Universidad Zaragoza

Year : 2020/21

28819 - Materials Engineering

Syllabus Information

Academic Year: 2020/21
Subject: 28819 - Materials Engineering
Faculty / School: 175 - Escuela Universitaria Politécnica de La Almunia
Degree: 424 - Bachelor's Degree in Mechatronic Engineering
ECTS: 6.0
Year: 2
Semester: First semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

The principal aim of the subject is to get our students to acquire sufficient knowledge concerning both the concepts and those technical aspects linked to materials and applications in the area of Engineering.

1.2.Context and importance of this course in the degree

The subject of Engineering of Materials is part of the present curriculum of Mechatronics Engineering at the EUPLA. This subject lasts a semester and is taught in the second year and consists of 6 ECTS credits. The subject is compulsory as it belongs to the teaching branch of Mechatronics Engineering.

The student must have a solid foundation concerning all those concepts developed in the subject in order to achieve a better understanding of the materials that can be used in each case, as well as their confirmation techniques and as a result the modification of their properties with each type of processing in order to be able to pass the subjects in later academic years.

1.3.Recommendations to take this course

The subject Engineering of Materials has no prior compulsory requirements. However, students taking the degree in Mechatronics are advised to have passed, or at least have studied, Mathematics I and II as well as Physics I and II.

2.Learning goals

2.1.Competences

As stated in the obligatory competence of the Joint Training CO7 in the Mecatronics Engineering Degree EUPLA report, the main competence of this subject will be acquiring the knowledge of concepts and technical aspects linked to materials and Applications.

Moreover, the student will acquire the following generic and specific competences:

- **GI03**: Knowledge of basic and technological materials that will enable our students to learn new methods and theories which will provide them with sufficient versatility to face new situations.
- **GI04**: The capacity to solve problems with initiative, take decisions, show creativity, foster critical reasoning and the ability to communicate and transmit knowledge, abilities and skills in the field of Industrial Engineering and more particularly in the area of Industrial Electronic Engineering.
- **GI06**: The ability to handle specifications, regulations and sets of mandatory rules.
- **GC02**: The ability to interpret experimental data, contrasting this data with theoretical data and so draw conclusions.
- **GC03**: The ability to use abstract thinking and logical reasoning.
- **GC04**: The ability to learn in a continuous, self-taught and autonomous way.
- **GC05**: The ability to assess options.
- **GC06**: The ability to adapt to rapid evolution of technology.
- **GC07**: The ability to lead a team as well as being a committed member of this team.
- **GC08**: The ability to pinpoint technical information as well as being able to understand and value it.
- **GC09**: Show a positive attitude when faced with technological innovation. **GC10**: The ability to put together

technical documents and be able to present them with the help of adequate computer tools.

- **GC11**: The ability to communicate the student?s reasoning and designs with clarity when speaking to specialist and non-specialist audiences.
- **GC14**: The ability to understand not only the functioning but also be able to develop the maintenance of mechanical, electric and electronic machines and installations.
- **GC15**: The ability to analyse and apply simplified models to technological equipment and applications which enable the students to forecast how they may behave.
- **GC16**: The ability to shape, simulate, build and check electronic and mechanical prototype systems.
- **GC17**: The ability to correctly interpret plans and technical documents.

EI03: Knowledge of the fundamentals of science, technology and materials chemistry. Understand the relationship between the microstructure, synthesis or process and the properties of materials.

2.2.Learning goals

- Know the fundamentals of science, technology and chemistry commonly used in Engineering.
- Understand the relationships between the microstructure and the macroscopic properties of materials.
- Know how to apply knowledge of science, technology and chemistry when it comes to choosing and, in addition, understand the behaviour of metallic, ceramic, poymeric and compound materials.
- Know how to carry out material testing.

2.3.Importance of learning goals

This subject has a marked engineering character, that is to say, it offers training with contents that can be applied and developed immediately in the work place and in the professional field.

Among the functions the graduate in Mecatronics Engineering, we can find application fields as diverse as ergonomics, manufacturing technologies and processes, graphic representation techniques, development of models and prototypes, study of materials and their applications, communication and aesthetics, marketing, design and innovation management, to name but some. Bearing this in mind, Materials Engineering constitutes one of the pillars on which the training of our students must be based, as the structures, components and devices that the graduate will design, manufacture, use and supervise, are made up of materials whose very properties in the last analysis will define both the limits of use and the capacities of the structure or device, such as those techniques that can be used in their manufacture.

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

Assessment is the basic element in the entire teaching-learning process as it is the only mechanism that enables the teacher, at any given moment in the educative process, to pinpoint the degree to which proposed learning results have been achieved and if necessary apply precise corrections.

Assessment must be understood as a continuous and individualised process throughout the entire teaching-learning process highlighting the capacities, attitudes and abilities of each student in addition to student performance.

