Universidad Zaragoza

**Year : 2019/20**

# 26402 - Crystallography

## Syllabus Information

**Academic Year:** 2019/20
**Subject:** 26402 - Crystallography
**Faculty / School:** 100 -

**Degree:** 296 - Degree in Geology
588 - Degree in Geology

**ECTS:** 6.5
**Year:** 588 - Degree in Geology: 1
296 - Degree in Geology: 1

**Semester:** Second semester
**Subject Type:** Basic Education
**Module:**

# 1.General information

### 1.1.Aims of the course

### 1.2.Context and importance of this course in the degree

### 1.3.Recommendations to take this course

# 2.Learning goals

### 2.1.Competences

### 2.2.Learning goals

### 2.3.Importance of learning goals

# 3.Assessment (1st and 2nd call)

### 3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

# 4.Methodology, learning tasks, syllabus and resources

### 4.1.Methodological overview

The learning process that has been designed for this subject is based on the following:

Master Classes

Problem-based learning Laboratory practices
Tutorials Evaluation

The course is taught on a face-to-face basis, both with respect to the theoretical part and to the practical part. In addition to the attendance and follow-up of the face-to-face classes and the web of the subject, a personal and continued work of the student is expected. Scripts are provided for the topics that facilitate the follow-up of the classes, the learning of the specific vocabulary and include the bibliographic references for each topic. These scripts do not constitute the notes of the subject, but a mere guide. The consultation of diverse bibliographical sources is considered fundamental for the achievement of the objectives foreseen in the subject.

### 4.2.Learning tasks

The program offered to the student to help him achieve the expected results includes the following activities ...
- Lectures: 3.3 ECTS.

For the development of these classes, written material will be provided in which the recommended reading bibliography in each subject is detailed, including, in some cases, the chapters or the most interesting pages in each case. In the theory classes, the different aspects that are relevant in each case will be discussed. In addition, questions and exercises on the theoretical contents are provided, which can be corrected and consulted in the tutorials.

- Practical classes: 3.2 ECTS
? Problem solving and cases: 1,8 ECTS
? Laboratory practices: 1.4 ECTS
- Exam: 5 hours

- Study: 92.5 hours

Throughout the course, both in the practical and theoretical classes will be used bibliography and internet resources in English. In addition, one of the theoretical classes (Theme 11) will be taught in English.

### 4.3.Syllabus

This course will address the following topics:

**Section 1. Geometric crystallography**

- 1. The concept of crystal: historical development of Crystallography. Order and periodicity. Properties of crystalline matter.
  2. Crystal networks. Periodic two-dimensional networks. Bravais networks and crystalline systems. Elements of the periodic networks
  3. Crystallographic notations: knots rows and planes. Weiss parameters and Miller indices. Relationship between morphology and structure. Empirical laws.
  4. Crystallographic areas.
  5. Symmetry I. Symmetry operations in 2 and 3 dimensions.
  6. Symmetry II. Symmetry compatible with translation. The 32 specific groups. Crystal systems and symmetry.
  7. Crystal morphology. Forms of the 7 systems.
  8. Graphic representation: the stereographic projection.

**Section 2. Structural crystallography and crystal chemistry**

- 9. The symmetry of the unit cell. Space groups. Atomic positions and structural positions.
  10. Crystal structures. Principles that govern the formation of crystalline structures. Pauling's laws.
  11. Variations in the chemical composition of the crystals. Isomorphism, solid solutions and stoichiometry.
  12. X-ray diffraction by crystals. Difraction methods: fundamentals and information they provide.

**Section 3. Physical properties of crystals**

- 13. Introduction to the physical properties of crystals, and their relation to crystalline symmetry.
  14. Optical properties 1. Nature of light, and other basic concepts.
  15. Optical properties 2. Isotropy and optical anisotropy. The optical surfaces.
  16. Optical properties 3. The transmitted light polarization microscope.
  17. Optical properties 4. Optical observations with parallel light and without analyzer. Optical determinations with parallel light and analyzer. Optical determinations with convergent light.

**Section 4. Crystal Dynamics**

- 20. The real crystal. Crystal defects and crystalline dynamics. Influence of defects on the physical properties of crystals.
  21. Crystal defects: punctual, linear, two-dimensional and three-dimensional.
  22. Crystal formation and growth. Morphology of the real crystal. Add and twins.
  23. Polymorphism

**Practical classes: 3,2 ECTS**

- - GEOMETRIC CRYSTALLOGRAPHY: networks, notations and symmetry (3 sessions)
  - GEOMETRIC CRYSTALOGRAPHY: crystal morphology and crystallographic models (5 sessions)
  - STRUCTURAL CRYSTALOGRAPHY: X-ray diffraction (1 session)
  - CRYSTAL OPTICS: handling of the polarization microscope (1 session)
  - CRYSTAL OPTICS: optical determinations with parallel light and parallel nicholes, optical determinations with parallel light and crossed nycols, optical determinations with convergent light (uniaxics and bixics) (5 sessions)
  - CRYSTAL OPTICS: description of minerals (2 sessions)

## 4.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the Faculty of Sciences and Earth Sciences Department websites (https://ciencias.unizar.es; https://cienciastierra.unizar.es) and Moodle.

* Beginning of theory classes: at the beginning of the 2nd semester

* Beginning of the classes of practices (Geometric Crystallography and diffraction: approximately 1 or 2 weeks after the beginning of the semester.

* End of the first module of practices (Geometric Crystallography and diffraction): end of March-beginning of April

* Start of the second module of practices (optical microscopy): in April

* End of theory classes: mid-May

* End of the second module of practices (optical microscopy): end of May

* Review of the first module of practices: last week of May

* Theory exam and the first module of practice: June and September according to the calendar approved by the Faculty of Sciences

* Exam of the second module of practices: June and September according to calendar approved by the Faculty of Sciences

## 4.5.Bibliography and recommended resources

**http://biblos.unizar.es/br/br_citas.php?codigo=26402&year=2019**