



FACULTAD DE
CIENCIAS QUÍMICAS

INORGANIC CHEMISTRY II

COURSE GUIDE

BSc Chemistry

Academic Year 2026-2027



UNIVERSIDAD
COMPLUTENSE
MADRID



I.- COURSE IDENTIFICACIÓN

| | |
|-------------------------|-------------------------------------|
| COURSE NAME: | Inorganic Chemistry II |
| CREDITS: | 12 |
| CHARACTER: | Mandatory |
| SUBJECT: | Inorganic Chemistry |
| MODULE: | Fundamental |
| DEGREE: | Degree in Chemistry |
| SEMESTER/COURSE: | Annual (3rd year) |
| DEPARTAMENT: | Inorganic Chemistry |

LECTURERS:

| | |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Course Coordinator | Professor: JOSEFA ISASI MARÍN Department: Inorganic Chemistry Office: QA-136 e-mail: isasi@ucm.es |
| Laboratory Coordinator | Professor: ESTER GARCÍA GONZÁLEZ Department: Inorganic Chemistry Office: QA-106 e-mail: esterg@ucm.es |

Group E

| | |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Theory Seminars Tutorials | Lecturer: M ^a JOSE MAYORAL MUÑOZ Department: Inorganic Chemistry Office: QA-225 e-mail: mj.mayoral@ucm.es |
| Theory Seminars Tutorials | Lecturer: DAVID ÁVILA BRANDE Department: Inorganic Chemistry Office: QA-118 e-mail: davidabr@ucm.es |

Laboratory QA141

| Group | Semester | Professor | e-mail | Office | Depar. |
|-------|----------------|-----------------|-----------------|---------|--------|
| E1 | 1 ^o | Cristián Cuerva | c.cuerva@ucm.es | QA-229 | QI |
| | 2 ^o | Jesús Prado | jpradogo@ucm.es | QA-222 | QI |
| E2 | 1 ^o | Laura Abad | laabad03@ucm.es | QA-229A | QI |
| | 2 ^o | Elena Solana | elsolana@ucm.es | QA-119 | QI |



II.- OBJECTIVES

■ GENERAL OBJECTIVE

The aim is for the student to acquire the necessary knowledge to understand and establish connections between the structure, properties, reactivity, and applications of metallic compounds.

Students are expected to learn specific synthesis procedures based on sustainability criteria, using proper materials and assemblies. Additionally, they will gain an introduction to the fundamentals and the use of different characterization methods for the inorganic compounds they prepare.

■ SPECIFIC OBJECTIVES

- To delve into the foundational aspects of Coordination and Organometallic Chemistry, fostering a comprehensive understanding of these subfields.
- To develop a strong foundation in the fundamental aspects of Solid-State Chemistry, enabling students to gain a comprehensive understanding of this field.
- To establish and explore the relationships between the structure and properties of elements, as well as their corresponding compounds.
- To learn and apply specific synthesis procedures to successfully obtain inorganic compounds.
- To provide a comprehensive understanding of the fundamental principles behind the most used techniques for characterizing inorganic compounds.
- To foster an understanding of the significance and importance of inorganic compounds containing metallic elements in the field of Science, particularly their role as advanced materials.
- To identify and/or recognize the potential application of Inorganic Chemistry II course content within the framework of Sustainable Chemistry and Green Chemistry.

III.- BACKGROUND KNOWLEDGE AND RECOMMENDATIONS

■ PRIOR KNOWLEDGE:

Characteristics of the elements and the general trends of their physical-chemical properties based on the periodic table. Basic structural aspects of molecular and non-molecular species. General characteristics of the electronic structure of a metal, a semiconductor and an insulator. General procedures for the synthesis of inorganic compounds.

■ RECOMMENDATIONS:

It is recommended that students enrolling in this course have previously taken and passed the *General Chemistry* and *Inorganic Chemistry I* courses.



IV.- CONTENTS

■ BRIEF DESCRIPTION:

Theoretical contents

Coordination compounds: bond, stereochemistry, spectroscopic and magnetic properties, reactivity. Organometallic compounds: basic aspects. Metal-metal bond in coordination and organometallic compounds. Structure, bond, properties and reactivity of non-molecular inorganic solids. Oxides and sulfides of the transition elements. Silicates.

Practical contents

Synthesis and characterization of non-molecular inorganic solids and coordination and organometallic compounds. Instrumental characterization techniques.

