COURSE DATA

DATA SUBJECT

Code: 34758
Name: Materials science II
Cycle: Undergraduate Studies
ECTS Credits: 6
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	Escola Tècnica Superior d'Enginyeria	2	Second quarter
1934 - Double Degree Program in Chemistry-Chemical Engineering	Facultat de Química	3	Second quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	Equipment materials and design	COMPULSORY
1934 - Double Degree Program in Chemistry-Chemical Engineering	Tercer curso	COMPULSORY

COORDINATION

BADIA VALIENTE JOSE DAVID

GIL CASTELL OSCAR

SUMMARY

The objective of this course is for students to acquire the basic knowledge of Materials Science necessary for the study, design, and/or operation of the most common systems in the chemical industry.

The course content is: Chemical technology, synthesis, and processing of materials.
Properties and applications of metallic, polymer, ceramic, and composite materials. Corrosion. Materials behaviour and control. Degradation and failure of materials. Inspection and testing. Elasticity and strength of materials.

The Materials Science II course is taught in the second year of the Bachelor's Degree in Chemical Engineering and in the third year of the Double Degree in Chemistry and Chemical Engineering, during the second semester. The University of Valencia curriculum consists of a total of 6 ECTS credits. It is part of the subject: Materials and Equipment Design.

Theory classes will be taught in Spanish, and practical classes will be taught in accordance with the course

details available on the degree website.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

To successfully complete this subject, students are advised to have prior knowledge corresponding to the required level in subjects taken in their first and second years. This prior knowledge includes:
- Knowledge of physics, chemistry, and mathematics, already developed in the degree.
- Materials Science I.
- Basic level of English.

COMPETENCES / LEARNING OUTCOMES

1401 - Degree in Chemical Engineering

Ability to apply quality principles and methods.

Ability to handle specifications, regulations and standards of compliance.

Acquire knowledge of basic and technological subjects to facilitate the learning of new methods and theories, and develop the versatility to adapt to new situations.

Act autonomously in learning, make informed decisions in different contexts, issue judgements based on experimentation and analysis and transfer knowledge to new situations.

Be able to understand and apply the legislation required for the practice of the profession of technical industrial engineer.

Knowledge and use of the principles of strength of materials.

Propose creative and innovative solutions to complex situations or problems, specific to the field of knowledge, to respond to diverse professional and social needs.

Saber comunicarse de manera efectiva, tanto de forma oral como escrita, adaptándose a las características de la situación y de la audiencia

Solve problems with initiative, make decisions, think creatively and critically, and communicate and convey knowledge, skills and competences in the field of industrial engineering.

Understand the fundamentals of materials science, technology and chemistry, and relate microstructure, synthesis or processing to material properties.

Work in a multilingual and multidisciplinary environment.

DESCRIPTION OF CONTENTS

Topic 1. Materials Science, Technology, and Engineering in Chemical Engineering
1.1. Materials in Chemical Engineering: professional context and training requirements. Connection with the Sustainable Development Goals of the UN 2030 Agenda.
1.2. Materials Science, Technology, and Engineering. The Material-Processing-Application triad.
1.3. Classification and structure of materials. Metallic, ceramic, polymeric, and composite materials.
1.4. R&D&I in Materials Science for Chemical Engineering.

Topic 2. Mechanical properties of materials I. Quasi-static service conditions.
2.1. Nominal and actual strain, stress, and tension. Static loads: axial and transverse. Poisson's modulus. Elasticity, plasticity, viscoelasticity, and fracture.
2.2. Tensile testing. Regulations. The engineering tensile-strain curve. Elastic and plastic deformations. Modulus of elasticity, yield strength, tensile strength, tensile strength, working stress. Energy moduli: resilience and toughness. Ductility. Strain hardening: the Hollomon equation. Effects of composition and engineering treatments.
2.3. Compression testing. Regulations. Tensile-compression relationship.
2.4. Hardness testing. Regulations. Types: Brinell, Vickers, Rockwell, Shore, Knoop. Properties-test relationship.
2.5. Flexural testing. Regulations. Types: One-point and two-point bending. Modulus of rupture.
2.6. Shear testing. Regulations. Relationship between axial and transverse strains.

Topic 3. Mechanical properties of materials II. Dynamic service conditions.
3.1. Dynamic loads. Deformation modes.
3.2. Creep testing. Regulations. Creep deformation and fracture. Maxwell and Kevin-Voigt models. Boltzmann superposition principle. Creep at room temperature. Hot creep: individual and joint influence of temperature and load.
3.3. Relaxation testing. Regulations. Relaxation at room temperature. Hot relaxation: individual and joint influence of temperature and deformation.
3.4. Simple fracture. Fracture mechanics. Stress intensification factor. Fracture toughness. Critical crack size. Ductile and brittle fracture. Influence of geometric factors. Non-destructive testing. Destructive testing: Charpy and Izod resilience testing. The Weibull distribution.
3.5. Fatigue testing. Regulations. Cyclic stresses. The Wholer curve. Paris equation: relationship between fatigue cycles and crack growth.
3.6. Torsion testing. Regulations. Deformations along a circular axis.

