Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2025/26

Faculty 345 - Faculty of Engineering - Bilbao **Cycle** .

Degree GITECI30 - Bachelor`s Degree in Industrial Technology Engineering **Year** Second year

COURSE

27308 - Fundamentals of Materials Science **Credits, ECTS:** 6

COURSE DESCRIPTION

The course includes subjects to acquire the basic knowledge of materials science. Common to other engineering studies in Europe that can homologate to this engineering degree, the course contains subjects including the growing importance of engineering materials, the basic structure of the different classes of materials (metals, ceramics, polymers), the transformations that have or may have taken place in their manufacturing and in service, as well as their mechanical, electrical, electronic, magnetic, thermal and optical properties. The course finishes with a brief description of the main features of the materials most commonly used among the three previously mentioned families, and by presenting the usual criteria in their selection for final uses.
Being located within a basic module, the course allows an initiation in the field of science and engineering of materials. It will also lead to generate in the future graduates the wish to complete their knowledge on materials from novel aspects that concern industrial engineering as a profession.
Mechanisms to ensure horizontal coordination within the course are based on the programmed coordination of this subject with others that introduce and employ similar concepts and principles, e. g. Static-Mechanics and Thermodynamics.
The mechanisms assuring vertical coordination are related to the structure of the planning itself of the undergraduate degree in Industrial Engineering, hence subjects necessary for the monitoring of materials are already studied previously (Physics and Chemistry), while subjects that need of this course are programmed for later on.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Knowledge of the fundamentals of science, technology and materials chemistry. Understand the relationship between the microstructure, synthesis or processing and materials properties.
Knowledge of basic and technological subjects that will enable students to learn new methods and theories, and provide them versatility to adapt to new situations.
Ability to solve problems with initiative, decision making, creativity, critical thinking.
Ability to communicate and transmit knowledge, skills and abilities in the field of Engineering in Industrial Technology.

Theoretical and Practical Contents

1 - History and importance of materials / Science and engineering of materials. Hystorical prospective. Current trends and uses of materials.
2 - Atomic structure and chemical bonding / Foundations of atomic structure. Electron models. Energy levels and electron configurations. Periodic Table. Bonding forces and energies. Atomic bonding: ionic, covalent, metallic, secondary. Mixed interactions.
3 - The structure of crystalline solids/ Crystalline arrangement. Bravais lattices. Miller indices. Crystal structures of metals. Other crystal structures. X-ray diffraction.
4 - The structure of non crystalline solids / Structure of polymers. Short and long chain molecules. Polymer chemistry. Families of polymeric materials. Molecular weight. Form, structure and molecular configuration. Crystallinity in polymers. Glasses. Cooling. Oxides and lattice modifiers. Other non crystalline materials.
5 - Real solids and diffusion/ Imperfections in solids. Point defects. Linear defects. Interfacial defects. Grain size determination. Diffusion in solid state. Mathematical laws of diffusion. Diffusion coefficient. Industrial processes.
6 - Phase diagrams / Definitions. Solid solutions: rule of Hume-Rothery. Phases rule of Gibbs. Types of phase diagram: pure substances, binary, ternary. Binary diagrams of complete solubility. Binary diagrams with invariant points: eutectic, peritectic, monotectic, eutectoid, peritectoid. Phase diagrams and intermediate compounds. Ternary phase diagrams.
7 - Fundamentals of corrosion / Electrochemical corrosion in metals. Rate of corrosion. Passivity. Environmental corrosion and protection. Oxidation. Corrosion of ceramics. Polymer degradation. Effect of the environment.
8 - Mechanical Properties of Materials / Introduction. Elastic deformation. Plastic deformation. Tensile properties and stress-strain diagram. Influence of temperature and strain rate. Modelling the tensile behaviour of materials. Hardness. Fracture and Charpy impact test. Fatigue. Creep.
9 - Functional properties / Electrical properties, electronic: Electrical conduction and electrical resistance, dielectric behaviour. Magnetic properties: Basic concepts and types of magnetism. Magnetic materials. Superconductivity. Thermal properties: Heat capacity. Thermal conductivity. Thermal expansion and stresses. Optical properties: Electromagnetic radiation. Interaction of light with solids. Luminiscence..
10 - Metallic materials / ferrous materials. Fabrications of steels and casto irons. Types of steels: building steels, stainless steels, tool steels. Type of cast iron. Non ferrous alloys: alluminium and its alloys, cooper and its alloys, titanium and its alloys. Other non ferrous alloys. Heat treatment of metallic materials.
11 - Polymer and composite materials / Additives. Mechanical behaviour of polymers. Viscoelasticity. Fracture. Thermoplastics. Thermosettings. Elastomers. Composite materials. Reinforcement with particles. Reinforcement with fibres. Laminar and structural composites.

