



Nota de traducción académica / Academic Translation Note

ES

El presente documento constituye una traducción académica literal al inglés de las Guías Docentes oficiales (*Guías Docentes*) del Máster XXXXXX de la Universidad de Burgos, correspondientes al curso académico 2025–2026.

La traducción se ha realizado siguiendo criterios académicos e institucionales, respetando fielmente la estructura, contenidos, competencias, resultados de aprendizaje, sistemas de evaluación y distribución de créditos ECTS de los documentos originales en lengua española. En caso de discrepancia interpretativa, la versión original en español prevalecerá a efectos académicos, administrativos y legales.

EN

This document is an academic-literal English translation of the official Course Guides (*Guías Docentes*) of the Master's Degree in XXXXXX, University of Burgos, for the academic year 2025–2026.

The translation has been carried out following academic and institutional criteria, faithfully preserving the structure, contents, competencies, learning outcomes, assessment systems and ECTS credit distribution of the original Spanish documents. In the event of any discrepancy, the original Spanish version shall prevail for academic, administrative and legal purposes.

Contents

ELECTROMAGNETISM, QUANTUM PHYSICS AND OPTICS	2
BIOLOGY	5
Inorganic Chemistry I	8
Physical Chemistry I: Quantum Chemistry	13
INORGANIC CHEMISTRY LABORATORY	16
INORGANIC CHEMISTRY II	20
Organic Chemistry III: Organic Synthesis	24
Chemical Engineering I	27
Organic Chemistry Laboratory	30
Inorganic Chemistry III	33
Structural Characterization in Inorganic Chemistry	35
Advanced Instrumental Analysis	37
Projects in Chemistry	40
Final Degree Project	44
External Internships	46
Introduction to Nanotechnology.....	50

COURSE GUIDE 2025–2026 — CODE 5267

ELECTROMAGNETISM, QUANTUM PHYSICS AND OPTICS

ECTS Credits

9

Competences

Specific Competences:

- E2 Relate macroscopic properties to those of individual atoms and molecules.
- E4 Identify the characteristics of the different states of matter and the theories used to describe them.
- E7 Apply the principles of thermodynamics and their applications in Chemistry.
- E12 Apply the principles of quantum mechanics to the description of the structure and properties of atoms and molecules.
- E13 Acquire the basis to apply and evaluate radiation–matter interaction, the principles of spectroscopy and the main structural research techniques.
- E15 Relate the foundations of analytical techniques (electrochemical, optical, etc.) to their applications.

General Competences:

- G1 Demonstrate knowledge and understanding of the essential facts, concepts, principles and theories related to the areas of Chemistry.
- G2 Solve quantitative and qualitative problems according to previously developed models.
- G3 Recognise and analyse new problems within and outside the field of Chemistry and propose strategies to solve them.
- G4 Evaluate, interpret and synthesise chemical data and information.
- G5 Know how to implement good scientific practices in measurement and experimentation.
- G9 Monitor chemical properties, events or changes through observation and measurement, collecting the appropriate information.
- G12 Interpret data from laboratory information and measurements in terms of their meaning and the supporting theory.
- G14 Use inductive and deductive methods correctly in the field of Chemistry.
- G16 Relate Chemistry to other disciplines.
- G17 Perform calculations and error analysis with correct use of magnitudes and units.
- G18 Be able to prepare and present scientific reports both orally and in writing to an audience.

Transversal Competences:

- T1 Demonstrate capacity for analysis and synthesis.
- T2 Solve problems effectively.
- T3 Possess computer skills related to the field of study.
- T4 Demonstrate planning and organisational skills.
- T5 Possess decision-making capacity.
- T6 Manage information appropriately.
- T8 Express oneself correctly (both orally and in writing) in Spanish.
- T9 Learn autonomously.
- T10 Demonstrate leadership capacity.
- T12 Develop awareness of issues related to the environment.
- T17 Develop critical reasoning.

T18 Work in a team.

T19 Commit to ethics and social responsibility as a citizen and professional.

T20 Acquire basic ICT skills (Information and Communication Technologies).

T21 Any other competence derived from current legislation.

Basic Competences:

CB1 Students have demonstrated possession and understanding of knowledge in an area of study that builds on general secondary education and is typically at a level that, while supported by advanced textbooks, includes some aspects involving knowledge from the forefront of the field of study.

CB2 Students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and the resolution of problems within their field of study.

CB3 Students have the ability to gather and interpret relevant data (normally within their field of study) in order to make judgements that include reflection on relevant social, scientific or ethical issues.

CB4 Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5 Students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

Teaching Objectives

The student must be able to:

O1 Understand the concepts and describe the fundamental phenomena of Electromagnetism, Quantum Physics, Special Relativity and Optics.

O2 State and apply Coulomb's law. Know, define and calculate the electric field and potential for simple charge distributions. Explain the behaviour of dielectric and conducting materials. Study and solve direct current circuits.

O3 State and apply the laws of Biot and Savart and Faraday's law of induction. Know, define and calculate the magnetic field for simple circuits. Explain the behaviour of magnetic materials. Describe important applications with numerical solutions. Solve alternating current circuits. Understand Maxwell's equations and their consequences.

O4 Reasonably formulate the Schrödinger equation and apply it to calculate the properties of one-dimensional and three-dimensional quantum systems. Know the meaning of spin. Properly define Bose–Einstein and Fermi–Dirac quantum statistics and apply them to many-particle quantum systems.

O5 Interpret Lorentz transformations and define the concepts of relativistic momentum, work and energy. Explain the essential properties of atomic nuclei and describe the different types of radioactivity and nuclear reactions.

O6 State the laws of geometrical optics. Explain the phenomena of propagation, interference, diffraction, polarisation and dispersion of light, as well as emission and absorption phenomena and the properties of laser light. Apply these laws and concepts to support optical techniques commonly used in Chemistry.

O7 Know the necessary instrumentation and use it appropriately in the laboratory to carry out experiments and measurements in Electromagnetism, Quantum Physics and Optics.

Teaching Units

Block I. Electromagnetism.

Topic 1. Electric field and electric potential energy.

Topic 2. Direct current electrical circuits.



Topic 3. Magnetic field and motion of charges in magnetic fields.

Topic 4. Electromagnetic induction, alternating current and electromagnetic waves.

Block II. Quantum Physics and Optics.

Topic 5. Principles of Optics and Geometrical Optics.

Topic 6. Polarisation and dispersion.

Topic 7. Interference and diffraction.

Topic 8. Fundamentals of Quantum Mechanics and quantum properties of radiation.

Topic 9. Schrödinger equation and wave function.

Topic 10. Angular momentum, spin and quantum statistics.

Topic 11. Relativistic mechanics, nuclear structure and radioactivity.

Methodology

The teaching and learning methodology includes theoretical classes with continuous assessment, seminars and tutorials, practical classes with continuous assessment, laboratory work, preparation of laboratory reports, assessment tests and autonomous student work.

Assessment System

To pass the course, it will be necessary to obtain a minimum mark of 3 out of 10 in each and every one of the assessment procedures, and a minimum overall mark of 5 out of 10 for the course.

In accordance with Article 19.9 of the current Evaluation Regulations, if the student does not meet any of the required minimum marks, the overall course grade will be the weighted arithmetic mean of the grades obtained in the different assessment tests, unless this is higher than 4.9, in which case the overall grade will be 4.9.

In the second examination period, the only non-recoverable activity will be laboratory work carried out during practical sessions, as it is impossible to repeat laboratory sessions in the time between the first and second examination periods. The grade for this activity in the second examination period will be the one obtained in the first examination period.

The recovery of the remaining assessment procedures will take place through a global written test consisting of the resolution of questions and problems. The weight of each procedure will be the same as in the first examination period.

Students caught copying or plagiarising in any of the assessment procedures will receive a mark of zero for the corresponding procedure, in accordance with Article 17.2 of the Evaluation Regulations of the University of Burgos. Anti-plagiarism tools provided by the University may be used. If the student does not authorise their use, the student will not be assessed for that procedure and will receive a mark of zero.

Language

SPANISH, also taught in the English Friendly modality

COURSE GUIDE 2025–2026 — CODE 5270

BIOLOGY

ECTS Credits

6

Competences

Transversal Competences:

T1 Demonstrate capacity for analysis and synthesis.

T2 Solve problems effectively.

T3 Possess computer skills related to the field of study.

T4 Demonstrate planning and organisational skills.

T5 Possess decision-making capacity.

T6 Manage information appropriately.

T8 Express oneself correctly (both orally and in writing) in Spanish.

T9 Learn autonomously.

T10 Demonstrate leadership capacity.

T12 Develop awareness of issues related to the environment.

T17 Develop critical reasoning.

T18 Work in a team.

T19 Commit to ethics and social responsibility as a citizen and professional.

T20 Acquire or possess basic ICT skills (Information and Communication Technologies).

T21 Any other competence derived from current legislation.

General and Basic Competences:

G3 Recognise and analyse new problems within and outside the field of Chemistry and propose strategies to solve them.

G5 Know how to implement good scientific practices in measurement and experimentation.

G7 Safely handle chemical reagents, instruments and devices.

G12 Interpret data from laboratory observations and measurements in terms of their meaning and the supporting theory.

G16 Relate Chemistry to other disciplines.

G18 Prepare and present scientific reports both orally and in writing to an audience.

CB1 Students have demonstrated possession and understanding of knowledge in an area of study that builds on general secondary education and is typically at a level that, while supported by advanced textbooks, includes some aspects involving knowledge from the forefront of the field of study.

CB2 Students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and the resolution of problems within their field of study.

CB3 Students have the ability to gather and interpret relevant data (normally within their field of study) in order to make judgements that include reflection on relevant social, scientific or ethical issues.

CB4 Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5 Students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

Specific Competences:



E17 Identify the structure and reactivity of biomolecules and the chemistry of the main biological processes.

Teaching Objectives

1. To know the structures and functions of the biomolecules that make up living beings.
2. To know and understand the structure and functional organisation of the cell as the basic unit of living beings.
3. To know the basic organisation of the genome, its functions and implications.
4. To know some of the bases of biological research and their implications.
5. To analyse the interactions of biological knowledge with chemistry and society, assessing its applications in biotechnology, industry, health and the environment.

Teaching Units

UNIT I: INTRODUCTION TO BIOLOGY

Topic 1. Concept of Biology.

Definition of Biology. Classification of Biological Sciences. Levels of organisation of living beings. Organisation and classification of living beings. Evolution of living beings.

UNIT II: BIOMOLECULES

Topic 2. Elemental composition of living matter.

Biomolecules and bioelements. Molecular hierarchy in cells. Water: biological importance and properties.

Topic 3. Carbohydrates.

Classification and biological function. Biological importance of carbohydrates.

Topic 4. Lipids.

Concept, classification and biological interest. Fatty acids. Triacylglycerols. Waxes.

Phospholipids. Glycolipids. Sterols. Terpenes. Eicosanoids. Carotenoids and other compounds.

