

Teaching Guide				
Identifying Data				2020/21
Subject (*)	Advanced Inorganic Chemistry	Code	610G01025	
Study programme	Grao en Química			
Descriptors				
Cycle	Period	Year	Type	Credits
Graduate	1st four-month period	Fourth	Obligatory	6
Language	SpanishEnglish			
Teaching method	Hybrid			
Prerequisites				
Department	Química			
Coordinador	Fernandez Sanchez, Jesus Jose	E-mail	jesus.fernandezs@udc.es	
Lecturers	Fernandez Lopez, Alberto A. Fernandez Sanchez, Jesus Jose	E-mail	alberto.fernandez@udc.es jesus.fernandezs@udc.es	
Web				
General description	<p>The Organometallic Chemistry is one of the wide fields of study in which the Inorganic Chemistry is divided. The Organometallic Chemistry studies the experimental research, the structure, bonding, reactivity and applications of those compounds with M-C bond. The importance of these go further than the mere academic interest, as many of the organometallic compounds are presently used in synthetic reactions, in stoichiometric or catalytic conditions, for both, laboratory or industrial and technological processes.</p> <p>The subject ?Advanced Inorganic Chemistry? is taught in the first term of the fourth year in the Chemistry Degree at de UDC. This subject, dedicated to the study of Organometallic Compounds consists of four theoretical and two laboratory credits.</p>			
Contingency plan	<p>1. Modifications to the contents</p> <p>There are no changes in the contents</p> <p>2. Methodologies</p> <p>*Teaching methodologies that are maintained</p> <p>All the methodologies are maintained.</p> <p>*Teaching methodologies that are modified</p> <p>There are no modifications in the lecture and seminar methodologies, except that the learning platforms Moodle and Teams, or any other used by UDC, will be used, if face-to-face learning is impossible.</p> <p>However, if ?laboratory practice? classes can not be conducted in a face-to-face manner, on-line activities dedicated to the synthesis and characterization of organometallic compounds will replace such classes. The remaining learning methodologies will be conducted using Moodle and Teams or similar learning platforms.</p> <p>3. Mechanisms for personalized attention to students</p> <p>Email, Moodle or Teams (or another similar platform), at the request of students. During the activities that replace the lab sessions, at least a compulsory tutorial will be held using Teams.</p> <p>4. Modifications in the evaluation</p> <p>There are no modifications in the evaluation methodologies or percentages assigned to them.</p> <p>*Evaluation observations</p> <p>No changes in the assessment methodology are foreseen except that the different evaluation activities will be taken by using Moodle, Teams or any other learning platform used by the UDC.</p> <p>5. Modifications to the bibliography or webgraphy</p> <p>There are no modifications to the literature resources referenced in Moodle and the teaching guide. However, the material available in Moodle and attendance to the different learning activities will suffice to pass the subject.</p>			

**Study programme competences / results**

Code	Study programme competences / results
A1	Ability to use chemistry terminology, nomenclature, conventions and units
A4	Knowledge of main types of chemical reaction and characteristics of each

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
A10	Knowledge of chemical kinetics, catalysis and reaction mechanisms
A14	Ability to demonstrate knowledge and understanding of concepts, principles and theories in chemistry
A16	Ability to source, assess and apply technical bibliographical information and data relating to chemistry
A17	Ability to work safely in a chemistry laboratory (handling of materials, disposal of waste)
A18	Risk management in relation to use of chemical substances and laboratory procedures
A20	Ability to interpret data resulting from laboratory observation and measurement
A22	Ability to plan, design and develop projects and experiments
A23	Critical standards of excellence in experimental technique and analysis
A26	Ability to follow standard laboratory procedures in relation to analysis and synthesis of organic and inorganic systems
B1	Learning to learn
B2	Effective problem solving
B3	Application of logical, critical, creative thinking
B4	Working independently on own initiative
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

Learning outcomes			
Learning outcomes	Study programme competences / results		
Students should know the structure, nature of bonding, reactivity and properties of organometallic complexes and apply this knowledge to the solution of chemical problems.	A1 A4 A6 A9 A10 A14 A16	B1 B2 B3 B4	C1 C2
Students should be able to apply the theoretical knowledge and practical skills necessary to carry out the synthesis and characterization of organometallic compounds.	A1 A9 A14 A16 A17 A18 A20 A22 A23 A26	B1 B2 B3 B4	C1 C2

Contents	
Topic	Sub-topic
I. Organometallic chemistry.	I.I. General characteristics of organometallic compounds. I.II. Organometallic compounds in the main groups. I.III. Reaction mechanisms of inorganic species.
II. Organometallic compounds with monohapto ligands.	II.I. Metal carbonyls. II.II. Organometallic compounds with monohapto ligands: sigma M-C bond. II.III. Metal carbenes and carbenes.