■ SYLLABUS:

THEORY. FIRST SEMESTER.

Coordination Compounds

Unit 1: Bonding in coordination compounds

- Molecular orbital theory: octahedral, tetrahedral and square-plane compounds.

Unit 2: Thermodynamic aspects of coordination compounds

- Equilibrium constants.
- The chelate, cryptate and macrocyclic effects.
- Hard-soft interaction.

Unit 3: Stereochemistry

- Factors influencing the stereochemistry of coordination compounds.
Low coordination numbers.
High coordination numbers.

Unit 4: Spectroscopic properties

- Adjusted crystal field theory
- Electronic transitions: d-d transitions and charge transfer transitions. Color
- Tanabe-Sugano diagrams.
- Analysis of electronic spectra.

Unit 5: Magnetic properties

- Magnetic behavior of transition metal coordination compounds.
- Spin moment and orbital contribution. Spin-orbital coupling.

Unit 6: Reactivity of coordination compounds

- Types of reactions.
- Substitution reactions.
- Electronic transfer reactions. Outer sphere and inner sphere mechanisms.

Unit 7: Basic concepts in organometallic compounds

- Classification of organometallic compounds.
- Metal-carbon bonds.
- Transition metal compounds. 18 electron-rule.

Unit 8: Metal-metal bonding in coordination and organometallic compounds

- Dinuclear compounds with metal-metal bond.
- Metal carbonyl clusters. Effective atomic number (EAN) rule. Wade's rules.
- Metal halide clusters.

**THEORY. SECOND SEMESTER.****Non- molecular inorganic solids****Unit 9: Reactivity of solids. Types of reactions**

- Solid-solid reactions: mechanisms.
- Solid-liquid reactions.
 - o Intercalation reactions.
 - o Ionic-Exchange reactions.
- Solid-gas reactions.
 - o Transport reactions.
- Crystal growth

Unit 10: Electronic structure of solids

- Information provided by spectroscopic methods.
- Overlapping orbitals in the crystal: Band models.

Unit 11: Metal oxides

- Binary oxides: relationship structure properties. Electrical and magnetic properties of the stoichiometry MO , M_2O_3 , MO_2 and MO_3 oxides. Applications. Nonstoichiometry in binary oxides.
- Mixed oxides: structure-properties relationship. Electronic, dielectric and magnetic properties in mixed oxides with stoichiometry ABO_3 (ilmenite and perovskite) and AB_2O_4 , (spinel). Non stoichiometry; homologous series, bronzes and perovskites.

Unit 12: Metal sulphides

- Analogies and differences between oxides and sulphides.
- Structure-properties relations: metal transition sulphides.
- Nonstoichiometry in sulphides.
- Applications.
- Synthesis methods .

Unit 13: Other inorganic relevant compounds: silicates.

- Introduction.
- General classification of silicates.
- Structural description of silicates.
- Zeolites: structural characteristics. Synthesis. Applications.

LABORATORY SESSIONS.**First Semester Seminars:**

- Characterization of coordination and organometallic compounds.
- Magnetic behavior I.

Second Semester Seminars:

- Characterization of solids by X-ray powder diffraction.
- Magnetic behavior II.

**Practical work:**

Practical sessions on coordination compounds will be conducted during the first semester, while practical sessions on non-molecular solids will take place during the second semester. All experiments will be selected from those listed below:

1. Template effect: Synthesis of Ni(II) tetraazamacrocyclic complexes.
2. Preparation of hexacoordinate chromium (III) complexes. Magnetic behavior. Determination of the spectrochemical series.
3. Preparation of TiO₂ by different synthesis methods. Study of the transformation of anatase-rutile phase.
4. Preparation and characterization of solid solutions:
 - Al₂O₃/Cr₂O₃ system
 - Fe₂O₃/Cr₂O₃ system
5. Preparation, structural and magnetic characterization of RCrO₄ oxides (R = Rare Earth).
6. Preparation of Fe(III) spinels. Structural characterization and magnetic behavior.
7. Preparation and study of the ionic exchange properties of zeolite A.

