VNIVERSITAT DE VALÈNCIA

**Course Guide**
**34211 Materials Science**

# COURSE DATA

## DATA SUBJECT

**Code:** 34211
**Name:** Materials Science
**Cycle:** Undergraduate Studies
**ECTS Credits:** 6
**Academic year:** 2025-26

## STUDY (S)

| Degree | Center | Acad. year | Period |
|---|---|---|---|
| 1110 - Degree in Chemistry | Facultat de Química | 4 | First quarter |

## SUBJECT-MATTER

| Degree | Subject-matter | Character |
|---|---|---|
| 1110 - Degree in Chemistry | Chemical Industry | COMPULSORY |

## COORDINATION

BLASCO LLOPIS SALVADOR

# SUMMARY

This subject tries to establish the bases to understand the relationship between the real structure (including amorphous materials, lattice defects and microstructure) and the properties of the materials. The application of phase and transformation diagrams of different types of materials is studied. The electronic structure of materials is described, which will be used for the interpretation of their electronic properties.

The transport, mechanical, electrical, magnetic and optical properties are studied, referring to the most relevant aspects of them for each type of material (metallic materials and alloys, ceramic materials, glass, polymer materials and composite materials).

Once the properties of each material have been studied, the subject will address their potential applications.

# PREVIOUS KNOWLEDGE

## RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

### OTHER REQUIREMENTS

This is a interdisplicinar subject, therefore it is related to all the subjects studied previously. It manage all the concepts studied in previous courses to interpret the relation between structure and properties of the different types of materials.

## COMPETENCES / LEARNING OUTCOMES

### 1108 -

Ability to recognise chemical elements and their compounds: preparation, structure, reactivity, properties and applications.

Demonstrate ability to work in teams both in interdisciplinary teams and in an international context.

Demonstrate a commitment to ethics, equality values and social responsibility as a citizen and as a professional.

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

Demonstrate leadership and management skills, entrepreneurship, initiative, creativity, organization, planning, control, leadership, decision making and negotiation.

Demonstrate the ability to adapt to new situations.

Express oneself correctly, both orally and in writing, in any of the official languages of the Valencian Community.

Have basic skills in the use of information and communication technology and properly manage the information obtained.

Interpret the variation of the characteristic properties of chemical elements according to the periodic table.

Recognise and analyse new problems and plan strategies to solve them.

Recognise and evaluate chemical processes in daily life.

Relate the macroscopic properties and the properties of individual atoms and molecules, including macromolecules (natural and synthetic), polymers, colloids and other materials.

Relate theory and experimentation.

Solve qualitative and quantitative problems following previously developed models.

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay

audiences.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

## 1110 - Degree in Chemistry

Act autonomously in learning, making well-founded decisions in various contexts, forming judgements based on experimentation and analysis, and applying knowledge to new situations.

Address new problems and propose strategies to solve them.

Apply metrology in chemical processes, including quality management.

Collaborate effectively in work teams, assume responsibilities and leadership roles, and contribute to collective improvement and development.

Communicate effectively both orally and in writing, adapting to the context and audience.

Comprender la empresa como una realidad sistémica e inherentemente compleja, reconociendo e identificando las dimensiones consustanciales a los sistemas de gestión empresarial y los condicionantes, externos e internos, que inciden sobre su gestión.
Ser capaces de categorizar y jerarquizar las decisiones organizativas, e interpretar los procesos de adopción de decisiones en el ámbito de los modelos teóricos. Discriminar y manejar los principales métodos y técnicas disponibles para la elaboración del diagnóstico estratégico. Poder elaborar un diagnóstico estratégico básico.

Comprender las particularidades contables que presenta la regulación jurídico-mercantil de las empresas, relacionando la legislación mercantil aplicable a los distintos tipos operaciones societarias con la contabilidad de los hechos económicos que se regulan. Aprender a relacionar las leyes mercantiles que se ocupan de los concursos de acreedores con la contabilidad, adquiriendo práctica en el manejo de determinados textos legales vigentes.

Contribute to the design, development and implementation of solutions that respond to social demands, using the Sustainable Development Goals as a reference.

Demonstrate critical and self-critical thinking, considering professional ethics, moral values and social implications of the different activities carried out throughout the degree.

Evaluate the risks involved in the use of chemical substances and laboratory procedures.

Express ideas correctly, both orally and in writing, in any of the official languages of the Valencian Community.

Identify chemical elements and their compounds, including their extraction, structure, reactivity, properties and applications.

Identify chemical processes in everyday life.

Identify the unit operations of chemical engineering.

Implement sustainable and environmentally friendly methodologies.

Interpret the relationship between the variation in the characteristic properties of chemical elements and the Periodic Table.

Prepare reports, assessments, and industrial and environmental projects in the field of chemistry.

Propose creative and innovative solutions to complex situations or problems in the field, addressing diverse professional and social needs.

Relate chemistry to other disciplines.

Relate theory to experimentation.

Ser capaces de analizar la influencia que sobre el diseño del sistema de información de costes, ejercen, tanto la actividad concreta desarrollada por la entidad como la tecnología utilizada, la estructura organizativa y el estilo de dirección. Calcular costes preestablecidos y relacionarlos con la planificación y el control de la actividad interna. Seleccionar aquellos indicadores de gestión que faciliten el desempeño personal, estableciendo la frecuencia y el formato en función del usuario de destino.

Ser capaces de configurar y manejar un sistema integrado para la gestión contable de la empresa. Utilizar la hoja de cálculo como herramienta de análisis de la información económica de la empresa. Saber aplicar programas de apoyo a tareas específicas de gestión.