12 - Ceramics materials / Fabrication of ceramics. Fundamental properties. Classic ceramics: bricks, tile, eartware, porcelain. Technical ceramics: alumina, zirconia, silicon carbide, silicon nitride. Glasses: fabrication, properties and applications. Vitroceramis: properties and applications.

TEACHING METHODS

Lecture will be given by the professor with the help of power point presentations. The book with all the subjects of the course will be available for students in reprographic service of the faculty.
The seminars will be focused on specific topics that require additional exercises to encourage teamwork and participation of students with possible occasional debates. Thus, deepening the theoretical knowledge of the subject in a more practical and applied manner is allowed.
In the laboratory practices students will develop experimental work to acquire knowledge and skills of the experimental techniques employed in materials science. Students should keep a laboratory notebook (available in the reprographic service center) where descriptions of the practice and brief questions for self-assessment are included.

In the event that minimum distances are established between students for health security, the practices will be organized in a delegated way

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	30	9	15	6					
Horas de Actividad No Presencial del Alumno/a	45	13,5	22,5	9					

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

- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 75%
- Exercises, cases or problem sets 10%
- Individual assignments 15%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The subject is evaluated through continuous evaluation. In both cases, the final note of the subject will take into account the evaluation of the competencies and learning results in each of the teaching modalities of the subject according to the following criteria:
75% written exam related to theoretical classes and classroom practices;
15% related to seminars;
10% related to laboratory practices.
To pass the subject you must get a 5/10 in each of these three parts.
Students have the right to waive the continuous assessment and opt for the assessment according to one single final assessment test. The students who choose this option must inform the lecturer before week 9th.
If, due to circumstances, the University is unable to organize the evaluation tests at the university, the changes relevant to the online evaluation will be made. In that case, the characteristics of the online evaluation will be published and communicated by eGela.
CONTINUOUS EVALUATION:
Written exam:
It consists of a theoretical part and a practical part. Both have the same weight in the exam score. The theoretical part will consist of test questions and short questions, in which the concepts of the subject will be developed. The practical part will consist of two problems to be solved. Marks of both parts must be compensated and the estimate is at the discretion of the professor. On the day of the written exam, only writing tools, ruler, square and calculator may be available.
Laboratory practice:
There are three laboratory practices. The evaluation of each practice will be carried out using an e-Gela test, which will be carried out according to established deadlines. The final practice note will be calculated by applying the arithmetic average of the three individual practices. However, to be able to perform the practice it will be necessary to have successfully completed a test prior to it through e-Gela. To do this, it is necessary to correctly answer 3 of the 5 questions of the previous test. People who do not perform or do not pass the test will not be able to perform the practice or answer the practice evaluation test and, therefore, the note corresponding to this practice will be zero. Likewise, even having attended the practice, not answering the questions of the corresponding test within the established deadlines will be zero.
We understood, that students who do not attend any of the laboratory practices refuse to be evaluated by continuous evaluation, so they will be evaluated by the final evaluation system.
*Students who, having attended the laboratory practices, do not achieve the minimum mark in the continuous evaluation criteria, will have the option of being evaluated by a theoretical/practical question on the day of the final exam.