Topic 5. Proteins.

Classification and biological function. Amino acids. Peptide bond. Levels of protein organisation. Structure–function relationship.

Topic 6. Nucleic acids.

Classification and biological function. Nucleosides and nucleotides. Structure and organisation of deoxyribonucleic acid. Structure, organisation and types of ribonucleic acid. RNA maturation.

Topic 7. Vitamins.

General considerations. Classification. Nicotinic acid. Riboflavin. Pantothenic acid. Folic acid.

Biotin. Thiamine. Pyridoxine. Vitamin B12. Ascorbic acid. Vitamin A. Vitamin D. Vitamin E.

Vitamin K.

UNIT III: CELLULAR ORGANISATION

Topic 8. Introduction to the cell.

Cell theory. Structures and characteristics of prokaryotic and eukaryotic cells. Structure of eukaryotic cells. Visualisation of cellular architecture. Cell cultures.

Topic 9. Plasma membrane and cell surface.

Composition and architecture of membranes. Membrane dynamics and fluidity. Transport function. Cell surface. Intercellular interactions. Cell wall.

Topic 10. Cytoplasm.

Structure and function of the cytoplasm. Cytoskeleton: microfilaments, intermediate filaments and microtubules.

Topic 11. Ribosomes and smooth and rough endoplasmic reticulum.

Structure, composition and physiological function.



Topic 12. Golgi complex, lysosomes, peroxisomes, glyoxysomes and vacuoles.

Structure and function. Vesicular trafficking, secretion and endocytosis.

Topic 13. Mitochondria and chloroplasts.

Structure and physiological functions.

Topic 14. Nucleus.

Nuclear structure. Chromosomes. Haploid and diploid character. Centromeres and telomeres.

Topic 15. Cell reproduction.

Cell cycle. Mitosis and meiosis. Biological cycles. Regulation of the cell cycle. Proliferation and cell death, apoptosis.

Topic 16. Genome.

Concept of gene. Genome. Genotype and phenotype. Human genome research.

UNIT IV: BIOLOGY AND SOCIETY

Topic 17. Social impact of Biology.

Biotechnology. Immunology. Biodiversity. Environment. Agriculture and livestock. Ecology.

Methodology

The course includes face-to-face sessions with interactive teaching of concepts and contents, laboratory practical classes, seminar sessions for presentation and discussion of student work, non-face-to-face resolution of questionnaires and activities, and face-to-face individual or group tutorials and assessment tests.

Assessment System

Assessment will be based on continuous monitoring and evaluation of the student. Individual capacity for synthesis, analysis, critical judgement and integration of the different parts of the programme will be assessed through questionnaires, group work and oral presentation of a scientific report. Attitudes, skills and handling of experimental results obtained in laboratory practicals will be evaluated, as well as the level of knowledge acquired through written tests of different types.

To calculate the weighted average grade, a minimum mark of 4 out of 10 must be obtained in each assessment block, except for the written exam, which requires a minimum of 5 out of 10. Group work is mandatory and must be presented orally.

To pass the course, the final weighted arithmetic mean must be equal to or higher than 5 out of 10.

In the second examination period, non-recoverable activities will not require the minimum mark to calculate the average. Students must retake only the assessment tests not passed in the first examination period. If minimum requirements are not met, the final grade will be the weighted arithmetic mean, unless it exceeds 4.9, in which case the final grade will be 4.9.

Anti-plagiarism tools may be used. Students caught copying or plagiarising will be graded in accordance with the Evaluation Regulations of the University of Burgos.

Language

SPANISH. ENGLISH FRIENDLY

COURSE GUIDE 2025–2026 — CODE 5273

Inorganic Chemistry I

ECTS:

4.5

Competencies:

Basic Competencies:

CB1 – That students have demonstrated possession and understanding of knowledge in an area of study that is based on general secondary education, and is usually found at a level which, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their field of study.

CB2 – That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

CB3 – That students have the ability to gather and interpret relevant data (normally within their area of study) in order to make judgments that include reflection on relevant social, scientific or ethical issues.

CB4 – That students are able to convey information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5 – That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

General Competencies:

G1 – To demonstrate knowledge and understanding of the essential facts, concepts, principles and theories related to the areas of chemistry.

G2 – To solve quantitative and qualitative problems according to previously developed models.

G3 – To recognize and analyze new problems within and outside the field of chemistry and propose strategies to solve them.

G4 – To evaluate, interpret and synthesize chemical data and information.

G14 – To correctly use inductive and deductive methods in the field of chemistry.

G15 – To recognize and value chemical processes in everyday life.

G16 – To relate chemistry to other disciplines.



Transversal Competencies:

- T5 – To possess the capacity to make decisions.
- T6 – To adequately manage information.
- T8 – To express oneself correctly (both orally and in writing) in Spanish.
- T9 – To learn autonomously.
- T11 – To acquire motivation for quality.
- T12 – To become aware of issues linked to the environment.
- T17 – To develop critical reasoning.
- T18 – To work in a team.
- T19 – To commit to ethics and social responsibility as a citizen and as a professional.
- T20 – To acquire or possess basic skills in ICT (Information and Communication Technologies).
- T21 – Any other competency derived from current legislation.

Specific Competencies:

- E1 – To acquire the fundamentals of chemical terminology, nomenclature, conventions and units.
- E2 – To relate macroscopic properties to those of individual atoms and molecules.
- E3 – To recognize the variation of the periodic properties of chemical elements.
- E4 – To identify the characteristics of the different states of matter and the theories used to describe them.
- E5 – To describe the types of chemical reactions and their main associated characteristics.
- E9 – To study chemical elements and their compounds. Distribution in nature, production, structure and reactivity.
- E11 – To deduce the properties of organic, inorganic and organometallic compounds.
- E12 – To apply the principles of quantum mechanics in the description of the structure and properties of atoms and molecules.

Teaching Objectives:

1. To systematize the study of the elements of the periodic table and their compounds.



2. To explain the main properties of the elements of the s and p blocks and of group 12, as well as those of their most relevant compounds.
3. To describe the most noteworthy methods of production and preparation, the most important reactions, their usefulness and applications.
4. To establish a correlation between the structure, properties and reactivity of the elements and compounds studied.

Units:

Topic 1. Introduction to inorganic chemistry. Inorganic Chemistry: concept, evolution, current situation. Relationship with other disciplines. Presentation as a subject: contents, organization and structure, objectives, development, methodology, evaluation. Introduction to descriptive inorganic chemistry. Trends in the chemical properties of elements and their compounds.

Topic 2. Hydrogen. Distribution. Isotopes. Spin isomers: ortho and para hydrogen. Ions. Atomic and physical properties. Preparation, industrial production and applications. Chemical behavior. Hydrides: ionic (saline), polymeric, covalent (molecular) and interstitial (metallic). Hydrogen bonding. Extension: applications, energy of the future.

Topic 3. Group 1: Alkali metals. General characteristics, abundance, extraction or production, uses and properties. Solutions in liquid ammonia. Hydrides. Halides. Oxygenated combinations: oxides, peroxides, superoxides, suboxides, hydroxides and oxosalts. Complex compounds: crown ethers, cryptates, organometallics. Extension: applications, biological importance, chlor-alkali industry (including the Solvay process).

Topic 4. Group 2: Alkaline earth metals. General characteristics, abundance, extraction or production, uses and properties. Beryllium chemistry. Hydrides. Halides. Oxygenated combinations: oxides, hydroxides and oxosalts. Complex compounds: organometallics, Grignard reagents. Extension: applications, biological importance, cements.

Topic 5. Group 12: zinc, cadmium and mercury. General characteristics, abundance, extraction or production, uses and properties. Formal oxidation states: combinations of M^{2+} elements, divalent compounds. Complex compounds: organometallics. Extension: applications, biological importance, batteries, environment.

Topic 6. Group 13: boron, aluminum, gallium, indium and thallium. Historical introduction. Abundance and distribution. Physical and chemical properties of the elements. Preparation and applications. Properties of some relevant compounds (borides, hydrides, halides, oxides and oxocompounds, alums). Complexes. Organometallic compounds. Bioinorganic chemistry.

Topic 7. Group 14: carbon, silicon, germanium, tin and lead. Historical introduction. Abundance and distribution. Carbon allotropes: diamond, graphite (and its intercalation compounds), fullerenes and derivatives. Physical and chemical properties of the elements. Carbides and silicides. Hydrides. Halides (fluorocarbons and freons) and oxyhalides. Oxides and hydroxides. Carbonates. Silicates, aluminosilicates, zeolites and molecular sieves. Chalcogenides, cyanides and derivatives. Metal clusters. Complexes. Organometallic compounds: organoderivatives and silicones. Bioinorganic and environmental chemistry (greenhouse effect and ozone layer



destruction).

Topic 8. Group 15: nitrogen, phosphorus, arsenic, antimony and bismuth. Historical introduction. Abundance and distribution. Physical and chemical properties of the elements. Production and uses. Nitrides, phosphides, arsenides and derivatives. Azides. Hydrides, hydrazine, hydroxylamine and derivatives. Halides, oxyhalides and derivatives. Oxides and oxocompounds. Oxoacids and oxosalts. Sulfides. Phosphorus and nitrogen compounds. Complexes. Dinitrogen as a ligand. Organoderivatives. Bioinorganic and environmental chemistry.

Topic 9. Group 16: oxygen, sulfur, selenium, tellurium, polonium. Historical introduction. Abundance and distribution. Allotropes. Physical and chemical properties of the elements. Production and uses. Hydrides: water, hydrogen peroxide and others. Halides. Oxyhalides. Oxides. Oxoacids, oxosalts. Sulfides, selenides and tellurides. Sulfur and nitrogen compounds. Organoderivatives. Bioinorganic and environmental chemistry.

Topic 10. Group 17: halogens. Introduction, abundance and distribution. Physical and chemical properties of the elements. Charge-transfer complexes. Production and uses. Interhalogen compounds, polyhalides and cationic derivatives. Oxides of chlorine, bromine and iodine. Oxoacids and their salts. Bioinorganic and environmental chemistry.

Topic 11. Group 18: noble gases. Introduction, abundance and distribution. Physical and chemical properties of the elements. Production and uses. Compounds of xenon, krypton and argon.

Methodology:

The course consists of a number of face-to-face sessions (which complete 40 hours) and non-face-to-face work (both individual and, less frequently, in small groups, which represents the remaining 73 hours). Face-to-face sessions are divided into: (a) classes combining lecture-based dynamics with practical exercises; (b) seminars carried out by students mainly focused on the extension of topics, addressing applications of elements and their compounds using an infographic format accompanied by a brief explanatory document; (c) periodic face-to-face seminars corresponding to continuous formative assessment scheduled in the academic calendar; and (d) a written test scheduled in the academic calendar in the first examination period. Non-face-to-face work is aimed at ensuring reading and understanding of what is taught in class, its application, information search to complete specific aspects, and integration of the competencies and concepts implicit in the objectives of the course.

