



## Teaching Guide

| Teaching Guide      |                                                                                                                                                                                                                                                                                                                                      |        |                                                                               |           |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|-------------------------------------------------------------------------------|-----------|
| Identifying Data    |                                                                                                                                                                                                                                                                                                                                      |        |                                                                               | 2016/17   |
| Subject (*)         | Xeoloxía                                                                                                                                                                                                                                                                                                                             |        | Code                                                                          | 610G01006 |
| Study programme     | Grao en Química                                                                                                                                                                                                                                                                                                                      |        |                                                                               |           |
| Descriptors         |                                                                                                                                                                                                                                                                                                                                      |        |                                                                               |           |
| Cycle               | Period                                                                                                                                                                                                                                                                                                                               | Year   | Type                                                                          | Credits   |
| Graduate            | 2nd four-month period                                                                                                                                                                                                                                                                                                                | First  | FB                                                                            | 6         |
| Language            | SpanishGalicianEnglish                                                                                                                                                                                                                                                                                                               |        |                                                                               |           |
| Teaching method     | Face-to-face                                                                                                                                                                                                                                                                                                                         |        |                                                                               |           |
| Prerequisites       |                                                                                                                                                                                                                                                                                                                                      |        |                                                                               |           |
| Department          | Ciencias da Navegación e da Terra                                                                                                                                                                                                                                                                                                    |        |                                                                               |           |
| Coordinador         | Lado Liñares, Marcos                                                                                                                                                                                                                                                                                                                 | E-mail | marcos.lado@udc.es                                                            |           |
| Lecturers           | Lado Liñares, Marcos<br>Paz Gonzalez, Antonio<br>Vidal Vázquez, Eva                                                                                                                                                                                                                                                                  | E-mail | marcos.lado@udc.es<br>antonio.paz.gonzalez@udc.es<br>eva.vidal.vazquez@udc.es |           |
| Web                 |                                                                                                                                                                                                                                                                                                                                      |        |                                                                               |           |
| General description | The aim of this course is to provide the students with basic knowledge on crystalline solid-state-matter, its structure and symmetry. Also, an important part of this course is focused on the natural processes that lead to the formation of minerals and on the recognition of common minerals based on some of their properties. |        |                                                                               |           |

## Study programme competences

| Code | Study programme competences                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------------------------------|
| A1   | Ability to use chemistry terminology, nomenclature, conventions and units                                                               |
| A3   | Knowledge of characteristics of the different states of matter and theories used to describe them                                       |
| A6   | Knowledge of chemical elements and their compounds, synthesis, structure, properties and reactivity                                     |
| A9   | Knowledge of structural characteristics of chemical and stereochemical compounds, and basic methods of structural analysis and research |
| A12  | Ability to relate macroscopic properties of matter to its microscopic structure                                                         |
| A15  | Ability to recognise and analyse new problems and develop solution strategies                                                           |
| A16  | Ability to source, assess and apply technical bibliographical information and data relating to chemistry                                |
| A20  | Ability to interpret data resulting from laboratory observation and measurement                                                         |
| A23  | Critical standards of excellence in experimental technique and analysis                                                                 |
| A24  | Ability to explain chemical processes and phenomena clearly and simply                                                                  |
| A25  | Ability to recognise and analyse link between chemistry and other disciplines, and presence of chemical processes in everyday life      |
| A27  | Ability to teach chemistry and related subjects at different academic levels                                                            |
| B1   | Learning to learn                                                                                                                       |
| B3   | Application of logical, critical, creative thinking                                                                                     |
| B4   | Working independently on own initiative                                                                                                 |
| B5   | Teamwork and collaboration                                                                                                              |
| B6   | Ethical, responsible, civic-minded professionalism                                                                                      |
| B7   | Effective workplace communication                                                                                                       |
| C1   | Ability to express oneself accurately in the official languages of Galicia (oral and in written)                                        |
| C2   | Oral and written proficiency in a foreign language                                                                                      |
| C3   | Ability to use basic information and communications technology (ICT) tools for professional purposes and learning throughout life       |
| C6   | Ability to assess critically the knowledge, technology and information available for problem solving                                    |
| C7   | Acceptance as a professional and as a citizen of importance of lifelong learning                                                        |

## Learning outcomes

| Learning outcomes | Study programme competences |
|-------------------|-----------------------------|
|-------------------|-----------------------------|



