Universidad del País Vasco Euskal Herriko Unibertsitatea

COURSE GUIDE 2025/26

Faculty 215 - Faculty of Chemistry **Cycle** .

Degree GQUIMI20 - Bachelor's Degree in Chemistry **Year** Fourth year

COURSE

26121 - Materials Science **Credits, ECTS:** 6

COURSE DESCRIPTION

The basic objective of the subject is to provide the students with the theoretical-practical knowledge that allows them to understand the relationship between the structure and the properties of the different materials, taking into account the influence of the processing. Specifically, it is about that the students know the different types of materials, understand their general behavior, their characteristic properties and their potentialities, and recognize the effects of the environment and the conditions of service on their behavior. This understanding is necessary to be able to select the ideal material to participate in the design of reliable and economical components, systems and processes that use the wide spectrum of materials currently available.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The subject is framed within the Fundamental Complements of Chemistry, located in the Fundamental Module of the Degree and, as such, shares the competences assigned to that Module. Among them, the following specific competence will be treated and evaluated:
- [M02CM05]: "Understanding of the relationships between structure, properties and processing of the various types of materials and their selection according to the intended applications".
Likewise, the 4 transversal competences will be worked on, with a special emphasis on the last of them:
- [M02CM08]: "Ability to select different instrumental techniques, simple or combined, for the characterization of chemical substances". - [M02CM09]: "To be able to present, orally and in writing, in a comprehensible manner, phenomena and processes related to Chemistry and related subjects".
- [M02CM10]: "Ability to search and select information in the field of Chemistry and other scientific fields making use of the bibliography and information and communication technologies".
- [M02CM011]: "Be able to relate Chemistry with other disciplines, as well as understand its impact on current society and the importance of the industrial chemical sector."
The coordination of this subject with the rest of the Module corresponds to the Coordination Commission of the Degree.

Theoretical and Practical Contents

THEORETICAL CONTENTS
PART 1
1.- Introduction: (1 hour). Historical perspective. Classification of materials. Advanced materials. New material requirements
2.- Structure of the polymers: (3.5 hours). Monomer, polymer, polymerization reactions, degree of polymerization. Molecular weight. Molecular structure. Thermoplastic and thermostable. Molecular configurations. Copolymers. Polymeric crystals. Solid state.
3.- Structures of metals and ceramics: (0.5 hours: Review of concepts).
4.- Imperfections in solids: (2 hours). Impurities in solids. Point defects in polymers. Linear defects. Interfacial defects. Optical and electronic microscopy.
5.- Diffusion: (1 hour). Factors that innfluence diffusion. Diffusion and processing. Diffusion in ionic and polymeric materials.
6.- Mechanical properties (6 hours). Concepts of stress and strain. Elastic deformation Mechanical behavior of metals. Mechanical behavior of ceramics. Mechanical behavior of polymers. Hardness and other mechanical properties.

PART 2
7.- Deformation and strengthening mechanisms (5 hours). Deformation mechanisms for metals. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Deformation mechanisms for ceramic materials. Mechanisms of deformation and for strengthening of polymers.
8.- Failure (2 hours). Fundamentals of fracture. Ductile fracture. Brittle fracture. Fracture toughness testing. Fatigue and creep
9.-Phase diagrams (2 hours + PO). Equilibrium phase diagrams. Binary isomorphous systems. Binary eutectic systems. Equilibrium diagrams having intermediate phases or compounds. Eutectoid and peritectic reactions.
10.- Steel phase diagram and phase transformations (6 hours). Iron-carbon system phase diagram. Phase transformations in metals. Microstructural changes in steel. Precipitation hardening.
PART 3
11.- Types and applications of materials (4 hours). Metal alloys. Processing of metals. Types of ceramics and their processing. Types of polymers and their processing.
12.- Composites: (4 hours). Particle-reinforced. Fiber-reinforced. Structural composites.
13.- Corrosion and degradation of materials: (2.5 hours). Corrosion rates. Prediction of corrosion rates. Passivity. Forms of corrosion. Corrosion prevention. Oxidation. Degradation of polymers.
14.- Electrical properties: (0.5 hours). Semiconductivity. Semiconductor devices. Electrical conduction in ionic ceramics

and in polymers. Dielectric behavior. Ferroelectricity and piezoelectricity.

PRACTICAL CONTENTS
1. Phase diagrams (computer practices).

EXPERIMENTAL CONTENTS
1. Scanning electron microscopy (laboratory practices).
2. Hardness (laboratory practices).
3. Stress-strain test (laboratory practices).