V.- COMPETENCES**■ GENERAL COMPETENCES:**

- **CG1-MF1:** Recognize chemical processes in daily life.
- **CG2-MF1:** Relate Chemistry to other disciplines.
- **CG3-MF1:** Continue her/his studies in multidisciplinary areas.
- **CG5-MF1:** Demonstrate knowledge and understanding of the essential facts, concepts, principles and theories related to the areas of Chemistry.
- **CG6-MF1:** Analyze and solve qualitative and quantitative problems.
- **CG7-MF1:** Recognize and analyze new problems and plan strategies to solve them.
- **CG8-MF1:** Consult and use scientific and technical information in an effective manner.
- **CG9-MF1:** Demonstrate knowledge of laboratory material and practical skills.
- **CG10-MF1:** Safe handling of chemical materials.
- **CG10-MF2:** Recognize and assess hazards in the use of chemicals and laboratory procedures.
- **CG11-MF1:** Handle standard and specific chemical instrumentation.
- **CG12-MF1:** Interpret data from observations and laboratory measurements.
- **CG13-MF1:** Recognize and implement good scientific practices for measurement and experimentation.

■ SPECIFIC COMPETENCES:

- **CE8-MFQI1:** Describe and relate the bond, structure and properties of compounds of metallic elements.



- **CE9-MFQI1:** Develop the fundamental aspects of Coordination and Organometallic Chemistry.
- **CE9-MFQI2:** Develop the fundamental aspects of Solid-State Chemistry.
- **CE10-MFQI1:** Use experimental methods for the synthesis of inorganic compounds.
- **CE10-MFQI2:** Explain the fundamentals and use the most frequent techniques for the characterization of inorganic compounds.

■ TRANSVERSAL COMPETENCES:

- **CT1-MF1:** Prepare and write scientific and technical reports.
- **CT2-MF1:** Cooperate with other students through teamwork.
- **CT3-MF1:** Apply critical and self-critical reasoning.
- **CT5-MF1:** Use chemical information, bibliography and specialized databases.
- **CT6-MF1:** Identify the importance of chemistry in the industrial, environmental and social context.
- **CT7-MF1:** Use computer tools and programs for the treatment of experimental data.
- **CT11-MF1:** Develop autonomous learning.
- **CT12-MF1:** Recognize the current energy problem and its importance.
- **CT12-MF2:** Develop sensitivity to environmental issues.

VI.- LEARNING OUTCOMES

Once the student has passed this course, he/she should be able to:

- Apply the Molecular Orbital Theory to coordination compounds.
- Discuss fundamental thermodynamic aspects of coordination compounds.
- Describe the chelate and macrocyclic effect.
- Predict the most favorable stereochemistry for a given coordination compound.
- Describe and apply the adjusted crystal field theory.
- Recognize and differentiate the different types of electronic transitions.
- Use the Tanabe-Sugano diagrams and calculate the corresponding parameters.
- Explain the color observed in coordination compounds.
- Explain the magnetic behavior of metal coordination compounds of the first transition series.
- Predict the existence of spin-orbital coupling.
- Analyze substitution reactions in coordination compounds and explain the reaction mechanism.
- Design synthetic procedures of square-plane compounds by ligand substitution.
- Analyze electron transfer reactions in coordination compounds and justify the most appropriate mechanism.
- Identify the different types of metal-carbon bond.
- Apply the 18 electron-rule.
- Explain the metal-carbon bond in representative examples.
- Determine the metal-metal bond order in clusters.
- Apply Wade's rules to determine the structure of clusters.



- Discuss the synthesis of non-molecular solids by ceramic method, intercalation reactions, ion exchange, hydrothermal synthesis and transport reactions.
- Explain the characteristics of the electronic structure of non-molecular solids through different approaches that consider either collective or localized electrons.
- Analyze the conceptual bases and general characteristics of the Goodenough band model for non-molecular solids.
- Interpret the crystalline structure, the electronic structure and its relationship with the properties of binary (MO , MO_2 , MO_3 and M_2O_3) and mixed oxides (ABO_3 and AB_2O_4).
- Discuss the accommodation of defects in non-stoichiometry.
- Explain the analogies and differences between sulfides and oxides of transition elements.
- Explain some examples of non-stoichiometric sulfides.
- Explain the crystal and electronic structure of some 2D and 3D sulfides of transition elements.
- Explain the general characteristics of silicates and establish a classification based on the dimensionality of the silicate anion.
- Discuss the crystal structure of silicates.
- Describe the methods of synthesis, structure, and most relevant technological applications of zeolites.
- Explain the fundamentals and use the most frequent techniques for characterizing inorganic compounds, and interpret the results obtained.
- To understand the importance of the theoretical and practical study of Inorganic Compounds, considering their impact and contribution to Sustainability and Green Chemistry standards.