|                                                                                                                                                                                                                                                              |                                |                      |                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|----------------------|----------------------|
| The student will become familiar with the international standard terminology both in crystallography and mineralogy studies                                                                                                                                  | A1<br>A16                      | B1                   | C3                   |
| The student will learn to recognize crystalline matter, to analyze its structure, and to describe its internal symmetry                                                                                                                                      | A3<br>A9<br>A12<br>A20         | B1<br>B3             | C3                   |
| The study of minerals, as natural inorganic chemical compounds, and mineral formation processes, provides knowledge on the reactivity of chemical elements that result in natural compounds                                                                  | A6<br>A20<br>A24               |                      |                      |
| The internal structure of each mineral class, crystal system and the most representative unit cells are analyzed                                                                                                                                             | A1<br>A3<br>A9                 | B3                   |                      |
| The student will be able to relate mineral properties (density, cleavage, hardness, piezoelectricity) and mineral chemical composition, bonds and internal structure                                                                                         | A6<br>A12<br>A16<br>A25<br>A27 | B5<br>B6<br>B7       | C1                   |
| The student will face practical and theoretical aspects of minerals and crystalline matter, and the relationship between atomic arrangement and macroscopic properties                                                                                       | A15<br>A16                     | B3                   |                      |
| Laboratory work includes the analysis of crystal forms and the identification of common minerals through a critical analysis of its symmetry, the development and training of spatial perception and the students' abstraction capabilities.                 | A1<br>A12<br>A20<br>A23        | B1<br>B3<br>B4<br>B5 | C1<br>C2<br>C6<br>C7 |
| Small group assignments are focused on solving problems related, in general, to practical aspects of mineralogy. The student should be able to present it in a synthetic manner, and to establish the interactions between the problem and other disciplines | A15<br>A23<br>A24<br>A25       | B3<br>B5<br>B7       | C1<br>C2<br>C3<br>C6 |

| Contents                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Topic                                                       | Sub-topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Crystallography and symmetry of crystalline matter          | 1. Introduction to crystallography and mineralogy. Definition of crystal and mineral. Main properties of crystalline matter. Fundamentals of crystal chemistry: coordination.<br>2. Crystal systems: Orthorhombic, tetragonal, hexagonal, monoclinic, triclinic and isometric.<br>3. Point symmetry: symmetry elements, symmetry class.<br>4. Morphology of crystal forms: crystallographic axis, axis relations, faces, Miller indices.<br>5. Crystallographic projections (spheric and stereographic).<br>6. Planar symmetry: 2-dimensional order and planar lattices. Planar symmetry and groups.<br>7. Space symmetry: 3-dimensional order. Bravais lattices. Space symmetry (glide planes and screw axes). Space groups. Relations between point groups and space groups.<br>8. Molecular symmetry and Schoenflies notation. |
| Geological processes, mineral formation, and types of rocks | 9. Formation of chemical elements.<br>10. Formation of minerals.<br>11. Types of rocks: igneous, sedimentary and metamorphic.<br>12. The most abundant minerals in Earth crust: silicates.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |



|                                                        |                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chemical and physical properties of crystalline matter | <p>13. Physical properties of minerals: cleavage and fracture, hardness, piezoelectricity, pyroelectricity, magnetic properties.</p> <p>14. Optical properties: X-ray diffraction, color, luster and streak, refraction, luminescence and phosphorescence).</p> |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Planning                                                                                                                        |                                                   |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                      | Ordinary class hours | Student's personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A1 A3 A12 A16 A20<br>B7 C7                        | 26                   | 60                            | 86          |
| Laboratory practice                                                                                                             | A1 A12 A20 A23 B1<br>B3 B4 B5 C1 C2 C6<br>C7      | 15                   | 22.5                          | 37.5        |
| Collaborative learning                                                                                                          | A15 A23 A24 A25<br>A27 B3 B5 B6 B7 C1<br>C2 C3 C6 | 4                    | 6                             | 10          |
| Problem solving                                                                                                                 | A1 A3 A6 A9 B4 C1<br>C2                           | 5                    | 7.5                           | 12.5        |
| Mixed objective/subjective test                                                                                                 | A1 A3 A6 A9 A12 A20<br>A24 A25 B3 B4 C1<br>C2 C6  | 2                    | 0                             | 2           |
| Introductory activities                                                                                                         | A12                                               | 1                    | 0                             | 1           |
| 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  | 50-min sessions that will cover the theoretical aspects of the course using audiovisual contents                                                                                                                                                                |
| Laboratory practice             | Hands-on activities where the students will learn to identify crystal groups, symmetry operations, and point groups based on model structures. These activities will include also the recognition of the most representative minerals in the rocks of the area. |
| Collaborative learning          | These sessions will be conducted in small groups, where students will solve problems and discuss the theoretical aspects that were developed in the keynote speeches.                                                                                           |
| Problem solving                 | These sessions will be focused on the individual work of students solving problems related to crystal lattices and the identification of combinations of symmetry elements in point groups.                                                                     |
| Mixed objective/subjective test | A written test that will be conducted in order to verify the knowledge and competences that the student developed during the course.                                                                                                                            |
| Introductory activities         | An introductory session during the first day of the course, where the methodology, contents, assessment criteria and time schedule of the different activities will be discussed.                                                                               |

| Personalized attention                    |                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                             | Description                                                                                                                                                                                                                                                                                                                                                                                                  |
| Collaborative learning<br>Problem solving | Personalized attention will be provided through individual meetings between the professor and the students, in dates previously selected. Moreover, non-presential tools, mainly e-mail, will be used to solve questions and doubts related to the course. Special attention will be provided to those students that can experience more difficulties during the learning process and to part-time students. |

