# Joining technologies: welding and adhesives

**Academic Year: ( 2024 / 2025 )** **Review date: 28-03-2023**

**Department assigned to the subject: Materials Science and Engineering and Chemical Engineering Department**

**Coordinating teacher: MARTINEZ CASANOVA, MIGUEL ANGEL**

**Type: Electives ECTS Credits : 3.0**

**Year : 4 Semester :**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Chemical Basis of Engineering
Materials Science and Engineering
Industrial Materials

## SKILLS AND LEARNING OUTCOMES

CB1. 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 at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study
CB2. Students are able 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 problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.
RA6. Transversal Skills: To have the necessary skills for the practice of engineering in today's society.

## OBJECTIVES

By the end of this content area, students will be able to have:
1. a systematic understanding of the key aspects and concepts of materials science and engineering.
2. coherent knowledge of materials science and engineering including some at the forefront of the branch in mechanical engineering.
3. awareness of the wider multidisciplinary context of engineering.
4. the ability to apply their knowledge and understanding to identify, formulate and solve problems of materials science and engineering using established methods.
5. the ability to design and conduct appropriate experiments of materials science and engineering, interpret the data and draw conclusions.
6. workshop and laboratory skills in materials science and engineering.
7. demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.

## DESCRIPTION OF CONTENTS: PROGRAMME

Topic 1. Non-destructive tests. Visual inspection. Acoustic inspection. Penetrating liquids. Magnetic particles. Induction currents: Eddy currents. X-ray and scintigraphy. Ultrasound Active thermography. Holographic interferometry. Test selection.
Topic 2. Welding technology. Materials to be welded Fe-C system. Thermal treatments of steels. Aluminum base alloys hardened by maturation or deformation. Types of welding. Welding with fusion. Welding without fusion. Heat flux. Mass flow. Gases.
Topic 3. Welding metallurgy. Solidification of the fusion bath. Transformations in the Fe-C system. Maturing hardened alloys. Alloys hardened by deformation. Galvanized steel. Defectology.
Topic 4. Introduction to adhesives. Basic concepts of adhesion. Formation of the adhesive bond. Design criteria and examples. Comparison of joining techniques. The interface. Adhesion models (mechanical, chemical bond, electrical, diffusion). Effect of weak layers of preferential breakage.
Topic 5. Surface treatments. Surfaces characteristics: Roughness. Influencing factors. Pretreatments: Abrasion and cleaning. Chemical treatments. Physical treatments. Surface analysis techniques.
Topic 6. Mechanical behavior and degradation. Mechanical properties of polymer materials. Mechanical requests for adhesive bonding. Analysis of single lap joints. Mechanics of fracture. Degradation Effect of temperature, humidity and solvents. Mechanical and thermal fatigue. Combined effects
Topic 7. Types of adhesives. Polymerization process. Types of adhesives. Dosing systems. Rigid adhesives: Epoxy, Cyanoacrylates, Anaerobics and Acrylics. Flexible adhesives: Polysulphides, Silicones, Polyurethanes and Modified Silanes. Prepolymerized adhesives: in liquid phase, adhesive tapes and hot melts.

## LEARNING ACTIVITIES AND METHODOLOGY

Master classes, personal and group work, student presentations; oriented to the acquisition of theoretical knowledge.
- The course consists of lectures and practical classes in the classroom that will include the exhibition of work on topics related to asigntura
- The student may apply for individual tutoring with his/her teachers prior appointment.
- -All teaching materials (class transparencies, worksheets, practice scripts, and additional material) will be available through the Global Classroom 2 platform in advance.

## ASSESSMENT SYSTEM

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|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

- The student's final grade will be the weighted average of the continuous assessment of the student's work throughout the course, the final exam grade and the grade of the papers (oral presentation and written work).
- The continuous evaluation throughout the course takes on a particular importance in the subject and represents up to 40% of the final grade. The students will have to prepare written documentation and will make the oral presentation of at least one work on the thematics or the contents of the subject.
- In the regular final exam, the student is evaluated of the remaining 60% of the grade, being necessary to pass this exam with a grade equal to or greater than 4 to be weighted with the rest of the continuous assessment.
- The remaining 40% corresponds to the continuous evaluation. The pass is achieved by reaching a global final grade of 5

Extraordinary exam.
It will be 60% of the mark if the continuous evaluation is taken into account

| | |
|---|---|
| **% end-of-term-examination:** | 60 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 40 |

It will be 100% of the mark if continuous evaluation is not taken into account

## BASIC BIBLIOGRAPHY


- A. Pizzi, K.L. Mittal  Handbook of Adhesive Technology, Marcel Dekker, 2003

- A.J. Kinloch  Durability of Structural Adhesives, Elsevier , 1983

- A.J. Kinloch. Adhesion and Adhesives: Science and Technology, Chapman & Hall, 1987

- D. Brandon, W.D. Kaplan. Joining Processes. An Introduction, John Wiley & Sons, 1977

- D.E. Packham Handbook of Adhesion, Longman Sci& Tech, 1992

- H. Granjon Bases de la Metalurgia de la Soldadura, Eyrolles, 1989

- L.F.M. Lucas, A. Öchsner, R.D. Adams Handbook of Adhesion vol 1 and 2, Springer, 2011

- R.D. Adams, W.C. Wake. Structural Adhesive Joints in Engineering, Elsevier, 1984

- Varios ASM Handbook vol. 17. Nondestructive Evaluation, ASM, 1989

- Varios ASM Handbook vol. 6. Welding, Brazing and Soldering , ASM, , 1993

- Varios Engineered Materials Handbook vol 3. Adhesives and Sealants, ASM, 1990

- Ø. Grong Metallurgical Modelling of Welding, The Institute of Materials, 1997