VII.– WORK TIME DISTRIBUTION AMONG ACTIVITY TYPES

| Activity | Face-to-face (hours) | Personal work (hours) | Credits (hours) |
|---------------------------------|----------------------|-----------------------|-----------------|
| Theory classes | 56 | 54 | 4,4 (110) |
| Seminars | 22 | 48 | 2,8 (70) |
| Tutorials/guided work | 6 | 14 | 0,8 (20) |
| Laboratory | 40 | 33 | 2,92 (73) |
| Classroom assignments and exams | 6 | 21 | 1,08 (27) |
| Total | 130 | 170 | 12 (300) |



VIII.- METHODOLOGY

A mixed methodology based on cooperative learning, collaborative learning and self-learning will be followed. The face-to-face activities of the course are structured in **lectures or master classes of the principles, seminar classes, tutorials and guided activities, and practical classes.**

The **theory classes** (2 hours/week throughout the course) will be expositive and in them the professor will present in an orderly manner the theoretical concepts and experimental facts that allow the student to obtain a global and comprehensive vision of the subject. At the beginning of each topic, the content and main objectives will be presented. At the end of the topic, new proposals may be proposed that allow the interrelation of contents. As support for the theoretical explanations, students will be provided with the appropriate teaching material which will be available in the UCM **Virtual Campus**.

The **seminar sessions** (1 hour/week throughout the course) will aim to apply the knowledge acquired to a set of questions/exercises. For this purpose, students will be given a list of questions/exercises related to each topic of the course. Part of the exercises will be solved in class by the professor and in other cases the resolution will be carried out by the students as personal work. Some of the questions will be related to inorganic species not described in the theory classes, so that students can use the acquired knowledge in the answer to the questions.

Short exams and questions will be required to assess the evolution of the students and the degree of achievement of the knowledge they are acquiring.

In order to carry out a more personalized follow-up of the students, and promote autonomous group work, a series of **directed activities** will be proposed. The professor will schedule **tutorials** on issues raised by the students (or by the professor), related to the syllabus of the subject.

Practical sessions in the laboratory will be developed with contents related to the theory to constitute a complement and support to the classes and seminars. The experimental laboratory sessions will take place over five days per semester (4 hours/day). In the sessions, selected experiments will be carried out among those proposed in the practical program of the subject and which are included in the laboratory practical guide.

During the practical sessions, 2 hours of seminars per semester will be given, where the necessary knowledge to carry out the planned experiences will be explained. In parallel to each practice, they will develop a report of their work, which reflects in detail each of the operations and reactions carried out, as well as the results obtained. The professor will supervise and discuss with the student the proposed work and the outline of the laboratory report, resolving any doubts that may have arisen during its development. The laboratory report will be delivered to the professor at the end of the practices of each semester, on the date that will be indicated in due time.



IX.- BIBLIOGRAPHY

■ BASIC:

At the beginning of the course, the recommended bibliography will be discussed, indicating the most relevant aspects of each text. General recommended texts are listed below:

THEORY

- Huheey J. E., Keiter E. A., Keiter R. L., Medhi O. K., *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th Ed. Pearson, 2006. 2^a ed. 1981.
- Ribas Gispert, J.: *Química de la Coordinación*, Ediciones Omega, 2000. English Version: *Coordination Chemistry*, Wiley-VCH, 2008.
- Smart, L.E.; Moore, E.A.: *Solid State Chemistry: An Introduction*, 4th ed., CRC Press, 2014.
- West A. R.: *Solid State Chemistry and its Applications*, Wiley, 2nd Edition, 2014.
- Pico, C.; López, M. L.; Veiga, M. L.: *Química del Estado Sólido*, Síntesis, 2017.
- Woodward, *Solid State Materials Chemistry* Cambridge Univ. Press. 2021.

LABORATORY

- Dann, S. E.: *Reactions and Characterization of Solids*, The Royal Society of Chemistry, London, 2000.
- Nakamoto K., *Infrared and Raman Spectra of Inorganic and Coordination Compounds (parts A and B)*, John Wiley & Sons, 2008.
- Schubert, U.; Hüsing, N.: *Synthesis of Inorganic Materials*, 2nd ed. Wiley, 2005.

The laboratory practical guide will be available in the UCM Virtual Campus.