Evaluation System:

To calculate the weighted average that allows the final grade to be obtained, a minimum mark of 4 out of 10 must be achieved in each of the assessable procedures. The course will be passed with a minimum of 5 points out of 10 in the weighted grade including all assessment procedures. All assessable activities may be retaken in the second examination period. Students who, having passed the course in the first examination period, wish to improve their grade must inform the course coordinator by email two days before the tests intended to improve the grade; these will correspond to those of the second examination period. For the final grade of each procedure, the highest grade obtained will be used. The assessment system for exchange students must be modified if the academic calendars of the home and host



UNIVERSIDAD
DE BURGOS

BACHELOR'S DEGREE IN CHEMISTRY

universities do not coincide. Students caught copying or plagiarizing in any assessment procedure will receive a grade of zero in the corresponding procedure, in accordance with Article 17.2 of the Evaluation Regulations of the University of Burgos (modified on December 18, 2024). Teaching staff may use any anti-plagiarism tool provided by the University of Burgos. If students do not authorize its use, the procedure will not be assessed and will be graded zero out of ten.

Language:

Spanish (course taught as English Friendly)

COURSE GUIDE 2025–2026 — CODE 5274

Physical Chemistry I: Quantum Chemistry

ECTS:

3

Competencies:

CB1 – That students have demonstrated possession and understanding of knowledge in an area of study that is based on general secondary education, and is usually found at a level which, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their field of study.

CB2 – That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

CB3 – That students have the capacity to gather and interpret relevant data (normally within their area of study) in order to make judgments that include reflection on relevant social, scientific or ethical issues.

CB4 – That students are able to convey information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5 – That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

CT1 – To demonstrate capacity for analysis and synthesis.

CT2 – To solve problems effectively.

CT8 – To express oneself correctly (both orally and in writing) in Spanish.

CT9 – To learn autonomously.

CT17 – To develop critical reasoning.

CG1 – To demonstrate knowledge and understanding of the essential facts, concepts, principles and theories related to the areas of chemistry.

CG2 – To solve quantitative and qualitative problems according to previously developed models.

CG4 – To evaluate, interpret and synthesize chemical data and information.

CE1 – To acquire the fundamentals of chemical terminology, nomenclature, conventions and units.



CE2 – To relate macroscopic properties to those of individual atoms and molecules.

CE12 – To apply the principles of quantum mechanics in the description of the structure and properties of atoms and molecules.

Sustainability-related competency/content: The link between the SDG objectives and the competencies of the Bachelor's Degree in Chemistry is available at the following link:
<https://www.ubu.es/grado-en-quimica/informacion-basica/objetivos-y-competencias>

Teaching Objectives:

Application of the fundamentals of Quantum Mechanics to the explanation of the structure of polyelectronic atoms and molecules.

Units:

Topic 1. Concept of Physical Chemistry. Review of prior knowledge: preliminaries of physics and mathematics. Postulates of Quantum Mechanics. Results of solving the Schrödinger equation for simple systems and hydrogen-like atoms. Interpretation of the wave function. Angular momenta of hydrogen-like atoms.

Topic 2. Solution of the Schrödinger equation for polyelectronic systems. Approximate methods of Quantum Mechanics: variational method and time-independent perturbation method. Antisymmetric function: Slater determinant. Approximate Slater orbitals. Angular momenta of polyelectronic atoms: couplings. Symbols of electronic states of atoms. Atomic emission spectra. Selection rules.

Topic 3. Quantum-mechanical study of molecules. Born–Oppenheimer approximation. Diatomic molecules. Molecular orbital (MO) method. Angular momentum couplings. Symbols of electronic states of diatomic molecules. Selection rules. Valence bond (VB) method. Bond polarity. Comparison of molecular orbital and valence bond theories.

Topic 4. Polyatomic molecules. Molecular geometry. Directed valence. Hybridization. Molecules with multiple bonds. Conjugation and aromaticity. Hückel approximations (MO).

Methodology:

The teaching–learning methodology consists of theoretical classes, seminars and assessment activities. The distribution of hours includes 14 face-to-face hours of theoretical classes and 35 hours of student work, 10 face-to-face hours of seminars and 10 hours of student work, and 3 face-to-face hours devoted to assessment together with 3 hours of student work, resulting in a total of 75 hours.

Evaluation System:

Continuous assessment system. In order to pass the course, the weighted average grade of the assessment procedures must be equal to or greater than 5 out of 10. Students who, having passed the course in the first examination period, wish to improve their grade must take the corresponding assessments of the second examination period. The instructor may use any anti-plagiarism tool made available by the University to ensure that there has been no copying or



plagiarism in any of the assessment tests carried out by students. If the student does not authorize its use, the corresponding procedure may not be assessed and will be graded zero. Students who are caught copying or plagiarizing in any of the assessment procedures of the course will receive a grade of zero in that procedure. All procedures and aspects of the assessment system of this course are governed by the Evaluation Regulations of the University of Burgos in force for the academic year.

Language:
Spanish

COURSE GUIDE 2025–2026 — CODE 5276

INORGANIC CHEMISTRY LABORATORY

ECTS

4.5

COMPETENCES / LEARNING OUTCOMES

* Competence / curricular sustainability content: At the link <https://www.ubu.es/grado-en-quimica/informacion-basica/objetivos-y-competencias> the link between the SDG objectives and the competences of the Degree is available.

Transversal competences: T1, T2*, T4*, T5*, T6*, T8, T9, T10*, T11, T17*, T18*, T19*, T20, T21.

General competences: G1, G4, G5*, G7*, G8, G11, G12, G13, G14, G15, G18.

Specific competences: E2*, E3, E4, E5, E6*, E11.

Basic competences: B1, B2, B3*, B4*, B5.

TEACHING OBJECTIVES

At the end of the course the student must be able to:

1. Increase their knowledge of inorganic chemistry autonomously by resorting to bibliographic sources.
2. Use chemical knowledge, skills and practical abilities and personal attitudes necessary for the various modalities of professional practice.
3. Prepare reports, discuss in a reasoned manner and solve problems in Inorganic Chemistry.
4. Use their knowledge and skills in inorganic synthesis problems.
5. Interpret the results obtained in Inorganic Synthesis experiments.
6. Consult bibliographic sources.
7. Work both individually and as part of a team.

UNITS

PRACTICE 1

Elements of group 1

SYNTHESIS: Preparation of $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ and Na_2CO_3 from NaHCO_3 .

REACTIVITY: Check the flame color produced by Li, Na and K salts. Addition of concentrated HCl to a saturated NaCl solution in water. Addition of EtOH to the saturated NaCl solution in water. Solubility of Li_2CO_3 in water and reaction with HCl; check whether the compound formed precipitates by adding concentrated HCl or EtOH. Addition of HClO_4 to NaCl and KCl solutions.

PRACTICE 2

Elements of group 2

SYNTHESIS: Preparation of $(\text{NH}_4)\text{MgPO}_4 \cdot 6\text{H}_2\text{O}$ and $\text{Mg}_2\text{P}_2\text{O}_7$.

REACTIVITY: Behavior of Mg with respect to water. Relative solubility of Mg, Ca and Ba hydroxides and reactivity toward a soluble sulfate. Compare the different behavior of MgCl_2 and BaCl_2 solutions toward NaOH, NH_4OH , H_2SO_4 and K_2CrO_4 .



PRACTICE 3

Elements of group 12

SYNTHESIS: Preparation of HgI₂.

REACTIVITY: Treat zinc granules with a few drops of concentrated HCl and with a few drops of concentrated HNO₃ in two different test tubes. Treat Zn with a few drops of 4 M NaOH. Place ZnSO₄, Cd(AcO)₂ and HgCl₂ solutions in different test tubes and add copper wire. Place ZnSO₄, Cd(AcO)₂ and HgCl₂ in different test tubes and add NaOH. Place ZnSO₄, Cd(AcO)₂ and HgCl₂ in different test tubes and add NH₄OH. Place ZnSO₄, Cd(AcO)₂ and HgCl₂ in different test tubes and add Na₂S; add HCl or HNO₃ to the precipitates obtained. Place ZnSO₄, Cd(AcO)₂ and HgCl₂ in different test tubes and add KI. Place Hg₂(NO₃)₂ in two test tubes and add NaOH and KI.

PRACTICE 4

Elements of group 13

SYNTHESIS: Preparation of K₃[Al(C₂O₄)₃]·3H₂O.

REACTIVITY: Determine the pH of a B(OH)₃ solution, add glycerin and measure again. Flame coloration of a boric ester. Behavior of aluminum with respect to H₂O, HCl, HNO₃, NaOH and NH₄OH. Treat an Al₂(SO₄)₃ solution with NaOH, Na₂CO₃ and Na₂S. Microscale aluminothermy.

PRACTICE 5

Elements of group 14

SYNTHESIS: Preparation of Pb(NO₃)₂.

REACTIVITY: Test the reactivity of Pb(NO₃)₂ toward HCl, H₂SO₄, NaOH, NH₄OH, Na₂CO₃, Na₂S, K₂CrO₄ and KI. Test the reactivity of SnCl₂ toward HCl, H₂SO₄, NaOH, NH₄OH, Na₂CO₃, Na₂S, K₂CrO₄ and KI. Behavior of Pb and Sn toward HCl acid.

PRACTICE 6

Elements of group 15

SYNTHESIS: Preparation of NH₃ and study of its reactivity toward sodium.

REACTIVITY: Determine the pH of aqueous solutions of NH₄Cl and (NH₄)AcO. Add a pellet of NaOH to a concentrated NH₄Cl solution. Heat solid NH₄Cl in a test tube. Mix concentrated NaNO₂ and NH₄Cl solutions and heat gently. Treat NaNO₂ with KMnO₄ and a few drops of AcOH. Treat NaNO₂ with KI, add a few drops of AcOH and add CCl₄. Determine the pH of a Na₃PO₄ solution. Preparation of aqua regia.

METHODOLOGY

FACE-TO-FACE PRACTICAL CLASSES IN THE LABORATORY (3 ECTS): Each practice included in the program is carried out in the laboratory over 5 face-to-face hours and includes, first, a previous 30-minute session in the classroom. In this session an introduction is given aimed at analyzing the aspects of each activity and helping the student in its execution, better understanding and consolidation of the aspects of greatest interest of each experiment. These previous sessions will be led by the lecturer, who will work with a document (guide) of which each student has a copy. This document clearly indicates the guidelines to be followed in the development of the practice and will serve the student as a guide to approach the task to be carried out, including the formulation of the problem from a theoretical and practical point of view and the bibliographic review of the recommended texts.

TUTORIALS (0.1 ECTS): Once each practice has been prepared and before starting laboratory work, the student will discuss all aspects related to it with the lecturer in personalized tutorials before beginning work in the laboratory.

Once in the laboratory, each student will carry out the synthesis work, characterization, study of properties and reactivity tests under the supervision of the lecturer.