*If you do not pass the subject, the practice note is not kept for the next course.
Seminars:
Each seminar is associated with an individual task that the students should perform and deliver on the corresponding dates. The final note to the seminars will be calculated as the arithmetic mean of the notes to these tasks. In the second and third seminars (Item 7: Corrosion), in addition to the tasks to be performed, a 5-question test in E-Gela is included, which must be answered prior to the relevant seminar session, and the note obtained will weigh the note of the task.
Even having attended the seminar, not handing over the corresponding task within the deadlines will be zero. Students who do not attend the seminar will not be able to give the corresponding task and consequently the corresponding note will be zero. If the student does not attend any of the seminars, we understand that he/she refuses to be evaluated by continuous evaluation, so he/she will be evaluated by the final evaluation system.
*Students who have attended the seminars and do not achieve the minimum mark in the continuous evaluation criteria will have the option of being evaluated by a theoretical/practical question on the day of the final exam.
*If you do not pass the subject, the seminar note is not kept for the next course.

FINAL EVALUATION
The final evaluation system will be carried out through a final written exam consisting of the same three parts as the continuous evaluation, with the same weighting, criteria and requirements to approve the subject: a written examination related to theoretical classes and classroom practices whose weighting is 75%, 15% related to seminars and 10% related to laboratory practices. A 5/10 note must be obtained to pass each of the three parts.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The final note of the subject will take into account the evaluation of the competencies and learning results in each of the teaching modalities of the subject according to the following criteria:
75% written exam related to theoretical classes and classroom practices;
15% related to seminars;
10% related to laboratory practices.
To pass the subject you must get a 5/10 in each of these three parts.
Students have the right to waive the continuous assessment and opt for the assessment according to one single final assessment test. The students who choose this option must inform the lecturer before week 9th.
If, due to circumstances, the University is unable to organize the evaluation tests at the university, the changes relevant to the online evaluation will be made. In that case, the characteristics of the online evaluation will be published and communicated by eGela.
The final evaluation system will be carried out through a final written exam consisting of the same three parts as the continuous evaluation, with the same weighting, criteria and requirements to approve the subject: a written examination related to theoretical classes and classroom practices whose weighting is 75%, 15% related to seminars and 10% related to laboratory practices. A 5/10 note must be obtained to pass each of the three parts.
Written exam:
It consists of a theoretical part and a practical part. Both have the same weight in the exam score. The theoretical part will consist of test questions and short questions, in which the concepts of the subject will be developed. The practical part will consist of two problems to be solved. Marks of both parts must be compensated and the estimate is at the discretion of the professor. On the day of the written exam, only writing tools, ruler, square and calculator may be available.
Laboratory practice:
They will be evaluated by one or two theoretical/practical questions.
Seminars:
They will be evaluated by one or two theoretical/practical questions.
* The mark of the seminars and laboratory practices of students, who have opted for continuous evaluation in the ordinary call and have successfully passed these parts, will be kept for the extraordinary call and they will only perform the written exam.

MANDATORY MATERIALS

Slides and notes of the lectures.
Materials Science an engineering: An Introduction. W.D. Callister. Ed: Wiley and Sons.

BIBLIOGRAPHY

Basic bibliography

-Materials Science and Engineering, 9th Edition. W. Callister. Ed. Wiley (2014)
-Introduction to materials science for engineers. J.F.Shackelfors. Ed: Pearson (2018)
--Ciencia e Ingeniería de los materiales. J.M. Montes, F.G. Cuevas, J. Cintas. Ed. Paraninfo. (2014)
-The Science and Engineering of Materials. D.R.Askeland. Ed: Thompson (2003)
-Foundations of Materials Science and Engineering. W. Smith. Ed: McGraww-Hill Science (2009)

Detailed bibliography

Engineering of Materials 1: An Introduction to properties, applications ande design. M.F.Ashby. Ed: Reverté (2008)

Engineering of Materials 2: An introduction to microstructures, processing and design. M.F.Ashby. Ed: Reverté (2008)

Journals

Revista de Metalurgia del CENIM (revistametalurgia.revistas.csic.es)
Boletín Cerámica y vidrio (boletines.secv.es)
Revista de Materiales Avanzados (www.iim.unam.mx/revista)
Journal of Materials Research.
Modern Plastics.

Web sites of interest

www.doitpoms.ac.uk
www.msm.cam.ac.uk
ocw.mit.edu/courses

Througt the course it will be provided other directions of specific interest to each topic.

OBSERVATIONS