■ COMPLEMENTARY:

- Astruc, D.: *Organometallic Chemistry and Catalysis*, Springer, 2007.
- Bochmann M.: “*Organometallics 1: Complexes with Transition Metal-Carbon σ -bonds*”, Oxford Univ. Press, 1994.
- Bochmann M.: *Organometallics 2: Complexes with Transition Metal-Carbon π -bonds*, Oxford Univ. Press, 1994.
- Cotton, F. A.; Wilkinson, G.; Murillo, C. A.; Bochmann, M.: *Advanced Inorganic Chemistry*, 6th ed., Wiley, 1995.
- Cotton, F. A., Murillo C.A., Walton R. A., *Multiple Bonds between Metal Atoms*, 3rd ed., Springer, 2005.
- Housecroft, C.E.; Sharpe, A.G.: *Inorganic Chemistry*. 4th ed., Pearson 2012. (Traducción de la 2^{ed.}, 2006).
- Miessler, G. L.; Fischer P. J., Tarr, D. A.: *Inorganic Chemistry*, 5th ed., Pearson 2013.
- Müller, H.: *Inorganic Structural Chemistry*, 2nd ed., Wiley, 2007.
- Porterfield, W. W.: *Inorganic Chemistry: An Unified Approach*, 2nd ed., Academic Press, 1999.



- Rao, C. N. R.; Raveau, B.: *Transition Metal Oxides: Structure, Properties and Synthesis of Ceramic Oxides*, Wiley, 1998.
- Wells A. F. *Structural Inorganic Chemistry*, 5th Ed. Oxford Univ. Press, 1985.
- David J Vaughan, *Sulfide Mineralogy and Geochemistry*, De Gruyter, Inc., Geochemical Society Mineralogical Society of America 2018.
- F. Liebau; *Structural chemistry of silicates: structure, bonding and classification* Springer-Verlag, cop. 1985.
- A. K. Tyagi y Raghmani S. Ningthoujam *Handbook on Synthesis Strategies for Advanced Materials, Volume-I: Techniques and Fundamentals*. Springer 2021

In addition to the basic and complementary texts, on time, students may be given a specific bibliography for each topic.

X.- EVALUATION

To access the final evaluation, participation in the different activities proposed and attendance at all laboratory sessions is mandatory. It will also be necessary for the student to have participated in at least 70% of the face-to-face activities.

The student's academic performance and the final grade for the subject will be computed according to the weights shown in each of the items listed below. All grades will be based on the absolute 10- points score and according to the scale established in the RD 1125/2003 law. This criterion will be maintained in all calls.

The final grade will be calculated as a weighted average of the evaluable activities. However, to pass the course, students must achieve the minimum required grade established for each activity. If this requirement is not met, the final grade will be the weighted average obtained, up to a maximum of 4.5 out of 10.

Students will be informed of their grades for all assessment activities (midterm exams, laboratory work, tutorials, assignments, etc.) with sufficient notice before the final exam, allowing them to plan their study time effectively. Specifically, midterm exam grades will be published within a maximum of 20 days, except for the second midterm, where the period may be shorter if the final exam date is approaching. In any case, a minimum of 7 days will always be respected between the publication of grades and the scheduled date of the final exam.

Midterm exams will be "liberatorios" (waiving the need to sit those topics in the final exam) provided the grade is 5.0 or higher. This condition applies only to the ordinary call (first official examination period).

■ WRITTEN EXAMS (theory): 60 %

The knowledge acquired by the student (CG1-MF1, CG2-MF1, CG3-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE8-MFQI1, CE9-MFQI1, CE9-MFQI2, CT3-MF1, CT5-MF1, CT6-MF1, CT11-MF1, CT12-MF1, CT12-MF2) will be evaluated by means of two mid-term ("partial") exams, one at the end of each semester, and a final exam.

The assessment of the general competences acquired in the theoretical part of the subject (CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, of the specific competences CE8-MFQI1, CE9-MFQI1 and CE9-MFQI2 and of the transversal competences CT3-MF1, CT5-MF1 and CT6-MF1, will be carried out from the



evaluation of two mid-term (“partial”) exams that will be carried out one at the end of each semester, and a final exam.