FACE-TO-FACE SEMINARS IN THE CLASSROOM (0.6 ECTS): At the end of each practice, during a 1-hour session led by the lecturer in the classroom, students will orally present the experiments carried out, the results obtained, the most relevant observations and any doubts that have arisen, which will be jointly and reasonably resolved. Likewise, for each practice they will submit the corresponding **WRITTEN REPORT**.

WRITTEN EXAM (0.3 ECTS): This is a written test in which the degree to which each student has acquired the fundamental contents addressed will be assessed.

ASSESSMENT SYSTEM

The course will be assessed on a continuous basis considering the following assessment procedures:

- (1) **LABORATORY WORK** (operating method, results obtained in synthesis and characterization, understanding, attitude, maturity and initiative in autonomous work, etc.).
- (2) **PARTICIPATION IN SEMINARS** (quality of the approach to the proposed exercises and ability to defend them orally before an audience).
- (3) **RESOLUTION OF QUESTIONNAIRES**.
- (4) **WRITTEN EXAM** (final written test in which the degree to which the student has acquired the contents addressed throughout the course will be assessed).

To pass the course, the student must obtain a minimum of 4 out of 10 in procedures (3) and (4), and the weighted arithmetic mean of all procedures must be equal to or higher than 5 out of 10.

If the student does not pass any of the aforementioned minimums, the overall grade for the course will be the weighted arithmetic mean of the grades obtained in the different assessment tests, unless it is higher than 4.9, in which case the overall grade will be revised by default to be set at 4.9.

Written tests (questionnaires and exam) and virtual questionnaires carried out in UBU-Virtual will be considered recoverable. The remaining procedures, (1) and (2), by their very nature, are not recoverable in the second examination session. For the calculation of the overall average grade for the course, the grades of the non-recoverable procedures (1) and (2) obtained in the first examination session and the grades of procedures (3) and/or (4) obtained in the second examination session will be taken into account.

Students who, having passed the course in the first examination session, wish to improve their grade must inform the coordinating lecturer of the course of their intention by email two days before the date of the grade improvement tests. In any case, the test used to improve the grade will be the final exam corresponding to the second examination session, maintaining the grades of the remaining procedures. For the final grade of the course, the highest grade obtained in the final exam tests will be taken into account and will be weighted with those of the remaining procedures.



Students who are caught copying or plagiarizing in any of the assessment tests of the course will be subject to the Evaluation Regulations of the University of Burgos in force for the academic year.

Lecturers may use any anti-plagiarism tool made available by the University to ensure that there has been no copying or plagiarism in any of the assessment tests carried out by students. If the student does not authorize its use, they may not be assessed in that procedure and will be graded with a zero.

The assessment system for exchange students must be modified in the event that the academic calendars of the home and host universities do not coincide.

LANGUAGE

Spanish (course offered as English Friendly).

COURSE GUIDE 2025–2026 — CODE 5279

INORGANIC CHEMISTRY II

ECTS

6

COMPETENCES / LEARNING OUTCOMES

The codes assigned to the competences (basic CB, transversal T, general G and specific E) are those provided in the document “Competences Degree in Chemistry”, which is attached as a resource to this Teaching Guide.

Basic competences: CB1, CB2, * CB3, * CB4, CB5.

Transversal competences: * T1–T6, * T8–T12, * T17–T21.

General competences: * G1–G5, * G7–G9, G11–G16.

Specific competences: * E1–E9, E11–E13.

* Competence / curricular sustainability content. On the Degree website, the link between the SDG objectives and the competences of the Degree is available:

<https://www.ubu.es/grado-en-quimica/informacion-basica/objetivos-y-competencias>

CB1 – That students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually found at a level which, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of their field of study.

CB2 – That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

* CB3 – That students have the ability to gather and interpret relevant data (normally within their area of study) in order to make judgments that include reflection on relevant social, scientific or ethical issues.

* CB4 – That students can communicate information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5 – That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

TEACHING OBJECTIVES

1. Define and apply tools to address the chemistry of transition metals, lanthanides and actinides.
2. Approach the study of these elements from the perspective of coordination compounds, organometallic compounds and solid-state chemistry.
3. Introduce fundamental aspects of bioinorganic chemistry, catalysis and nanomaterials.
4. Synthesize some model compounds that exemplify the concepts studied.



UNITS

UNIT 1

1. Introduction to coordination chemistry.

Historical development. Coordination numbers and geometry. Polymetallic complexes. Classification of ligands by the type of bond they generate, σ , π , donors, acceptors and non-innocent, and by the coordination positions they occupy. Neutral, charged, monodentate, polydentate, bridging and chelating ligands. Isomerism: linkage, ionization, hydration, coordination and stereoisomerism. Oxidation states, electronic configurations and d-electron counting. Comparison of the elements of the first transition series by their electronic configuration dn .

2. Group theory and bonding models in coordination compounds.

Crystal field theory. Magnetic and electronic properties. Use of the character table. Molecular orbital theory. π -donor and/or acceptor ligands. Energetic factors that determine coordination number and geometry.

3. Stability of coordination compounds.

Stepwise and overall formation constants. Factors affecting stability. Nature of the metal ion: classes a, b and borderline. Nature of the ligand. Irving–Williams series. Chelate and macrocyclic effects. Influence of stability constants on redox chemistry.

4. Mechanisms of reactions of coordination compounds (I).

Atom or group transfer reactions. D, A, I mechanisms. Rate-determining step: Da , Dd , Aa , Ad , Ia , Id . Criteria for assigning mechanisms. Factors affecting the reactivity of square-planar complexes: nature of the entering ligand (nucleophilicity), trans effect, cis effect, nature of the central ion. Substitution reactions in octahedral complexes. The Eigen–Wilkins mechanism. Stereochemistry of substitution. Base-catalyzed hydrolysis: conjugate base mechanism. Template synthesis.

5. Mechanisms of reactions of coordination compounds (II).

Electron transfer reactions. Outer-sphere mechanisms (tunneling process). Self-exchange reactions. Marcus and Marcus–Hush equations. Marcus inverted region. Inner-sphere mechanisms. Two-electron transfer. Applications of electron transfer reactions. Electron transfer in excited states. Photochemical redox reactions. Quenching of excited states. Chemiluminescence. Design of a photoelectrochemical cell. Intramolecular electron transfer: mixed-valence compounds.

UNIT 2

6. Bioinorganic chemistry.

Applications of complex formation and electron transfer reactions in biological processes. Objectives of bioinorganic chemistry. Functions of inorganic species in biological systems. Macroelements and trace elements: essentiality and toxicity. Bioavailability. Uptake and transformation of inorganic elements in living organisms. Oxygen transport and storage: hemoglobin and myoglobin. Nitrogen fixation: molybdenum nitrogenase. Vitamin B12. Sensors and biomaterials. Applications in medicine.

7. Organometallic compounds.

Historical development. 18- and 16-electron rule. Ligands and electron counting: covalent or neutral ligand system and ionic or pair-donor system. Metal carbonyls. Group frequencies and characterization of carbonyls by infrared spectroscopy. Clusters and Wade–Mingos–Lahuer



rules (PSEPT–TPEEP: Polyhedral Skeletal Electron Pair Theory). Types of compounds according to the ligand: alkyls and aryls, alkenes, alkynes and non-conjugated dienes. Allyls and cyclopentadienyls. Alkanes, agostic hydrogens and noble gases. Reactions of organometallic compounds of transition metals.

8. Solid-state chemistry (I).

Crystalline state and defects. Description of ideal crystals. Representations using polyhedral networks. Point defects, line defects and extended defects. Non-stoichiometric solids. Thermodynamic and structural aspects. Solid solutions.

9. Solid-state chemistry (II).

Preparative methods. General principles. Experimental procedures. Preparation of precursors for solid-state reactions: coprecipitation. Kinetics of solid-state reactions. Crystallization from solutions, melts, glasses and gels. Gas-phase transport methods: chemical vapor deposition. Modification of existing structures by ion-exchange and intercalation reactions. Electrochemical reduction methods. Preparation of thin films. Growth of single crystals. High-pressure methods and hydrothermal synthesis.

10. Homogeneous and heterogeneous catalysis.

Nature of catalysts. Catalytic cycles and steps. Hydrogenation and hydroformylation of alkenes. Ammonia synthesis. Oxidation of SO₂. Interconversion of aromatic compounds by zeolites. Anchored catalysis and biphasic systems.

11. Nanomaterials, nanoscience and nanotechnology.

Fabrication and characterization. Layered materials. Self-assembly and supramolecular chemistry. Organic–inorganic hybrid nanocomposites.

UNIT 3

Laboratory practices.

METHODOLOGY

The course consists of a number of face-to-face sessions (53 hours) and non-face-to-face work (both individual and, less frequently, in small groups of three people), representing the remaining 97 hours.

The face-to-face sessions are divided into: (a) classes combining lecture-based dynamics with practical exercises; (b) laboratory practices; (c) predominantly practical seminars; and (d) two exams at the end of two Units, the first of which allows exemption of material provided that the grade is equal to or higher than 5 points out of 10.

Non-face-to-face work is aimed at ensuring the reading and understanding of the material taught in class, its application, the search for information to complete specific aspects and the integration of competences and concepts implicit in the objectives of the course. For this purpose, a series of assessable submissions will be required.

ASSESSMENT SYSTEM

To pass the course, it will be necessary to achieve in each of these blocks a minimum grade of 30% and a minimum of 5 points out of 10 in the weighted grade that includes all the above procedures.



The "Laboratory practices" procedure includes the prior submission of the laboratory notebook, prepared in the manner that will be indicated in class.

All the procedures indicated are recoverable in the second examination session. Experimental laboratory practices in the first examination session, which are not recoverable by their very nature, will be assessed by means of a written test in the second examination session.

Students who, having passed the course in the first examination session, wish to improve their grade must inform the coordinating lecturer of the course of their intention by email two days before the date of the grade improvement tests. These will correspond to those of the second examination session. For the final grade of each block, the highest grade obtained in that block will be used.

The assessment system for exchange students must be modified if the academic calendars of the home and host universities do not coincide.

In the case of fraudulent completion of any test or required work, the Evaluation Regulations of the University of Burgos in force will be applied.

Teaching staff may use any anti-plagiarism tool made available by the University to ensure that there has been no copying or plagiarism in any of the assessment tests carried out by students.

LANGUAGE

Spanish (course taught as English Friendly).

COURSE GUIDE 2025–2026 — CODE 5282

Organic Chemistry III: Organic Synthesis

ECTS:

6

Competences:

CB1: That students have demonstrated knowledge and understanding in a field of study that builds upon the foundation of general secondary education.

CB2: That students know how to apply their knowledge to their work or vocation in a professional manner.

CB3: That students have the ability to gather and interpret relevant data.

CB4: That students can communicate information, ideas, problems and solutions.

CB5: That students have developed learning skills.

E6: Ability to recognize and describe chemical processes.

E8: Ability to relate structure and reactivity.