III. Organometallic compounds with polyhaptoligands.	III.I: Organometallic compounds with dihapto ligands: akenes and alkynes. III.II: Organometallic compounds with trihapto ligands: allyls. III.III. Organometallic compounds with tetrahapto ligands: conjugated diolefins. III.IV. Organometallic compounds with pentahapto ligands: cyclopentadienylyls. III.V. Organometallic compounds with hexahapto ligands: arenes.
IV. Experimental organometallic chemistry.	IV.I. Syntheses of organometallic compounds. IV.II. Structural determination applied to organometallic compounds.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student's personal work hours	Total hours
Guest lecture / keynote speech	A14 B3 C1 C2	21	42	63
Problem solving	A1 A4 A6 A9 A10 A14 A16 B1 B2 B3 C1 C2	7	14	21
Laboratory practice	A1 A4 A6 A9 A16 A17 A18 A20 A22 A23 A26 B1 B4	20	20	40
Mixed objective/subjective test	A1 A4 A6 A9 A10 A14 B2 B3 C1 C2	4	22	26
Personalized attention		0	0	0

(\*)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	Lectures dedicated to introduce the most relevant contents of the course. Active participation of students are encouraged as an important part of the lectures methodology. Prior to each lecture students are supposed to have read the suggested readings related to the topics of the lecture. If necessary the students are expected to prepare by themselves part of the course contents in the student's personal work hours.
Problem solving	Classes given in small groups of students, which must participate actively. Problem-solving classes are dedicated to solving the doubts arisen during lectures and the preparatory readings. They are also dedicated to the resolution of problems and questions previously given to the students or to the intensive study of a particular topic through the active discussion methodology. If necessary, practical cases may also be solved using the university Moodle.
Laboratory practice	Laboratory classes which are dedicated to the synthesis, isolation and characterization of organometallic compounds. Prior to the lab class, the student studies the theoretical and synthetic aspects of each laboratory experiment using the recommended bibliographic sources. Before starting the laboratory work, the student has to show, in a personal tutorial with the professor, that has reached the necessary level of knowledge and skills necessary to understand and carry out the experiment safely. During the laboratory work, the student must work carefully paying special attention to the safety rules and showing the rigor and efficiency characteristic of the scientific method. The preparatory work, the experimental description (laboratory diary) and the conclusions drawn must be recorded in the laboratory notebook, which must be given to the professor before the deadline.
Mixed objective/subjective test	The mixed test is a written exam, which consists of essay-type questions in which the student must find the answer to a more or less complex problem, which may be of logic or numeric nature. It may also contain objective test questions.

Personalized attention	
Methodologies	Description



<p>Guest lecture / keynote speech</p> <p>Problem solving</p> <p>Laboratory practice</p> <p>Mixed objective/subjective test</p>	<p>Personalized attention is aimed to give support to the students in the process of autonomous learning. The tutorials are organized by the professor and dedicated to the solution of doubts related to the contents of this subject or arisen during the preparation of the problem-solving sessions; but, especially during the preparation of the laboratory practice classes.</p> <p>Part-time students (according to the UDC regulations) will be given personalized tutorial support:</p> <p>The students will be given tutorial support according to their needs at any moment.</p> <p>Particularly, those students will be periodically given handouts with problems and questions designed to gauge the acquisitions of competencies. The students will solve those problems individually and, after this, attend to a tutorial to solve doubts and correct the problems.</p> <p>On request, the students will also be given tutorial support in order to prepare the laboratory experiments.</p>
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Assessment			
Methodologies	Competencies / Results	Description	Qualification
Guest lecture / keynote speech	A14 B3 C1 C2	<p>During lectures, the professor assesses the active participation of students as well as their reasoning and oratory skills.</p> <p>If necessary, the students might take a brief test consisting of short answer or multiple election questions, during the lecture hours. The solution and presentation of a study case using Moodle are also possible. The marks corresponding to these activities will be added to the ?problem solution? marks.</p>	0
Problem solving	A1 A4 A6 A9 A10 A14 A16 B1 B2 B3 C1 C2	<p>During the problem-solving classes, the professor assesses the active participation of students as well as their reasoning and oratory skills.</p> <p>If necessary, the students might take a brief test consisting of short answer or multiple election questions, during the lecture hours. The solution and presentation of a study case using Moodle are also possible. The marks corresponding to these activities will be added to the ?lecture? marks.</p>	20
Laboratory practice	A1 A4 A6 A9 A16 A17 A18 A20 A22 A23 A26 B1 B4	<p>During the pre-lab tutorial, the professor assess the rigorous preparation of the theoretical and experimental parts of the laboratory experiment which concerns both the synthetic and the characterization methodology.</p> <p>The professor also assesses the laboratory work, particularly: the organization, safety work, knowledge of the material and technical procedures, the manual skill and, especially, the ability to find relationships between the experimental procedure carried out and the theoretical background acquired during the previous work.</p> <p>The laboratory notebook will also be marked. It consists of four parts: preparatory work, exact description of laboratory work (laboratory diary), characterization of the products synthesized and results and conclusions drawn from the experiment.</p>	20
Mixed objective/subjective test	A1 A4 A6 A9 A10 A14 B2 B3 C1 C2	Students will take the mixed test in the hours designed by the Faculty. The assessment criteria will be given before the exam.	60

Assessment comments
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In order to pass the subject, the students must attend to all the laboratory classes and to the 80% of the remaining activities.