Students who pass the two mid-term exams, having obtained a minimum grade of 5.0 in each of them, will not be required to sit the final exam in the ordinary call. Those who have only passed one of mid-term exam with a grade greater than or equal to 5.0, may take the final exam, taking only the part of the partial that they have failed. In these cases, the final exam score will be averaged as long as a minimum score of 5.0 is obtained in the mid-term exam. In any case, it is essential to achieve a minimum score of 5.0 in the final exam (both in the ordinary and the extraordinary call) for this activity to contribute to the overall grade for the subject. Additionally, students who have passed the mid-term exams and wish to improve their grades may also take the final exam. In these cases, half an hour will be left for them to read the exam and, if they decide not to take it, the final grade will be the one obtained from the average of the two mid-term exams. If they choose to take the final exam, their grade will be that obtained on that exam.

■ PERSONAL WORK AND GUIDED ACTIVITIES (5 % + 5 %)

The evaluation of the individual learning work carried out by the student is carried out considering the following factors:

- Student skill in solving the proposed problems and exercises, which will be collected periodically.
- Evaluation of the student's work in the seminars.
- The work done by the students will be evaluated during the tutorials.

The evaluation of these parameters will allow knowing the degree of achievement of the general competences CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG12-MF1, of the specific competences CE8-MFQ11, CE9-MFQ11, CE9-MFQ12, CE10-MFQ12 and transversal competences CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF1, CT12 -MF2.

■ LABORATORY: 30 % (10 % exam; 20 % laboratory)

In order to pass the course, students must successfully complete and pass all activities related to the laboratory sessions, which account for 30 % of the final grade.

Attendance at all experimental sessions and laboratory seminars is mandatory and group changes can only be made for justified reasons.

Participation in the laboratory will be evaluated through the professor's assessment of the theoretical knowledge acquired, the experimental procedures used, the aptitude and attitude of the student in the sessions and the progress observed in the student.

To successfully complete the course, it is essential to achieve a minimum score of 5.0 in the set of activities related to laboratory practices.

The skills acquired in the practical part of the subject by each student will be evaluated by the teaching staff who will assess the theoretical knowledge acquired in the laboratory sessions, the experimental procedures used, their aptitude and attitude, as well as the observed progress. The presentation of the laboratory report made will be a necessary



requirement. The professor will analyze and assess the preparation of this work, the way in which the results obtained are presented and interpreted, and the capacity for synthesis.

In each semester there will be a laboratory exam that in sum constitutes a single exam and that is the one corresponding to the ordinary call. It is essential to achieve a minimum score of 4.0 in this exam for this activity to contribute to the overall laboratory grade.

The activity of laboratory practices will reinforce the knowledge acquired by the student body, both in the face-to-face theory classes and seminars as well as in the other activities of the course, which will result in the consolidation of all the general CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG9-MF1, CG10-MF2, CG11-MF1, CG12-MF1, CG13-MF1 competences, the CE8-MFQ11, CE9-MFQ11, CE9-MFQ12, CE10-MFQ11 and CE10-MFQ12 specific competences and all transverse.



ACTIVITY PLANNING – CHRONOGRAM

| SUBJECT | ACTIVITY | HOURS | GRUPS | START | END |
|--------------------------------------------------------------------------------------------------------|-----------------------|-------|-------|-------------------------------|------------------------|
| 1. Bonding in coordination compounds, Thermodynamic aspects and Stereochemistry (Units 1, 2 and 3) | Theory | 6 | 1 | 1 st week | 3 rd week |
| | Seminar | 2 | 1 | | |
| 2. Spectroscopic and Magnetic properties (Units 4 and 5) | Theory | 8 | 1 | 3 rd week | 7 th week |
| | Seminar | 4 | 1 | | |
| | Tutorial | 1 | 1 | | |
| 3. Reactivity of coordination compounds (Unit 6) | Theory | 6 | 1 | 8 th week | 10 ^a Semana |
| | Seminar | 1 | 1 | | |
| | Tutorial | 1 | 1 | | |
| 4. Basic concepts and Metal-metal bonding in coordination and organometallic compounds (Units 7 and 8) | Theory | 8 | 1 | 10 th week | 14 th week |
| | Seminar | 4 | 1 | | |
| | Tutorial | 1 | 1 | | |
| 5. Reactivity of solids. Types of reactions (Unit 9) | Theory | 3 | 1 | 15 th week | 16 th week |
| | Seminar | 1 | 1 | | |
| | Tutorial | 1 | 1 | | |
| 6. Metal oxides and sulphides (Units 10, 11 and 12) | Theory | 16 | 1 | 17 th week | 23 rd week |
| | Seminar | 5 | 1 | | |
| | Tutorial | 1 | 1 | | |
| 7. Other inorganic relevant compounds: Silicates (Unit 13) | Theory | 8 | 1 | 24 th week | 28 th week |
| | Seminar | 3 | 1 | | |
| | Tutorial | 1 | 1 | | |
| Laboratory | 5 laboratory sessions | 20 | 4 | 5 days of the first Semester | |
| | 5 laboratory sessions | 20 | 4 | 5 days of the second Semester | |
| Laboratory sessions are planning according to the established theory groups | | | | | |