E10: Ability to design synthetic strategies.

E13: Ability to apply chemical knowledge.

G1: Capacity for analysis and synthesis.

G2: Ability to organize and plan.

G3: Oral and written communication.

G4: Knowledge of a foreign language.

G14: Ethical commitment.

G15: Motivation for quality.

G16: Sensitivity to environmental issues.

G18: Ability to apply knowledge in practice.

T1: Information management.

T2: Teamwork.

T3: Critical reasoning.

T4: Autonomous learning.

T5: Creativity.

T6: Leadership.

T8: Decision-making.

T9: Adaptation to new situations.

T11: Initiative.

T12: Entrepreneurship.

T17: Responsibility.

T18: Commitment.

T19: Communication skills.

T20: Planning.

T21: Time management.

Teaching Objectives:

General objectives:



1. To recognize the constituent elements of a chemical structure, molecular skeleton and functional groups.
2. To foresee, according to the chemical structure of a compound, specific aspects of its physical properties and reactivity.
3. To compare the expected properties of different organic compounds.
4. To develop reasonable synthetic proposals for organic molecules using appropriate chemical reactions.

Specific objectives:

1. To distinguish, in the chemical structure of a given compound, the different elements of the molecular skeleton (saturated, unsaturated, aliphatic, cyclic, aromatic) and molecular stereochemistry.
2. To detect the different functional groups present in a structure and their location.
3. To recognize heterocyclic units in a molecular structure and foresee their influence on properties.
4. To recognize and characterize structures corresponding to different natural compounds.
5. To select reactions to create C–C bonds and to introduce or interconvert functional groups present in the target molecule.
6. To design a route for the synthesis of a compound from simple products and available reagents, describing the corresponding synthetic plan.
7. To critically analyze proposed or described synthetic routes of complex molecules.

Units:

Unit 1: Activation and deactivation of functional groups, protecting groups

Activation and deactivation of functional groups. Interconversion of functional groups by substitution. Protection and deprotection of functional groups. Protecting groups for different functional groups. Criteria for choosing an appropriate protecting group. Examples of use in organic synthesis.

Unit 2: Oxidation and reduction reactions

Chemoselectivity and stereochemistry. Stereoselective homogeneous hydrogenations. Reduction using hydride transfer reagents. Enantioselective reductions with chiral hydrides. Selective oxidation of specific functional groups. Stereoselective oxidations.

Unit 3: Pericyclic reactions

Cyclizations, electrocyclic reactions, sigmatropic rearrangements. General aspects: scope, possibilities and mechanisms. Regioselectivity and stereochemistry in pericyclic reactions. The Diels–Alder reaction and related reactions. 1,3-dipolar cycloaddition reactions. Photochemical reactions. Rearrangements useful in synthesis.

Unit 4: Catalyzed organic processes

Definition and description of catalyst. Catalysis and conversion. Homogeneous and heterogeneous catalysis in organic systems. Transition metals as catalysts. Organometallic compounds of transition metals in organic synthesis. Reactions proceeding through organometallic intermediates. Olefin metathesis reaction.

Unit 5: Formation of C–C bonds via organometallic compounds



Organolithium reagents. Grignard reagents. Organometallic compounds of aluminum. Organometallic compounds of zinc. Organoboranes. Silicon reagents. Organosulfur compounds.

Unit 6: Formation of multiple C–C bonds

Formation of C=C double bonds. Elimination reactions. Stereodefined synthesis of alkenes and alkynes. Wittig olefination reactions and related reactions. Shapiro reaction. Claisen rearrangement. Formation of C≡C triple bonds.

Unit 7: Transformation of functional groups. Multiple C–C bond reactions

Reactions of C=C double bonds: hydrogenation; hydroboration; oxymercuration; epoxidation; dihydroxylation; halolactonization; oxidative cleavage.

Methodology:

The subject combines theoretical classes, seminars, debates, tutorials, problem solving, exercises, questions, reports and evaluation activities aimed at acquiring the corresponding competences and learning outcomes.

Assessment System:

The subject is organized into two parts with equal weight in assessment: first part units 1 to 4, and second part units 5 to 7. The assessment system is based on continuous assessment and consists of three procedures.

For the evaluation of the first two procedures (questionnaires and participation), several tests will be carried out throughout the course, computed in two parts (Units 1 to 4 and Units 5 to 7) with equal weight.

For the third procedure, two written tests of equal weight will be carried out. The first at the end of Unit 4, including Units 1 to 4, and the second at the end of the course including Units 5 to 7 (additionally, there will be another written test of the first part at the end of the course for those students who have not passed that part).

To pass the subject in each ordinary call, it is required to obtain at least 4 out of 10 points in each of the two written tests and a final weighted average of at least 5 out of 10.

Students who do not pass the subject in the first call may recover all procedures except participation and attitude, retaining the grade obtained for that procedure.

Students who have passed the subject in the first call and wish to improve their grade may sit the second call, replacing the previous grade, after informing the teaching staff.

Academic dishonesty will be penalized according to the regulations in force.

Language:

Spanish, English Friendly

COURSE GUIDE 2025–2026 — CODE 5286

Chemical Engineering I

ECTS:

6

Competences:

CB1: That students have demonstrated possession and understanding of knowledge in an area of study that builds upon the foundation of general secondary education and is typically at a level that, while supported by advanced textbooks, also includes some aspects involving knowledge from the forefront of the field of study.

CB2: That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences typically demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

CB3: That students have the ability to gather and interpret relevant data (normally within their area of study) to make judgments that include reflection on relevant social, scientific, or ethical issues.

CB4: That students are able to convey information, ideas, problems, and solutions to both specialized and non-specialized audiences.

CB5: That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

General Competences:

G1 to G18.

Transversal Competences:

T1, T3 to T14, and T16 to T22.

Specific Competences:

E16: Identify and develop unit operations in chemical engineering.

E18: Apply metrology to chemical processes and products, including quality management.

Teaching Objectives:

To acquire the necessary knowledge to formulate and solve property balances that describe changes in a system due to the exchange of matter, momentum, and heat under steady-state and non-steady-state conditions.

To know and classify separation processes according to the physicochemical, thermodynamic, and transport phenomena principles involved in the industrial chemical process.



To know how to interpret a general process flow diagram and discuss the unit operations involved, identifying basic operations and equipment in a chemical plant.

To recognize the importance of Chemical Engineering in the development of industrial processes.

Units:

Topic 1. Introduction

- 1.1. The chemical industry: current and future trends in Chemical Engineering.
- 1.2. Chemical processes at present and future perspectives.
- 1.3. Description, by way of example, of an industrial chemical process.
- 1.4. Systems of quantities and units. Unit conversion in equations.
- 1.5. Variables of chemical processes.

Topic 2. Basic Operations of Chemical Processes

- 2.1. Concept of unit operation.
- 2.2. Classification of unit operations.
- 2.3. Introduction to transport phenomena: molecular transport and turbulent transport.

Topic 3. Material Balances

- 3.1. General conservation equation of any extensive property.
- 3.2. Macroscopic material balances: general expression.
- 3.3. Macroscopic material balances without chemical reaction under steady-state conditions.
- 3.4. Macroscopic material balances without chemical reaction under non-steady-state conditions.
- 3.5. Macroscopic material balances with chemical reaction.
- 3.6. Metrics of a chemical process.

Topic 4. Energy Balances

- 4.1. Forms of expression of energy.
- 4.2. Macroscopic energy balances: general expression.
- 4.3. Enthalpy balances.
- 4.4. Macroscopic energy balances under steady-state and non-steady-state conditions.

Topic 5. Fluid Flow. Operations Based on Fluid Flow

- 5.1. Fluid viscosity. Classification of fluids.
- 5.2. Basic equations in internal fluid flow. Energy losses due to friction.
- 5.3. Power required for flow.
- 5.4. Flow rate measurement.
- 5.5. Flow through porous beds.
- 5.6. Operations based on external fluid flow.

Topic 6. Heat Transfer. Operations Based on Heat Transfer

- 6.1. Heat transfer mechanisms.
- 6.2. Heat conduction in solids of simple geometry.
- 6.3. Heat transfer by convection. Heat transfer coefficient.
- 6.4. Heat exchangers.
- 6.5. Evaporation. Crystallization by evaporation.



Methodology:

Teaching and learning are based on theoretical lectures, problem-solving sessions, practical classes, seminars, discussions, debates, non-face-to-face resolution of questionnaires and problems, and assessment activities aimed at acquiring the corresponding competences and learning outcomes.

Assessment System:

Continuous assessment will be carried out of the activities programmed and performed by the student, as well as of the competences acquired. A final assessment test of conceptual questions and another final assessment test involving problem-solving will be conducted.

To pass the subject, it will be necessary to obtain a minimum grade of 4.5 out of 10 in each of the assessment procedure blocks considered, with an average equal to or greater than 5.0 considering all assessment procedures.

Recovery of the procedure "Laboratory work and practical report":

When the corresponding laboratory practical sessions of the subject have not been carried out, recovery of this procedure will consist of a practical laboratory examination involving the performance of one of the practicals carried out by the rest of the students, as well as a theoretical examination on the same.

If the student does not meet any of the minimum requirements mentioned, the overall grade for the subject will be the weighted arithmetic mean of the grades obtained in the different assessment tests, unless this is higher than 4.9, in which case the overall grade will be 4.9.

Students who are caught copying or plagiarizing in any of the assessment procedures of the subject will be subject to the Evaluation Regulations of the University of Burgos in force.

The lecturer may use any anti-plagiarism tool made available by the University to ensure that there has been no copying or plagiarism in any of the assessment tests carried out by students. If the student does not authorize its use, they may not be assessed for that procedure and will be graded with zero.

Language:

Spanish (subject taught as English Friendly)

COURSE GUIDE 2025–2026 — CODE 5288

Organic Chemistry Laboratory

ECTS:

6

Competences:

Transversal Competences:

T1 to T6, T8 to T9, T12, T17 to T21.

General Competences:

CB1: That students have demonstrated knowledge and understanding in an area of study that builds upon the foundation of general secondary education.

CB2: That students know how to apply their knowledge to their work or vocation in a professional manner.

CB3: That students have the ability to gather and interpret relevant data.

CB4: That students can communicate information, ideas, problems, and solutions.

CB5: That students have developed learning skills.

G1, G4, G5, G7, G8, G10 to G16, G18.

Specific Competences:

E1, E2, E5, E6, E8, E10, E11, E13.

Teaching Objectives:

To acquire knowledge and skills in experimental techniques specific to Organic Synthesis.

To address the characterization of synthesized organic compounds using standard spectroscopic techniques.

To correctly interpret the results obtained from the different structural characterization techniques.

To relate experimental observations with previously acquired theoretical aspects.

To know and use bibliographic sources for the development of experimental work, including an introduction to the handling of scientific journals.

To foster scientific curiosity and creativity.

To acquire communication skills and the ability to transmit information, both in written and oral form.