| Assessment |
|------------|
|------------|



| Methodologies                   | Competencies                                      | Description                                                                                                                                                                                    | Qualification |
|---------------------------------|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Collaborative learning          | A15 A23 A24 A25<br>A27 B3 B5 B6 B7 C1<br>C2 C3 C6 | The assessment will include activities related to information analysis, brief oral presentations, discussions and problem solving. The effort, participation and presentation will be assessed | 7             |
| Laboratory practice             | A1 A12 A20 A23 B1<br>B3 B4 B5 C1 C2 C6<br>C7      | The assessment will include questions to be answered during the laboratory work and a test about crystalline structures                                                                        | 20            |
| Problem solving                 | A1 A3 A6 A9 B4 C1<br>C2                           | The assessment will consist on a booklet with problems that the student needs to solve                                                                                                         | 3             |
| Mixed objective/subjective test | A1 A3 A6 A9 A12 A20<br>A24 A25 B3 B4 C1<br>C2 C6  | A test designed to assess the theoretical background of the acquired during the course. The minimum grade to pass the test will be 5 points out of 10                                          | 70            |

## Assessment comments

The requisite to pass each of the activities included in the assessment is to obtain a minimum grade of 5 out of 10 points in each of those activities. Otherwise, the student will not pass the course. In those cases when the average of all grades of the different activities is higher than 5, but the student did not obtain a minimum of 5 in all the activities, the grade that will be assigned in the official records will be 4.

Once all the activities have been passed, the final grade of the course will be the sum of the different grades obtained in the tests and activities. The mixed test will yield 70% of the final grade. Laboratory work and small-group activities will result in the other 30% of the final grade. Nevertheless, it will be strictly necessary to obtain 5 points out of 10 in each of the activities: the mixed test, the laboratory work, and the small group activities. The attendance to lectures, laboratory work, and the completion of the individual and group exercises are compulsory in order to be evaluated.

The student will be assessed as NOT PRESENTED only if he/she did not participate in more than 25% of the course activities.

The tests of May-June (first opportunity) and July (second opportunity) will be evaluated similarly in terms of percentages and requirements to pass the course. The qualification obtained in the laboratory work and group activities will be preserved until the second opportunity, while the mixed test qualification in the second opportunity will replace the one obtained in the first one.

Honors will be given only to students whose evaluation is conducted during the course and will pass the tests in any of the two opportunities, until the maximum number of Honors dictated by the institution regulations is reached.

The students who haven't pass the course in previous years will have to participate in all the activities and pass a new assessment of all the activities, since the learning-teaching process, which includes the assessment, is only valid for one academic year.

Part-time students are not obligated to attend to lectures and small-group activities, although they must attend to laboratory work. The percentage of the final grade corresponding to small-group activities will be replaced by the corresponding increase in the percentage of the mixed objective/subjective test, both in the first and second opportunities.

## Sources of information



|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>         | <ul style="list-style-type: none"><li>- Borchardt-Ott, W. (2012). Crystallography: An Introduction. Springer</li><li>- KLEIN, C. y HURLBUT, C.S. Jr (1996). Manual de mineralogía basado en la obra de J. Dana. Reverté</li><li>- Phillips, F.C. (1972). Introduccion a la Cristalografía. Paraninfo</li><li>- Gay P. (1977). Introduccion al estado cristalino. EUNIBAR</li></ul> <p>Recursos en la web:<a href="http://www.uned.es/cristamine/">http://www.uned.es/cristamine/</a> (curso de Cristalografía y Mineralogía de la UNED)<a href="http://www.ucm.es/info/crismine/TEXTOS_MONOGRÁFICOS.htm">http://www.ucm.es/info/crismine/TEXTOS_MONOGRÁFICOS.htm</a> (Facultad de Ciencias Geológicas de la UCM)<a href="http://161.116.85.21/crista/castella/index_es.htm">http://161.116.85.21/crista/castella/index_es.htm</a> (Cristalografía de Màrius Vendrell, UB)<a href="http://webmineral.com/">http://webmineral.com/</a> (Sitio con abundantes recursos relacionados con la cristalografía y mineralogía)</p> |
| <b>Complementary</b> | <ul style="list-style-type: none"><li>- Amorós, J.L. (1990 ). El cristal. Morfología, estructura y propiedades físicas. Atlas</li><li>- Galán, E. y Mirete, S. (1979). Introducción a los minerales de España. IGME</li></ul> <p>Recursos en la web:Jiménez, J. y Velilla, N. Óptica mineral. Universidad de Jaén (consultado enero de 2011). <a href="http://geologia.ujaen.es/opticamineral">http://geologia.ujaen.es/opticamineral</a>Tindle, A. 2010. Andy Tindle's Pages. The Open University(consultado en diciembre de 2010). <a href="http://www.open.ac.uk/earth-research/tindle/">http://www.open.ac.uk/earth-research/tindle/</a>García del Amo et al., 2008. Microscopía óptica de polarización (consultado enero 2011). <a href="http://www.uned.es/cristamine/mineral/metodos/prop_micr.htm">http://www.uned.es/cristamine/mineral/metodos/prop_micr.htm</a><a href="http://www.nature.com/news/specials/crystallography-1.14540">http://www.nature.com/news/specials/crystallography-1.14540</a></p>       |

## 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

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.