SUMMARY OF ACTIVITIES

| Teaching activity | Associated competences | Professor activity | Student activity | Evaluation procedure | IP | NIP | Total | C (%) |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|-------|-------|
| Theory classes | CG1-MF1, CG2-MF1, CG3-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE8-MFQI1, CE9-MFQI1, CE9-MFQI2, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT12-MF1, CT12-MF2 | <ul style="list-style-type: none"> Preparation of the materials. Presentation of theoretical concepts. | <ul style="list-style-type: none"> Note taking. Completion of exercises. Development of new proposals. Formulation of questions and doubts. | <ul style="list-style-type: none"> Marking of the written answers to questions related to the theoretical concepts explained. | 56 | 54 | 110 | 5 % |
| Seminars | CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG12-MF1, CE8-MFQI1, CE9-MFQI1, CE9-MFQI2, CE10-MFQI2, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF1, CT12-MF2 | <ul style="list-style-type: none"> Previous preparation of the classes. Application of theory to the resolution of exercises and problems. | <ul style="list-style-type: none"> Note taking. Completion of exercises. Formulation of questions and doubts. | <ul style="list-style-type: none"> Marking of the answers (approach and result) made in writing for the resolution of the given practical exercises. | 22 | 48 | 70 | |
| Tutorials | CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE8-MFQI1, CE9-MFQI1, CE9-MFQI2, CT1-MF1, CT2-MF1, CT3-MF1, CT5-MF1, CT6-MF1, CT7-MF1, CT11-MF1, CT12-MF1, CT12-MF2 | <ul style="list-style-type: none"> Direction and supervision of the student's study and activities. Proposal of detailed resolution of exercises. | <ul style="list-style-type: none"> Consult the teacher about the conceptual and methodological difficulties encountered when studying the subject matter. Completion of exercises Student cooperation and critical analysis of assignments. | <ul style="list-style-type: none"> Marking of the answers (approach and result) made in writing for the resolution of practical exercises. | 6 | 14 | 20 | 5 % |



| Teaching activity | Associated competences | Professor activity | Student activity | Evaluation procedure | IP | NIP | Total | C (%) |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|-----|-------|-------|
| Examinations (theory) | CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CE8-MFQI1, CE9-MFQI1, CE9-MFQI2, CT3-MF1, CT5-MF1, CT6-MF1 | <ul style="list-style-type: none"> Proposal, proctoring and correction of the examinations. Student marking. | <ul style="list-style-type: none"> Preparation and completion of exams and other tests. | <ul style="list-style-type: none"> Assessment of written Exams. | 4 | 11 | 15 | 60 % |
| Laboratories | All general, specific and transversal competences | <ul style="list-style-type: none"> Explanation and supervision of the experimental procedures. Teach how to interpret and discuss the experiments carried out. | <ul style="list-style-type: none"> Conducting and analyzing experiments. Whrite a laboratory report. | <ul style="list-style-type: none"> Continuous evaluation of the student's attitude and aptitude (skills) in the laboratory. Laboratory report evaluation. | 40 | 33 | 73 | 20 % |
| Examinations (laboratory) | CG1-MF1, CG2-MF1, CG5-MF1, CG6-MF1, CG7-MF1, CG8-MF1, CG9-MF1, CG10-MF2, CG12-MF1, CE8-MFQI1, CE10-MFQI1, CE10-MFQI2, CT3-MF1, CT5-MF1, CT6-MF1 | <ul style="list-style-type: none"> Proposal, proctoring and correction of the examinations. Student marking. | <ul style="list-style-type: none"> Preparation for and completion of the exams. | <ul style="list-style-type: none"> Exams evaluation. | 2 | 10 | 12 | 10 % |

IP: In-person; NIP: non in-person (autonomous work); C: rating