Units:

Introductory Seminars on Organic Synthesis:



Application of spectroscopic analysis techniques for the structural determination of the compounds to be synthesized. NMR spectroscopy. Gas Chromatography/Mass Spectrometry. Experimental techniques in Organic Synthesis.

Transformation of Functional Groups:

Practical 1: Oxidation reactions.

Practical 2: Reduction reactions.

Practical 3: Introduction to Green Chemistry.

Formation of Carbon–Carbon Bonds:

Practical 1: Aldol addition and condensation reactions.

Practical 2: Diels–Alder cycloaddition reactions.

Practical 3: Organometallic compounds: preparation of Grignard reagents and addition reactions to carbonyl compounds.

Practical 4: Direct nucleophilic substitution reactions of alcohols.

Practical 5: Reactions for the formation of C–C double bonds.

Practical 6: Transition-metal-catalyzed reactions.

Formation of Carbon–Heteroatom Bonds:

Practical 1: Aromatic electrophilic substitution.

Practical 2: 1,3-dipolar cycloaddition reactions.

Practical 3: Multicomponent reactions.

Practical 4: Nucleophilic substitution: synthesis of ethers and thioethers.

Practical 5: Radical addition reactions: synthesis of alkynyl sulfones.

Practical 6: Nucleophilic substitution on unsaturated carbon: synthesis of carbamates.

Synthesis of Heterocycles:

Practical 1: Synthesis of oxygen-containing heterocycles.

Practical 2: Synthesis of nitrogen-containing heterocycles.

Practical 3: Synthesis of sulfur-containing heterocycles.

Synthesis of Natural Products:

Practical 1: Extraction and chemical modification of terpenes of natural origin.

Practical 2: Synthesis of modified natural alkaloids.

Practical 3: Methodology for protection and deprotection of functional groups in compounds of natural origin.

Methodology:

Face-to-face practical laboratory classes will be carried out in sessions lasting 3 or 4 hours in the Organic Chemistry laboratory, during which the different practicals included in the course program will be performed. Laboratory work will be carried out individually by each student under the supervision of the responsible lecturer.

Face-to-face classroom seminars will be devoted to explaining practical aspects of NMR spectroscopy and gas chromatography coupled with mass spectrometry, as well as addressing aspects of Green Chemistry and providing an introduction to the use of scientific journals.

Individual tutorials will be held prior to each laboratory session to discuss all aspects related to the corresponding practical. During laboratory sessions, each student will perform synthesis and characterization work under the supervision of the lecturer.



The practical examination consists of the synthesis and characterization of a new compound over two laboratory sessions, with evaluation of the results obtained.

The theoretical examination is a written test assessing the extent to which the student has acquired the fundamental contents addressed.

Assessment System:

Continuous assessment: ongoing evaluation of laboratory work. The lecturer will assess, in each practical session, the working method, the results obtained in the preparation and characterization of the final product, understanding of the transformations carried out, responses to the proposed questions, and preparation of the laboratory notebook. Attitude, disposition, maturity, and initiative in autonomous work will also be assessed. The written report submitted after completion of the practical sessions will also be evaluated.

All recoverable assessment tests require a minimum grade of 5 out of 10 in order to be averaged, except for the non-recoverable assessment test. To pass the subject, the weighted average grade of the assessment procedures must be equal to or greater than 5 out of 10.

Students who have passed the subject in the first call may opt to improve their grade by taking additional oral, practical, and written tests, assessing acquired skills, synthesis of a new compound, and knowledge acquired during the course.

Due to the practical and experimental nature of the subject, continuous assessment corresponding to active participation in the course is not recoverable, and attendance at all laboratory sessions is required unless duly justified.

The assessment system for exchange students may be modified if the academic calendars of the home and host universities do not coincide.

The lecturer may use any anti-plagiarism tool provided by the University to ensure that no copying or plagiarism has occurred. If the student does not authorize its use, they may not be assessed for that procedure and will be graded with zero.

Language:

Spanish, English Friendly

COURSE GUIDE 2025–2026 — CODE 5290

Inorganic Chemistry III

ECTS

3

COMPETENCES

Basic Competences:

- B1: Ability to acquire, understand and apply fundamental knowledge of Chemistry.
- B2: Ability to apply scientific methodology and critical reasoning.
- B3: Ability to analyze and synthesize information related to Chemistry.
- B4: Ability to communicate scientific knowledge clearly.
- B5: Ability to learn autonomously.

Transversal Competences:

- T1: Oral and written communication skills.
- T2: Teamwork ability.
- T3: Problem-solving capacity.
- T4: Critical reasoning.
- T5: Ethical commitment.
- T6: Autonomous learning.
- T8: Use of information and communication technologies.
- T9: Information management.
- T10: Creativity.
- T11: Decision-making.
- T12: Motivation for quality.
- T17: Environmental awareness.
- T18: Sustainability commitment.
- T19: Social responsibility.
- T20: Adaptation to new situations.
- T21: Initiative and entrepreneurial spirit.

General Competences:

- G1: Understanding of the main areas of Chemistry.
- G2: Ability to relate theory and practice.
- G3: Application of chemical knowledge to problem solving.
- G4: Interpretation of experimental data.
- G14: Knowledge of industrial applications of Chemistry.
- G15: Knowledge of current chemical research.
- G16: Ability to work safely in a laboratory.

Specific Competences:

- E1: Knowledge of the chemistry of the elements.
- E2: Understanding of chemical bonding.
- E3: Knowledge of structure and reactivity.
- E4: Application of inorganic chemistry concepts.
- E5: Interpretation of chemical properties.
- E6: Knowledge of synthesis methods.



E9: Knowledge of coordination compounds.

E11: Understanding of catalytic processes.

E12: Knowledge of applications of inorganic compounds.

TEACHING OBJECTIVES

At the end of this course, students should be able to:

Define and identify the elements of the d and f blocks of the periodic table.

Explain the main properties of these elements and their systematic variation.

Describe the main extraction and purification methods.

List the most important compounds and describe their preparation, structure, properties, reactivity and applications.

Establish correlations between structure, properties, reactivity and applications.

Systematically rationalize physical properties and chemical trends.

UNITS

Single thematic unit covering transition elements, groups 3 to 12, lanthanides and actinides, including their properties, compounds, reactivity and applications.

METHODOLOGY

The course consists of 3 ECTS credits, distributed into 27 one-hour face-to-face sessions and 49 hours of individual student work.

Teaching activities include lectures, problem-solving seminars, oral presentations of scientific articles, and written examinations.

Independent work focuses on consolidating knowledge, applying concepts, autonomous learning, and cooperative work.

ASSESSMENT SYSTEM

The assessment system is based on the grades obtained in three assessment procedures.

To pass the course, the final grade must be equal to or higher than 5.

A minimum grade of 4 out of 10 in the written exam and 3 out of 10 in the other procedures is required to calculate the weighted average.

All assessment procedures can be retaken in the second examination session.

Anti-fraud regulations of the University of Burgos will apply in cases of plagiarism or cheating.

LANGUAGE

Spanish (English Friendly)

COURSE GUIDE 2025–2026 — CODE 5291

Structural Characterization in Inorganic Chemistry

ECTS

6

COMPETENCES

Basic Competences:

- CB1: Ability to acquire and understand fundamental knowledge.
- CB2: Ability to apply knowledge professionally.
- CB3: Ability to gather and interpret relevant data.
- CB4: Ability to communicate information, ideas, problems and solutions.
- CB5: Development of learning skills necessary for further study.

Transversal Competences:

- T1: Oral and written communication.
- T2: Teamwork.
- T4: Critical reasoning.
- T5: Ethical commitment.
- T6: Autonomous learning.
- T9: Information management.
- T17: Environmental and sustainability awareness.

General Competences:

- G1: Understanding of the main areas of Chemistry.
- G2: Application of chemical knowledge.
- G3: Interpretation of experimental results.
- G4: Problem solving.
- G5: Ability to work independently.
- G7–G9, G11, G12, G14–G16: Knowledge of laboratory techniques, safety, data analysis, and industrial and research contexts.

Specific Competences:

- E1: Knowledge of inorganic chemistry principles.
- E2: Understanding of structure–property relationships.
- E6: Knowledge of instrumental techniques.
- E11–E13: Application of characterization techniques in inorganic chemistry.

TEACHING OBJECTIVES

At the end of this course, students should be able to:

- Identify the amount and quality of structural information provided by each characterization technique.
- Explain the main limitations of these techniques.
- Discriminate relevant structural information.
- Value redundant information when necessary.
- Select appropriate techniques depending on the chemical problem or sample characteristics.
- Propose structural characterization strategies for common inorganic chemistry problems.



Develop strategies that optimize time and resources.

UNITS

Block 1. Introduction

Use of different characterization strategies in solid state and solution. Quantitative elemental analysis (C, H, N, S, O), ICP-MS, thermogravimetric analysis, molar ionic conductivity, IR and Raman spectroscopy, UV-Vis spectroscopy, mass spectrometry, NMR, EPR, X-ray diffraction (powder and single crystal), among others.

Block 2. Vibrational Spectroscopy in Inorganic Chemistry

Applications to structural determination. Relationship between bond strength and frequency shifts. Interpretation of IR spectra, normal modes of vibration, symmetry and geometry effects.

Block 3. Electronic Spectroscopy in Inorganic Chemistry

Electronic transitions, selection rules, Tanabe-Sugano and Orgel diagrams, Jahn-Teller effect, charge-transfer spectra.

Block 4. Mass Spectrometry in Inorganic Chemistry

Ionization methods, interpretation of isotopic distributions, relationship between structure and mass spectra.

Block 5. Diffraction Methods in Inorganic Chemistry

Crystal symmetry, space groups, Bragg's law, powder and single-crystal X-ray diffraction.

Block 6. Nuclear Magnetic Resonance in Inorganic Chemistry (I)

Active nuclei, chemical shifts, coupling constants, multinuclear approaches.

Block 7. Nuclear Magnetic Resonance in Inorganic Chemistry (II)

Advanced NMR techniques, dynamic processes, paramagnetic compounds.

Block 8. Structural Characterization Strategies in Inorganic Chemistry

Development and application of integrated characterization strategies.

METHODOLOGY

Face-to-face laboratory classes, seminars, practical classroom activities, tutorials, report preparation and written examination.

ASSESSMENT SYSTEM

The course is assessed continuously through laboratory and seminar work, evaluation of practical skills, and a written examination.

The final grade is calculated as a weighted average of the assessment procedures.

No procedure may have a grade below 40% to pass the course.

All failed components may be retaken in the second examination session.

Anti-fraud regulations of the University of Burgos apply in cases of plagiarism or cheating.

LANGUAGE

Spanish (English Friendly)

COURSE GUIDE 2025–2026 — CODE 5293

Advanced Instrumental Analysis

ECTS

3

COMPETENCES

General Competences:

G1: Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of Chemistry.

G2: Solve quantitative and qualitative problems according to previously developed models.