Topic 4. Mechanical Properties of Materials III. Design of Composite Materials.
4.1. Typology and manufacturing technologies of composite materials. Matrix and reinforcement phases. Importance of the interface. Tensile and compressive behavior. Absolute and specific mechanical properties.
4.2. Design of composite materials reinforced with large and dispersed particles. Mechanical properties along the axial and transverse axes of load application. Influence of particle characteristics, distribution, and quantity.
4.3. Design of fiber-reinforced composite materials. Critical fiber size. Behavior of short-fiber-reinforced composite materials. Behavior of long-aligned fiber-reinforced composite materials.
4.4. Structural composite materials. Laminated and sandwich composites.

Topic 5. Thermo-rheological properties of materials.
5.1. Importance of temperature in the processing and performance of materials. Thermal properties of

interest: heat capacity, thermal conductivity, characteristic tests, and advanced evaluation techniques.
5.2. Rheology of materials: importance in production processes.
5.3. Differential scanning calorimetry testing.
5.4. Thermogravimetry testing. Regulations.

Topic 6. Degradation, corrosion, and protection of materials.
6.1. Degradation of materials: environmental impact, costs, and need for protection.
6.2. Degradation of ceramics. Techniques for protection against ceramic degradation.
6.3. Degradation of polymers. Techniques for protection against polymer degradation.
6.4. Degradation of metals. Principles of electrochemistry. FEM and galvanic series. Corrosion thermodynamics: the Nernst equation and Pourbaix diagrams. Corrosion kinetics: Evans diagrams, polarization types, and corrosion rates. High-temperature dry corrosion. Corrosion protection techniques for metals.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	40,00
Classroom practices	20,00
Total hours	**60,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	10,00
Independent study and work	0,00
Preparation of lessons	60,00
Preparation for assessment activities	20,00
Resolution of case studies	0,00
Total hours	**90,00**

TEACHING METHODOLOGY

The course is structured around theory and problem-solving classes, and the reading of research papers.

Theory classes will use a lecture model. The professor will present and/or explain the content of each topic, emphasizing key aspects for understanding the topic.

Practical problem-solving classes will follow two models. In some classes, the professor will solve a series of standard problems so that students can learn to identify the essential elements of problem-solving and problem-solving. In other problem-solving classes, students, individually or in groups, will solve similar problems under the professor's supervision. Once the work is completed, part of the problems will be collected, analysed, and corrected by the professor.

The work assigned to the student will include a collection of submissions, participation in activities, and completion of questionnaires, designed to deepen the most important concepts of each topic and the understanding of research papers.

EVALUATION

Learning assessment will be carried out through continuous assessment, taking into account assignments (TR) and objective tests (PO).

Assignments (TR) will consist of a collection of questionnaires, activities, and/or problems to be completed individually and/or in groups. No individual or weighted minimum grade is established for this aspect. Not submitted activities will be counted at the average, without scoring.

The objective test (PO) will consist of theoretical and practical questions and problems that demonstrate the assimilation of the concepts and procedures covered in the course. In the first sitting, this test will be grouped into two blocks (Block I: topics 1 to 3; Block II: topics 4 to 6). The Block I test will be administered at the end of the coursework for this block, and the Block II test will be administered on the official date of the first sitting. In the second sitting, an objective test covering all content will be administered on the official date. If the student does not attend to the Block I exam in the first sitting, they must take it directly in the second sitting. A minimum score of 5.0 on the objective test is required for weighting.

The grade for the course will be the highest of the following categories (A and B), both in the regular and extraordinary sittings:
A. Grade = 50% PO (minimum = 5.0) + 50% TR
B. Grade = 85% PO (minimum = 5.0) + 15% TR

If the student does not pass the objective test in either the first or second sitting, the grade will be the same as the objective test from the last sitting in which the student took the exam.

If the student does not pass the course in the first sitting, the grades for the assignments will be carried over to the second sitting. Grades for assignments in the assignment section will not be carried over between academic years.

The obvious copying or plagiarism of any activity that forms part of the assessment will make it impossible to pass the subject, and the student will then be subject to the appropriate disciplinary procedures indicated in the PROTOCOL FOR ACTION IN THE FACE OF FRAUDULENT PRACTICES AT THE UNIVERSITY OF VALENCIA (ACGUV 123/2020).

REFERENCES

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