In the ?first opportunity?, the contribution of the different methodologies to the final assessment is as follows:

C1 Mixed text, 6.0 points.

C2 Laboratory practice, 2.0 points

C3 Keynote speech + problem solving + short test, 2.0 points.

C4 Student progression, 1 point.

In order to pass the subject the students have to attain a minimum mark of 5 points corresponding to the sum of (C1 + C2+ C3) and comply with the following requirements:

The student must attain a minimum of the 45% of the maximum mark in contributions C1 and C2. If the sum (C1 + C2+ C3) is 5 points or higher but C1 and C2 do not reach the 45% threshold, the final mark will be 4.5 points.

The contribution C4 ?Student progression? will be added to the final marks only if the sum C1 + C2+ C3 is 5 or more points. (In any case, the maximum mark is 10 points)

The condition of ?no presentado? will be granted to those students who have participated in activities summing less than the 20% of the total mark.

In the ?second opportunity?, the student repeats only of the mixed test. The marks corresponding to laboratory practice, and keynote speech + problem solving + short test are those attained during the normal period of classes (first opportunity). The contribution of each methodology and the conditions to pass the subject are the defined for the first opportunity. Consequently, a minimum mark of 45% in laboratory practice (C1) in the first opportunity is also necessary to pass the subject in the second opportunity.

The mark ?matricula de honor? will be granted preferably to the students that have passed the subject in the first opportunity.

Attendance to laboratory practice classes is mandatory for part-time students (according to the UDC regulations). For those students, the contribution to the final marks is as follows: 75% of the final marks corresponds to the mixed text and the remaining 25% corresponds to the laboratory practice.

The marking system (percentages) will be the same for both opportunities. The condition of ?no presentado? will be granted to those part-time students who do not take the mixed text.

### Sources of information

<b>Basic</b>	<ul style="list-style-type: none"> <li>- A.F. Hill (2002). Organotransition metal chemistry. Cambridge, Royal Soc. of Chem.</li> <li>- R.H. Crabtree (2009). The organometallic chemistry of the transition metals. New Jersey, Wiley</li> <li>- C. Elschenbroich (2006). Organometallics. Weinheim, Wiley-VCH</li> </ul> <p>Bibliografía de prácticas de laboratorio, síntese e determinación estrutural enfocada cara á Química Inorgánica en xeral e a Química Organometálica en particular, a disposición pública na Biblioteca da Facultade de Ciencias da UDC.</p>
<b>Complementary</b>	<ul style="list-style-type: none"> <li>- G.O. Spessard y G.L. Miessler (2010). Organometallic Chemistry. New York, Oxford Univ. Press</li> <li>- D. Astruc (2003). Química organometálica. Barcelona, Reverté</li> <li>- R.H. Crabtree y E. Peris Fajarnés (1997). Química organometálica de los metales de transición. Castellon, Pub. Univ. Jaume I</li> <li>- G.A. Carriedo Ule y D. Miguel Sanjosé (1995). Iniciación a la química organometálica. Oviedo, Pub. Univ. Oviedo</li> </ul> <p>Bibliografía de Química Organometálica, a disposición pública na Biblioteca da Facultade de Ciencias da UDC. "Organometallic Hypertext Book", R. Toreki (ILPI, Interactive Learning Paradigms Incorporated), <a href="http://www.ilpi.com/organomet/">http://www.ilpi.com/organomet/</a></p>

### Recommendations

#### Subjects that it is recommended to have taken before

Inorganic Chemistry 1/610G01021

Inorganic Chemistry 2/610G01022

Inorganic Chemistry 3/610G01023

Inorganic Chemistry 4/610G01024

#### Subjects that are recommended to be taken simultaneously

#### Subjects that continue the syllabus



Other comments

The subject 'Advanced Inorganic Chemistry' is the last compulsory subject corresponding to Inorganic Chemistry in the Chemistry Degree therefore, is highly recommendable to have passed the previous 'Inorganic Chemistries 1-4'. Complementary material will be given to the students through the Moodle. It is highly advisable to attend all classes and the active participation in all activities.

(\*)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.