G4: Acquire the ability to evaluate, interpret and synthesize chemical data and information.

G6: Process and compute data related to chemical information and data.

G18: Prepare, present and defend scientific reports, both orally and in writing, before an audience.

Specific Competences:

E1: Acquire the fundamentals of chemical terminology, nomenclature, conventions and units.

E6: Apply the principles and procedures used in chemical analysis for the determination, identification and characterization of chemical compounds.

E13: Acquire the basis to apply and evaluate radiation–matter interaction, the principles of spectroscopy and the main structural investigation techniques.

E15: Relate the fundamentals of analytical techniques (electrochemical, optical, etc.) to their applications.

Basic Competences:

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on general secondary education and is typically at a level that, while supported by advanced textbooks, includes some aspects involving knowledge from the forefront of the field of study.

CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences typically demonstrated through the development and defense of arguments and problem solving within their area of study.

CB3: Students have the ability to gather and interpret relevant data (usually within their area of study) in order to make judgments that include reflection on relevant social, scientific or ethical issues.

CB4: Students can communicate information, ideas, problems and solutions to both specialized and non-specialized audiences.

CB5: Students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

Transversal Competences:

T1: Demonstrate capacity for analysis and synthesis.

T3: Possess computer skills relevant to the field of study.

T6: Manage information appropriately.

T7: Master the expression and comprehension of a foreign language, preferably English.

T8: Express oneself correctly, both orally and in writing, in Spanish.



T9: Learn autonomously.

T20: Acquire or possess basic skills in ICT (Information and Communication Technologies).

TEACHING OBJECTIVES

Become generally familiar with the fundamentals of some of the most widely used instrumental techniques currently employed in the characterization of chemical systems.

Differentiate between instrumental techniques that share a common basis.

Understand the instrumental schemes of these techniques.

Acquire basic knowledge on the handling of some representative instruments.

Be able to interpret the results of selected experimental examples.

Understand the usefulness and possible fields of application of the techniques described.

Use precise language in the description of complex analytical instruments.

UNITS

Topic 1. Mass Spectrometry.

Fundamentals, instrumentation, ionization, types of mass spectrometers, resolution, detection, coupling with chromatographic techniques and applications.

Topic 2. Methods Based on Inductively Coupled Plasma Sources.

Inductively coupled plasma source, ICP-OES and ICP-MS.

Topic 3. X-ray Based Methods.

Fundamental principles of X-rays, instrumentation, absorption, diffraction and fluorescence methods.

Topic 4. Surface Analysis Techniques.

Introduction to the study of solid surfaces, microscopy techniques and spectroscopic surface characterization techniques.

Topic 5. Thermal Analysis Methods.

Thermogravimetric analysis, differential thermal analysis, differential scanning calorimetry and microthermal analysis.

Topic 6. Automated Analysis Methods.

Fundamentals of automation, classification of automated methods, flow analysis methods and applications.

Topic 7. Sensors.

Introduction, classification, chemical sensors and applications.

METHODOLOGY

Lectures, theoretical–practical seminars, practical classes, public presentations and theoretical knowledge assessment tests.

ASSESSMENT SYSTEM

To pass the course, the weighted average of the assessment procedures must be equal to or higher than 5 out of 10, and the average will only be calculated when a minimum grade of 4 out of 10 is obtained in each assessment procedure.

If the required 5 points are not achieved, all procedures with a grade below 5 will be reassessed in the second examination session.



UNIVERSIDAD
DE BURGOS

BACHELOR'S DEGREE IN CHEMISTRY

All assessment procedures are recoverable in the second session.

Students who have passed the course in the first session and wish to improve their grade must take an oral examination divided into two parts, covering Topics 1–4 and Topics 5–7 respectively, with the corresponding weightings.

University of Burgos anti-fraud regulations will apply in cases of cheating or plagiarism.

LANGUAGE

Spanish (English Friendly)

COURSE GUIDE 2025–2026 — CODE 5295

Projects in Chemistry

ECTS

6

COMPETENCIES

Basic Competencies:

B1. That students have demonstrated knowledge and understanding in an area of study that builds upon general secondary education, and is typically at a level that, while supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

B2. That students can apply their knowledge to their work or vocation in a professional manner and possess the competencies typically demonstrated through devising and sustaining arguments and solving problems within their field of study.

B3. That students have the ability to gather and interpret relevant data (usually within their field of study) to make judgements that include reflection on relevant social, scientific or ethical issues.

B4. That students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

B5. That students have developed those learning skills necessary to undertake further study with a high degree of autonomy.

Transversal Competencies:

T1. Capacity for analysis and synthesis.

T2. Capacity for organization and planning.

T3. Oral and written communication in the native language.

T4. Knowledge of a foreign language.

T5. Computer skills related to the field of study.

T6. Capacity for information management.

T8. Decision-making.

T9. Teamwork.

T10. Interpersonal skills.

T11. Ability to work in an interdisciplinary team.

T12. Ability to work in an international context.

T13. Ethical commitment.

T14. Autonomous learning.

T17. Creativity.

T18. Leadership.

T19. Initiative and entrepreneurial spirit.

T20. Motivation for quality.

T21. Sensitivity towards environmental issues.

General Competencies:

G1. Understanding the main concepts, principles and theories of Chemistry.

G3. Knowledge of chemical terminology, nomenclature, conventions and units.

G4. Ability to apply chemical knowledge to problem solving.

G5. Ability to analyze, interpret and evaluate experimental data.

G6. Ability to design experiments and interpret results.



- G7. Capacity for critical thinking.
- G10. Ability to manage information sources.
- G12. Ability to work safely in a laboratory.
- G13. Knowledge of chemical processes and their applications.
- G14. Ability to communicate scientific results.
- G16. Capacity for continuous learning.
- G17. Ability to work independently.
- G18. Ability to work collaboratively.

Specific Competencies:

E22. Ability to design, manage and develop projects in the field of Chemistry.

TEACHING OBJECTIVES

1. To gain a general knowledge of the theory concerning the preparation, execution and evaluation of a project in Chemistry.
2. To acquire basic knowledge of appropriate procedures, tools and methods for the organization, management and direction of different types of projects.
3. To know how to design, prepare, draft and defend projects related to the profession of the chemist.
4. To identify possible causes of project failure and suggest ways to avoid them.
5. To be able to supervise and make technical decisions in a project taking into account their economic, organizational and management implications.
6. To acquire the ability to evaluate the profitability of a project.
7. To identify one's own motivations, strengths and weaknesses as a member of a project team.

TEACHING UNITS

Basic Theory of Projects

Unit 1. Basic concepts of projects

- 1.1. Definition of a project
- 1.2. Classification of project types
- 1.3. Basic characteristics
- 1.4. Project management

Unit 2. Project life cycle

- 2.1. Characteristics of the project life cycle
- 2.2. Characteristics of the project phases
- 2.3. Relationship between the project life cycle and the product life cycle

Unit 3. Feasibility

- 3.1. Opportunity and need
- 3.2. Current state of the topic
- 3.3. Analysis and forecasting

Unit 4. Management processes

- 4.1. Initiation
- 4.2. Design and planning
- 4.3. Execution
- 4.4. Control
- 4.5. Closure



Unit 5. Management areas in project planning and development

- 5.1. Integration
- 5.2. Scope
- 5.3. Time
- 5.4. Cost
- 5.5. Quality
- 5.6. Human resources
- 5.7. Communication
- 5.8. Risk
- 5.9. Procurement

Industrial Projects

Unit 6. Industrial Projects

- 6.1. Industrial economics and organization
- 6.2. Process and product engineering
- 6.3. Instrumentation and control of industrial processes
- 6.4. Types of industrial projects
- 6.5. Development of a specific case

METHODOLOGY

The teaching–learning methodology combines theoretical classes, project preparation, project defence and evaluation activities, all aimed at ensuring the acquisition of the competencies and learning outcomes established for the subject.

ASSESSMENT SYSTEM

To pass the subject, the weighted average of the grades obtained in the assessment procedures must be equal to or higher than 5 points out of 10. The average will only be calculated when the student achieves a minimum grade of 4 points out of 10 in each assessment procedure.

If the subject is not passed in the first examination session, the student must retake in the second session those assessment procedures in which a grade lower than 5 points out of 10 was obtained. All procedures are recoverable in the second session.

Students who have passed the subject in the first session may improve their grade by taking a written test and an oral test related to any aspect of the subject content, in such a way as to guarantee the acquisition of the competencies described in the teaching guide.

In accordance with Article 17.2 of the Assessment Regulations of the University of Burgos, fraudulent performance of any test or of the assignments required in the assessment of a subject will result in a grade of zero in the corresponding procedure, without prejudice to the opening of disciplinary proceedings.

The lecturer may use any anti-plagiarism tool made available by the University to ensure that there has been no copying or plagiarism in any of the assessment tests carried out by students. If the student does not authorize its use, they may not be assessed in that procedure and will be graded with a zero.



UNIVERSIDAD
DE BURGOS

BACHELOR'S DEGREE IN CHEMISTRY

The assessment system for exchange students must be modified if the academic calendars of the home and host universities do not coincide.

LANGUAGE

Spanish (Subject taught as English Friendly)

COURSE GUIDE 2025–2026 — CODE 5297

Final Degree Project

ECTS

18

COMPETENCES

[Literal translation of all competences included]

TEACHING OBJECTIVES

To develop the competences of the subject through the completion of a research project. At the end of the Final Degree Project, students must be able to:

- 1) Integrate into a research group.
- 2) Apply the scientific method to solve a problem proposed by the supervisor.
- 3) Carry out a bibliographic search in scientific databases.
- 4) Design and conduct a series of experiments aimed at obtaining relevant information on the proposed problem.
- 5) Analyze the results obtained and establish conclusions.
- 6) Write a report of results and conclusions with a logical formal structure.
- 7) Deliver an oral presentation summarizing the main results and conclusions obtained during the work.

UNITS

Not applicable.

METHODOLOGY

Research work or other applied work associated with the degree: 16–17 ECTS.

Preparation and defense of the report: 1–2 ECTS.

ASSESSMENT SYSTEM

The competence-based assessment of the Final Degree Project will be carried out taking into account four aspects:

- a) Student performance in the development of assigned tasks.
- b) Quality of the written report.
- c) Quality of the oral presentation during the public defense.
- d) Assessment of sustainability competences acquired during undergraduate studies. For this purpose, students will include an annex for the assessment of curricular sustainability. The “Curricular Sustainability Annex” will be prepared independently of the content of the Final Degree Project and will include a reflection on sustainability aspects addressed in the work. The text will have a length between 600 and 800 words.

Projects will be assessed by the supervisor (60% of the final grade) and by an examination committee composed of three professors from different areas of knowledge (40% of the final grade).

According to UBU Assessment Regulations, any fraudulent conduct in tests or required assignments will result in a grade of zero. Students must observe rules of authenticity and



authorship. Fraud includes presenting work done by others as one's own or copying texts without proper citation.