TEACHING METHODS

In the case of the Theoretical Programme, the methodology will consist of the presentation of the subject through lectures in which computers will be used intensively for the projection of the content. In seminars, students (either individually or in groups) will make presentations on the proposed themes, and will be given sufficient notice to prepare them. Practical laboratory work will be carried out in 3-4-hour sessions in the afternoons, coinciding with the period of theoretical classes on the calendar. Practical work will be done in groups of 3-4. After an explanation of the activities to be carried out and of the handling of the equipment, the students will perform the experiments, compiling incidents and the experimental data obtained. Finally, an analysis and discussion of the results will be carried out. Each part of practical work will be reflected in a report, which must be drawn up and handed in by the group so that it can be marked. Practical work with computers will be done individually, with students working on an in-depth analysis of phase diagrams of different binary systems.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40	7		10	3				
Horas de Actividad No Presencial del Alumno/a	60	18		10	2				

Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 70%
- Individual assignments 5%
- Teamwork assignments (problem solving, Project design) 15%
- Oral presentation of assigned tasks, Reading¿ 5%
- Computer practices 5%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

- Ordinary Evaluation: continuous evaluation of theoretical-practical (TP) and experimental (EX) activities. Final mark: average of TP (85%) and EX (15%) scores.

- Evaluation of the TP part: 3 partial exams on each of the three parts contained in the syllabus, plus a final exam on all the subjects. Partial exams will have a pass mark of 7. Each partial exam will represent 10% of the final mark, and the final exam 40%. Written tests will represent 70% of the final mark. Assessment of seminars and work proposed: each student will make an oral presentation on a theme proposed by the seminars. The oral presentation will represent 5% of the final mark. The backup documentation will represent another 5%. Evaluation of practical work with computers: done through the solving of a series of problems proposed: 5%; skills assessed: M02CM05, M02CM09, M02CM10 and M02CM011.

- Evaluation of the EX part: quality of the results obtained, reports presented, exercise book and group work (10% of the final grade). Final oral or written test to be performed on the last day of the practical work period, or on the day of the final exam: performance of practical work and/or answers to questions related to the practical work (5% of the final mark). Attendance at practical work is compulsory. Skills evaluated: M02CM08 and M02CM10.

Conditions to pass the course:
- ≥ 5.0 mark in theoretical part, seminars, and laboratory sessions.
- ≥ 5.0 mark in final mark.

No-show: Only applicable to students who do not attend any continuous evaluation test (no exam, seminar or practical work session), or who OPT OUT in the set period.
Opt-out (waiver): a student who chooses continuous evaluation may opt out of the system within a minimum of 1 month

before the end of the teaching period, in writing to the professor in question. Therefore, it will be understood that any student that does not do this will be considered as having failed, even though he/she does not present him/herself for the final exam, as established in chapter 2, article 12 of the Regulations governing student evaluation in undergraduate degrees of the UPV/EHU.
A request for evaluation, through a single test or a final evaluation, will be sent to the teaching staff within 9 weeks of the start of the term or course, in accordance with the content of chapter 2, article 8 of the Regulations governing student evaluation in undergraduate degrees of the UPV/EHU. This will consist of an examination on all the theoretical-practical content of the subject and the performance of a practical laboratory exam.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Extraordinary Evaluation: One exam (100% mark) on the failed parts(TP and/or EX).

MANDATORY MATERIALS

The teacher will indicate the necessary material at the beginning of the course.

BIBLIOGRAPHY

Basic bibliography

W. D. Callister, Jr. Materials Science and Engineering. An Introduction (7th Edition). Wiley, 2007.
W. D. Callister, Jr. Introducción a la Ciencia e Ingeniería de los Materiales. Ed. Reverté, 1995.
D.R. Askeland, P.P. Phulé, The Science and Engineering of Materials. (5th Edition). Cengage-Engineering (2005).
D. R. Askeland. Ciencia e Ingeniería de los Materiales. Thomson Editors, 2001.
W. F. Smith, J. Hashemi. Foundations of Materials Science and Engineering (4th Edition). McGraw-Hill, 2006.

Detailed bibliography

W. D. Callister, Jr. Fundamentals of Materials Science and Engineering. Wiley, 2007.
P.L. Magonon. Ciencia de Materiales: Selección y Diseño. Prentice Hall, 2001.
M. F. Ashby. Materials Selection in Mechanical Design. Butterworth-Heinemann, 1999.
M. F. Ashby, D. R. H. Jones. Engineering Materials 1: An Introduction to their Properties and Applications. Pergamon Press, 1980.
M. F. Ashby, D. R. H. Jones. Engineering Materials 2: An Introduction to Microstructures, Processing and Design. Pergamon Press, 1988.
D. R. H. Jones Engineering Materials 3: Materials Failure Analysis. Pergamon Press, 1993.
L. Smart, E. Moore, Solid State Chemistry: an introduction (3th Edition). CRC Taylor & Francis (2005).

Journals

Progress in Materials Science
Materials Science and Engineering R-Reports
Materials Chemistry and Physics
Journal of Materials Research
Journal of Materials Science
Materials Letters
Nature Materials
Chemistry of Materials

Web sites of interest

http://www.wiley.com/college/callister
http://www.matter.org.uk/
http://www.matweb.com/
http://www.msm.cam.ac.uk/doitpoms/
http://www.soton.ac.uk/~pasr1/
http://www-g.eng.cam.ac.uk/mmg/teaching/phasediagrams/index4.html
http://matse1.mse.uiuc.edu/~tw/

OBSERVATIONS