The assessment process of each student will include two types of testing:

Continuous Assessment Global Testing which will be carried out throughout the entire period of learning.

Global Assessment Testing the results of which will reflect the achievement of learning by the end of the teaching period.

Continuous Assessment Systems.

Following the spirit of The Bologna Plan as regards the degree of involvement and continuous work on the part of the student throughout the academic year, the assessment of the subject will take into account continuous assessment as the most appropriate tool in order to be in tune with the guidelines laid down by the new EHEA framework.

The assessment criteria which are to be followed for those activities involving continuous assessment include:

Individual Project Work: This activity will take shape in the creation of a report regarding a Final Application Project which will include a presentation together with an exposition and discussion of the same, carried out in class and addressed to his/her classmates. This activity will be marked out of ten (the minimum pass mark will be a 5). (Should the group be numerous, this activity will be carried out in pairs).

Laboratory Practice: In each of the practice classes the results and the conclusions obtained in addition to the process followed will be taken into account. Once the practice has been carried out, a report will be handed in to the teacher (according to the model). This activity will be marked out of 10. This activity will be carried out in groups of 2/3 students and the work handed in will be of an individual nature. The final mark will consist of the arithmetic average. (Minimum pass mark 5)

Written Assessment Tests: 3 tests which will consist of the typical written exam marked out of 10 will be carried out. The final mark of the aforementioned activity will be the result of the arithmetic average of those tests, provided there is no mark below 4 in which case the activity would be a fail. (Minimum pass mark 5)

To sum up what has already been said, we have designed the following weighted table of the marking process involving those different activities in which the continuous assessment process of the subject has been structured.

Assessment Activity	*Weighted Mark*
Individual Project Work	15 %
Laboratory Practice	15 %
Written Tests	70 %

Final Assessment Global Test.

The student must choose this option, when owing to the student's personal situation he/she is unable to adapt to the rhythm of work demanded by the continuous evaluation system or has previously failed or wishes to increase his/her mark having already taken part in this kind of assessment.

Just as in the continuous assessment system, the final assessment global test must aim at checking if the learning results have been achieved, in addition to contributing to the acquisition of diverse competences which must be carried out my means of even more objective methods.

The final assessment global test will consist of the following group of assessable activities:

Laboratory Practice: The student will hand in a report of all the practices (carried out throughout the academic year) at the beginning of the global assessment test as a *sine qua non* to being able to pass the subject. The student will be asked to answer those questions formulated by the teacher in written form. This activity will be marked out of 10, 5 marks will be given to the report and 5 marks to those questions formulated by the teacher. (Minimum pass mark 5)
Written Exam: This will consist of a test which will be made up of questions and problems relative to the topics explained throughout the academic year. The teacher will mark this test out of 10. (Minimum pass mark 5)

By way of summarising what has already been explained, the following weighted marking table has been designed to assess the different activities which make up the final assessment process of the subject.

Assessment Activity	**Weighted Mark**
Individual Project Work	**10 %**
Laboratory Practice	**10 %**
Written Tests	**80 %**

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The learning process designed for this subject is based on the following:

Strong interaction between the teacher/student. This interaction is brought into being through a division of work and responsibilities between the students and the teacher. Nevertheless, it must be taken into account that, to a certain degree, students can set their learning pace based on their own needs and availability, following the guidelines set by the teacher.

The current subject Materials Engineering is conceived as a stand-alone combination of contents, yet organized into three fundamental and complementary forms, which are: the theoretical concepts of each teaching unit, the solving of problems or resolution of questions and laboratory work, at the same time supported by other activities.

The organization of teaching will be carried out using the following steps:

1. Face-to-face generic activities:

- **Lectures**: The theoretical concepts of the subject are explained.
- **Practice Sessions**: Problems and practical cases are carried out.
- **Monitored Practices**: Exercises and practical cases are carried out, complementary to the theoretical concepts studied.

2. *Supervised Autonomous Activities*: These activities are carried out independently by students under the supervision of the teachers of the subject. The student will have questionnaires available per unit and suggested exercises and will be allowed to attend face-to-face or group tutorials to focus on solving them.

3. *Reinforcement activities*: Through the virtual learning portal (Moodle) or email of the University of Zaragoza, teachers of the subject will develop, for particular cases for which conventional tutoring cannot be applied, support and help activities for students who need it solving doubts or providing solutions to problems connected with the units covered.

