Morphological study of crystallographic solids (4 sessions)
PRACTICE 2: Macroscopic identification of common minerals (3 sessions)

7. Bibliography

7.1 Basic Bibliography:

- A.K. Tareen, T.R.N. Kutty. A Basic course in crystallography. Universities Press, Hyderabad, 2001
- D. Nesse. Introduction to Mineralogy. Oxford University Press, 3ª ed., 2016

7.2 Additional Bibliography:

- Authier. Early days of X-ray crystallography. Oxford University Press, 2013
- Kelly, G.W. Groves y P. Kidd. Crystallography and crystal defects. John Wiley & Sons Inc, Chichester, 2000
- Klein. Minerals and Rocks: Exercises in Crystallography, Mineralogy and Hand Specimen Petrology. John Wiley & Sons, 1989
- Klein, A.R. Philpotts. Earth Materials. Introduction to Mineralogy and Petrology. Cambridge University Press, 2013
- D. Bloss. Crystallography and Crystal Chemistry. Mineralogical Society of America, Washington, 2ª ed., 1994

8. Systems and Assessment Criteria

8.1 System for Assessment:

- Final exam.
- Practical laboratory work and report.
- Continuous assessment.

8.2 Assessment Criteria and Marks:

8.2.1 Examinations Convocatory I

The system of continuous evaluation of the subject will be divided into the following three components:

- Practical exercises or problems: The grade for this part will constitute 20% of the overall score for the course. These seven activities consist of exercises or problems tutored by the teacher that are carried out and delivered during theory class time. Therefore, class attendance is crucial for its evaluation.

- Laboratory practices: The grade for this part will constitute 20% of the overall score for the course. It will be evaluated through an exam of the Practice 1 (Morphological study of crystallographic solids) and an exam of the Practice 2 (Identification of common minerals).

- Theory contents: The grade for this part will constitute 60% of the overall score for the course. It will be evaluated through a final theory exam that will consist of answering a series of open-ended questions on the theory contents and some practical exercises or problems.

Each part will be evaluated in terms of a numerical scale from 0 to 10. Students are required to obtain a minimum of 4 in each part to make the final average grade. Final results will be given using the final average grade taking into account the percentages, with the corresponding qualitative ratings below: • <=4.9: Fail (D) • 5.0 - 6.9: Pass (C) • 7.0 - 8.9: Pass with Merit (B) • 9.0 - 10: Distinction (A).

8.2.2 Examinations Convocatory II

Continuous evaluation is not applicable.

8.2.3 Examinations Convocatory III

Continuous evaluation is not applicable.

8.2.4 Extraordinary Convocatory

Continuous evaluation is not applicable.

8.3 Single Final Evaluation:

Those students that have not properly followed the course or those that choose to have a single assessment will sit a final exam. The single final evaluation will consist of a written test in which 80% of the score will correspond to questions related to the contents of the theory program and the practical exercises or problems and the remaining 20% to the contents explained in the laboratory practices.

Note: This system is also applicable to ordinary evaluations II and III and to extraordinary evaluation.

ANEXO I

9. Illustrative week schedule:							
Date	**Standard Group**	**Small group**				**Exams and evaluation activities**	**Content**
		Classroom	**Lab.**	**Practices**	**Comp. Classr.**		
1st	3						Lesson 1
2nd	3						Lesson 2
3rd	3					AAD1, AAD2	Lessons 1 and 2
4th	3						Lesson 3
5th	3					AAD3	Lesson 3
6th	3					AAD4	Lesson 4
7th	3						Lesson 5
8th	3		1			AAD5	Lesson 5
9th	3		2			AAD6	Lessons 6 and 7; Practice 1
10th	3		2				Lesson 8; Practice 1
11th	3		2				Lesson 8; Practice 1
12th	3		2			AAD7	Lesson 8; Practice 1
13th	3		2				Lesson 9; Practice 2
14th	3		2				Lesson 9; Practice 2
15th	3		2				Lesson 9; Practice 2
Total	45		15				