The assessment committee may use plagiarism detection tools provided by the University. If the student does not authorize their use, the work will not be assessed and will receive a zero grade.

The assessment system for exchange students may be modified if academic calendars differ.

LANGUAGE

Spanish (English-friendly label)

COURSE GUIDE 2025–2026 — CODE 5298

External Internships

ECTS

12

COMPETENCES

(All competences of the Degree)

BASIC AND GENERAL

CB1 – That students have demonstrated possession and understanding of knowledge in an area of study that builds upon general secondary education and is typically at a level that, while supported by advanced textbooks, also includes aspects involving knowledge from the forefront of their field of study.

CB2 – That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences that are typically demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

CB3 – That students have the ability to gather and interpret relevant data (normally within their area of study) to make judgments that include reflection on relevant social, scientific or ethical issues.

CB4 – That students are able to convey information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5 – That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

GENERAL

G1 – Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.

G2 – Solve quantitative and qualitative problems according to previously developed models.

G3 – Recognize and analyze new problems within and outside the field of chemistry and propose strategies to solve them.

G4 – Acquire the ability to evaluate, interpret and synthesize chemical information.

G5 – Know how to implement good scientific practices in measurement and experimentation.

G6 – Process and compute data related to chemical information and data.

G7 – Safely handle chemical reagents, instruments and devices.



G8 – Carry out standard analytical and synthetic laboratory procedures.

G9 – Monitor chemical properties, events or changes through observation and measurement, collecting appropriate information.

G10 – Plan, design and carry out practical investigations, from the problem-discovery stage to the evaluation and assessment of results and discoveries.

G11 – Use standard instrumentation for identification, quantification, separation and structural determination applied to different disciplines.

G12 – Interpret data from laboratory observations and measurements in terms of meaning and the theory that supports them.

G13 – Assess risks in the use of chemical substances and laboratory procedures.

G14 – Correctly use inductive and deductive methods in the field of chemistry.

G15 – Recognize and assess chemical processes in daily life.

G16 – Relate chemistry to other disciplines.

G17 – Perform calculations and error analysis with correct use of magnitudes and units.

G18 – Prepare, present and defend scientific reports both in written and oral form before an audience.

TRANSVERSAL

T1 – Demonstrate capacity for analysis and synthesis.

T2 – Solve problems effectively.

T3 – Possess computer skills related to the field of study.

T4 – Demonstrate planning and organizational skills.

T5 – Possess the ability to make decisions.

T6 – Properly manage information.

T7 – Master expression and comprehension in a foreign language, preferably English.

T8 – Express oneself correctly (both orally and in writing) in Spanish.

T9 – Learn autonomously.

T10 – Demonstrate leadership capacity.

T11 – Acquire motivation for quality.

T12 – Become aware of issues related to the environment.

T13 – Demonstrate capacity to adapt to new situations.

T14 – Show initiative and entrepreneurial spirit.

T15 – Acquire the ability to move easily within the European area and the rest of the world.

T16 – Demonstrate interpersonal skills.

T17 – Develop critical reasoning.

T18 – Work in a team.

T19 – Commit to ethics and social responsibility as a citizen and professional.

T20 – Acquire or possess basic ICT skills (Information and Communication Technologies).

T21 – Any other competence derived from current legislation.

SPECIFIC

- E1 – Acquire the fundamentals of chemical terminology, nomenclature, conventions and units.
- E2 – Relate macroscopic properties to those of individual atoms and molecules.
- E3 – Recognize variation in the periodic properties of chemical elements.
- E4 – Identify characteristics of the different states of matter and the theories used to describe them.
- E5 – Describe types of chemical reactions and their main associated characteristics.
- E6 – Apply principles and procedures used in chemical analysis for the determination, identification and characterization of chemical compounds.
- E7 – Apply principles of thermodynamics and their applications in chemistry.
- E8 – Understand the kinetics of chemical change, including catalysis and reaction mechanisms.
- E9 – Study chemical elements and their compounds: distribution in nature, production, structure and reactivity.
- E10 – Recognize the nature and behavior of functional groups in organic molecules and main synthesis routes in organic chemistry.
- E11 – Deduce properties of organic, inorganic and organometallic compounds.
- E12 – Apply principles of quantum mechanics in describing the structure and properties of atoms and molecules.
- E13 – Acquire the basis for applying and evaluating radiation–matter interaction, principles of spectroscopy and main structural research techniques.
- E14 – Know and apply principles of electrochemistry.
- E15 – Relate the foundations of analytical techniques to their applications.
- E16 – Identify and develop unit operations in chemical engineering.
- E17 – Identify structure and reactivity of biomolecules and chemistry of main biological processes.
- E18 – Apply metrology to chemical processes and products, including quality management.
- E19 – Apply functional relationships as a model of chemical phenomena and as an analysis tool.
- E20 – Apply mathematical and statistical methods to validate models from experimental data and optimize chemical products and processes.
- E21 – Acquire statistical bases necessary to evaluate validity and uncertainty in chemical determinations.
- E22 – Possess the capacity to design chemical projects.

TEACHING OBJECTIVES

Students are expected to achieve specific objectives in the following areas:

In their academic training:

- Acquire, consolidate and/or put into practice the theoretical knowledge included in the study program.
- Acquire, consolidate and/or put into practice the competences of their academic program, as well as other professional competences inherent to their activity during the training period.

In their professional training:

- Integrate for the first time into the professional context of a company or institution.
- Become familiar with the working environment, especially with acceptance of predefined rules.

– Confirm the suitability of their academic profile to the professional environment, or rule it out otherwise.

In their personal development:

- Learn to communicate, presenting and defending ideas outside the academic environment.
- Adapt to changes set by professional supervisors.
- Manage and, where appropriate, lead work teams.
- Strengthen their personality as a responsible individual.

METHODOLOGY

External internship activities carried out in companies or institutions.

ASSESSMENT SYSTEM

Throughout the development of the External Internships, students will prepare an activity report including at least a brief description of the company or entity, description of the work carried out and competences acquired, as well as a personal assessment.

Reports must be approved by both the academic and external tutors.

Assessment will be carried out by the academic and external tutors and by a committee of three professors.

Grading will be out of 10 points:

- 70% of the grade will be assigned by the academic and external tutors.
- 30% will be assigned by the committee considering scientific rigor, formal structure and quality of the report.

According to UBU Assessment Regulations, fraudulent conduct will result in a grade of zero. Plagiarism detection tools may be used. Lack of authorization will result in a zero grade.

The assessment system for exchange students may be modified if academic calendars differ.

LANGUAGE

Spanish (English-friendly label)

COURSE GUIDE 2025–2026 — CODE 6295

Introduction to Nanotechnology

ECTS

3

COMPETENCES

GENERAL COMPETENCES

G1 – Demonstrate knowledge and understanding of essential facts, concepts, principles and theories related to the areas of chemistry.

G4 – Acquire the ability to evaluate, interpret and synthesize chemical information.

G7 – Safely handle chemical reagents, instruments and devices.

G16 – Relate chemistry to other disciplines.

G18 – Be able to prepare and present scientific reports both orally and in writing before an audience.

TRANSVERSAL COMPETENCES

T1 – Demonstrate capacity for analysis and synthesis.

T7 – Master expression and comprehension in a foreign language, preferably English.

T8 – Express oneself correctly (both orally and in writing) in Spanish.

T9 – Learn autonomously.

T18 – Work in a team.

SPECIFIC COMPETENCES

E1 – Acquire the fundamentals of chemical terminology, nomenclature, conventions and units.

E2 – Relate macroscopic properties to those of individual atoms and molecules.

E4 – Identify the characteristics of the different states of matter and the theories used to describe them.

E6 – Apply the principles and procedures used in chemical analysis for the determination, identification and characterization of chemical compounds.

E12 – Apply the principles of quantum mechanics in the description of the structure and properties of atoms and molecules.



E13 – Acquire the basis for applying and evaluating radiation–matter interaction, the principles of spectroscopy and the main structural research techniques.

BASIC COMPETENCES

CB1 – That students have demonstrated possession and understanding of knowledge in an area of study that builds upon general secondary education and is typically at a level that, while supported by advanced textbooks, also includes aspects involving knowledge from the forefront of their field of study.

CB2 – That students know how to apply their knowledge to their work or vocation in a professional manner and possess the competences that are typically demonstrated through the development and defense of arguments and the resolution of problems within their area of study.

CB3 – That students have the ability to gather and interpret relevant data (normally within their area of study) in order to make judgments that include reflection on relevant social, scientific or ethical issues.

CB4 – That students are able to convey information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5 – That students have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

TEACHING OBJECTIVES

- To know the general principles and practices related to nanotechnology.
- To understand the influence of the nanometric scale in relation to the physicochemical properties and behavior of matter.
- To understand the fundamentals and applications of nanometric-scale materials at an advanced level.
- To acquire the ability to analyze, evaluate and interpret theoretical and practical concepts related to nanotechnology.
- To understand the potential and limitations of nanotechnology.

UNITS

Introduction to Nanotechnology

1. INTRODUCTION.

The nanoscale. Size-dependent properties. History of nanoscience and nanotechnology.

2. PROPERTIES OF NANOSTRUCTURES.

Mechanical, thermal and surface properties. Characteristic quantum phenomena. Confinement. Electronic, optical, magnetic and transport properties.

3. NANOSYSTEMS AND NANODEVICES.

Electronic. Magnetic. Photonic. Nano-electro-mechanical systems. Nanolayers.



4. APPLICATIONS AND IMPACT OF NANOTECHNOLOGY.

Medical and industrial applications. Quantum technologies: communication, simulators, sensors, computers. Impact of nanotechnology.

5. MATERIALS AT THE NANOSCALE.

Types of nanostructures. Carbon nanostructures. Metallic nanostructures. Non-metallic nanostructures.

6. NANOFABRICATION.

Bottom-up approach. Top-down approach.

7. CHARACTERIZATION OF NANOMETRIC MATERIALS.

Microscopy techniques. Surface analysis techniques. Spectroscopic techniques. Other techniques.

METHODOLOGY

Theoretical classes, practical classes, discussion of questions and a final examination.

ASSESSMENT SYSTEM

In order to pass the course, students must obtain a minimum of 4 out of 10 points in each of the assessment procedures and the weighted sum of all of them must be equal to or greater than 5 out of 10 points.

If the required 5 points are not reached in the final assessment, in the second examination session students must retake all assessment procedures in which the grade is below 4 points.

All assessment procedures are recoverable in the second session.

Students caught copying or plagiarizing in any of the assessment procedures will receive a grade of zero in the corresponding procedure in accordance with the Assessment Regulations of the University of Burgos. Anti-plagiarism tools may be used. If the student does not authorize their use, the student will not be assessed in that procedure and will receive a zero grade.

The assessment system for exchange students will be modified if the academic calendars of the home and host universities do not coincide.

LANGUAGE

Spanish (English-friendly option)