If classroom teaching were not posssible due to health reasons, it would be carried out on-line

4.2.Learning tasks

The course includes the following learning tasks:

Involves the active participation of the student, in a way that the results achieved in the learning process are developed, not

taking away from those already set out, the activities are the following:

- Theory/Practice Lectures: Theoretical activities or problems carried out mainly through exposition by the teacher.
- Practice Sessions: Theoretical discussion activities or exercises and practical cases presented by students
- Practical laboratory testing: This work is tutored by a teacher in the laboratory. These activities will continue with autonomous student work.
- Individual tutorials: These tutorials may be face-to-face or virtual (Moodle or email).
- Group tutorials: Scheduled tracking learning activities in which the teacher meets with a group of students to answer questions, exams or problems

The subject has 6 ECTS credits, which represents 150 hours of student work in the subject during the trimester, in other words, 10 hours per week for 15 weeks of class. 40% of this work (60h) will be held in the classroom and or lab and the rest will be autonomous.

A summary of a weekly timetable guide can be seen in the following table.

Activity	Weekly school hours
Lectures	2-3
Practical laboratory testing	1-2
Other Activities	6

4.3.Syllabus

The course will address the following topics:

- THEORETICAL CONTENT

UNIT 1. MATERIALS FOR ENGINEERING. PROPERTIES.

Types of materials for engineering. Classification of Materials based on Structure.Materials design and selection. Atomic Structure.Electronic structure of the atom. Atomic bonding.Mechanic, thermal, electric and magnetic properties.

UNIT 2. MECHANICAL PROPERTIES, TEST AND FATIGUE.

Stress and Strain.Solid solution hardening (alloying).Hardening mechanisms of materials.Precipitation hardening. Polymorphic transformation. Hot-working. Tensile, compression, shear, torsion, bending and hardness testing. Fatigue testing. Impact testing.Factors related to the selection of materials. Stress concentration.Cyclic stress. Stress-life (S-N) and factors that affect fatigue behaviour. The crack formation, crack propagation and fracture.

UNIT 3. ELECTRICAL, MAGNETIC AND OPTICAL PROPERTIES.

Electrical resistivity and conductivity.Semiconductors and superconductors.Dielectric properties and polarization. Piezoelectricity and electrostriction. Ferromagnetic theory. Magnetic materials. Applications.Optical properties. Example of emission.Material photonic interactions.

UNIT 4. METALS. HEAT TREATING.

Iron and steel products.Fe-C system.Fe-C alloys.Structural constituents.Role of alloying elements in the steels.Classification of steels and commercial forms. Effects of alloying in iron and steel.Heat treatment of steels. Annealing. Normalizing. Tempering. Hardening. Surface treatment systems. Surface hardening. Thermochemical treatments.Cementation. Nitriding.Cast iron. Classification of cast iron and cast alloys. Alloyed steels.Alloying elements. Classification. Metals and non-ferrous alloys (Aluminum. Magnesium. Titanium, Copper).Anti-friction alloys and refractory alloys.

UNIT 5. CERAMIC MATERIALS.

Classification.Crystalline ceramics. Characteristics. Study of the different ceramic materials: crystalline and/or refractory. Structural and electronic ceramic compounds. Glass.

UNIT 6. POLYMERIC MATERIALS.

Introduction. Structure in polymers and copolymers. Polymerization reactions.Classification based on structure. Effect of temperature on polymers. Elastomers (Rubbers) and plastics. Natural fibres. Artificial and synthetic fibres.

UNIT 7. COMPOSITE AND HYBRIDS MATERIALS.

Reinforced materials.Dispersion-strengthened composites.Particulate composites.Fiber-reinforced composites. Fiber-reinforced characteristics and composite matrix. Manufacturing techniques for reinforced composites. Laminar composite materials.Agglomerate compound materials .

UNIT 8. CORROSION AND WEAR.

Chemical corrosion.Electrochemical cell or battery. Types of electrochemical corrosion, propagation and protection. Oxidation. Radiation damage. Wear and erosion.

- PRACTICAL CONTENTS

Most of the subjects in the section above have different situations and their possible solution. And some of them have practical laboratory testing. Next is a list of the test to be developed by the students in the laboratory in two hours sessions.

Section I. Determination of mechanical characteristics. Destructive testing.

1- Tensile Testing on metallic materials and polymers.

2- Hardness determination of metallic materials.

3- Determination of Shore hardness in plastics and elastomeric materials.

4- Impact testing. Resiliency

Section II. Material properties. Inspection.

1- Metallography

2- Ultrasonic testing

3- Extensometry.

Section III. Properties and characteristics of composite materials

1- Porous materials density determination.

2- Cement Mechanical strength.

3- Fiber laminated composites testing

4.4.Course planning and calendar

For the students in the continuous evaluation system, the written test will be held at the end of each section. The final dates will be announced during the scholar year in the Moodle. The weekly schedule of the subject will be published at http://www.eupla.unizar.es/asuntos-academicos/calendario-y-horarios

The dates of the global evaluation test (official calls) will be published at http://eupla.unizar.es/asuntos-academicos/examenes

4.5.Bibliography and recommended resources

http://biblos.unizar.es/br/br_citas.php?codigo=30120&year=2020