Understand and analyse, from the perspective of the degree programme, social inequalities based on sex and gender; integrate gender-sensitive approaches into problem-solving and solution design.

## DESCRIPTION OF CONTENTS

# 1. Introduction.

Material concept. Structure-property relationship. Materials today. Materials design. Materials classification.

# 2. Bonding and structure of materials. Ideal solids.

Bonding in solids. Review of crystallography concepts. Close-packed structures. Structure of intermetallic compounds. Structures of inorganic solids.

# 3. Real solids.

Defects in solids: Point defects. Line defects. Extended defects. Defect notation: Kröger-Vink nomenclature.

# 4. Transport properties.

Diffusion in solids. Fick's first law. Fick's second law. Heat transport. Thermal expansion. Thermal conductivity.

# 5. Metals I. Mechanical properties.

Properties of metals. Definitions of mechanical properties. Dislocations and slip. Hardness: Hardening Mechanisms. Fracture and Fatigue.

# 6. Metals II. Phase Diagrams and Transformations.

Phase Diagrams. Binary Diagrams with Phase Separation. Invariants and Intermediate Compounds. The Iron-Carbon System. Phase Transformations, Avrami Equation.
Microcomponents of the Iron-Carbon System.

# 7. Electrical Properties of Materials.

Fundamentals of Current. Electronic Structure of Metals. Electrical Resistivity in Metals. Brief Introduction to Band Theory. Semiconductors. Dielectric Behavior. Other Electrical Behaviors. Photoelectric Effect and Photovoltaic Materials. Electrical Properties of Ceramics and Polymers.

# 8. Magnetic Properties.

Fundamental Concepts. Types of Magnetic Behavior. Effect of Temperature. Domains and Hysteresis. Soft and Hard Magnets. Superconductivity.

# 9. Optical Properties.

Interaction of light with matter: Reflection, absorption, and transmission. Absorption, emission, and

excitation spectra. Reflection and refraction. Transparency and opacity. Optical fibers. Light-emitting diodes (LEDs). Laser emission: Types of lasers.

## 10. Specific Materials: Polymers, Glasses, and Ceramic Materials.

Concept of polymer, monomer, molecular weight distribution. Molecular structure of polymers and tacticity. Mechanical properties of polymers. Types of polymers.
The glassy state. Definition of glass. Thermodynamics and kinetics of the glass transition. Models for glass formation. Types of glasses.
Phase diagrams of ceramic materials. Mechanical Properties of Ceramics.

## 11. Composite Materials.

Introduction to Composites. Particle-reinforced materials. Fiber-reinforced materials. Fiber phase. Structural composites.

## WORKLOAD

### PRESENCIAL ACTIVITIES

| Activity | Hours |
|---|---|
| Tutorials | 9,00 |
| Theory | 51,00 |
| **Total hours** | **60,00** |

### NON PRESENCIAL ACTIVITIES

| Activity | Hours |
|---|---|
| Attendance at other activities | 0,00 |
| Individual or group project | 0,00 |
| Independent study and work | 75,00 |
| Preparation of lessons | 0,00 |
| Preparation for assessment activities | 15,00 |
| Resolution of case studies | 0,00 |
| **Total hours** | **90,00** |

## TEACHING METHODOLOGY

This subject is designed so that students lead their own learning and is structured in the following components:

Lectures.- In these classes the lecturer will provide an overview of the topic under study with special emphasis on new aspects or on those particularly complex. Lessons will also involve the specific application of the knowledge acquired by students via the resolution of questions and practical problems that students have previously worked on. Logically, these classes must be complemented with individual study.

Group tutorials.- Students will come to them in smaller groups. For the development of the tutoring sessions the teacher will propose a set of exercises and questions in advance according to the program of each tutoring. In the face-to-face sessions, these questions will be reviewed and any doubts raised will be resolved.

## EVALUATION

The knowledge acquired will be evaluated through a written examen, in the periods established by the Faculty, which will represent 80% of the contribution to the final grade.

The exam will consist of objective questions, dedicated to knowledge considered as basic and numerical and relational problems that force us to consider aspects of the subject that appear in different topics. Students who do not pass the first call must take the second call exam.

The rest of the grade (20%) will consist of the student's participation in evaluable activities that the teacher will propose and that may consist of:

• Resolution of problems and issues.

• Participation in discussions and seminars.

• Preparation of content or work.

The overall grade will be that of the exam plus the one obtained in all the activities, with the weight that each teacher establishes and communicates at the beginning of the course.

To pass the subject, a minimum grade of 5 must be achieved in the evaluation average.

**Final warning**

Copying or plagiarism of any assignment that is part of the evaluation will make it impossible to pass the course, and the student will be subject to the appropriate disciplinary procedures.

Please note that, according to Article 13 d) of the University Student Statute (RD 1791/2010, December 30), "*it is the duty of a student to refrain from using or cooperating in fraudulent procedures in evaluation tests, in the work performed or in official University documents*".

## REFERENCES


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- West, A. R. Solid State Chemistry and Its Applications; John Wiley & Sons, Inc.: Chichester, West Sussex, 2014. (Chapter 2). B. Ciències Planta1 - SalaB CI 54 WES
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- Ashby, M. F.; Scherclif, H.; Cebon, D. Materials: Engineering, Science, Processing and Design, 3td ed.; Elsevier Science, 2014. https://links.uv.es/materiales/Ashby
- Carter, C. B.; Norton, G. Ceramic Materials: Science and Engineering; Springer: New York, Heidelberg, 2013. https://links.uv.es/materiales/Norton
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