Materials science and engineering

Academic Year: (2023 / 2024) **Review date: 12/05/2023 13:15:27**

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

Coordinating teacher: ALVAREDO OLMOS, PAULA

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 2

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.
COCIN1. Ability to draft, sign and develop projects in the area of industrial engineering for construction, renovation, repair, preservation, demolition, manufacture, installation, assembly or operation of: structures, mechanical equipment, energy installations, electrical and electronic installations, industrial plants and installations and automation and manufacturing processes.
COCIN3. Knowledge of basic and technological subject areas that will capacitate them to acquire new methods and theories and endow them with the versatility to adapt to new situations.
COCIN4. Ability to resolve problems with initiative, decision-making, creativity, and critical reasoning skills and to communicate and transmit knowledge, skills and abilities in the Industrial Engineering field.
COCIN5. Knowledge to perform measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and other similar jobs.
CEP3. Ability to design and carry out experiments to analyze and interpret data obtained.
CER3. Knowledge of the fundamentals of materials science, technology and chemistry. Understanding of the relation between the microstructure, synthesis and processing and materials properties.
CER8. Knowledge and use of the principles of materials resistance.

By the end of this content area, students will be able to have:
RA1.1. Knowledge and understanding of materials science and engineering fundamentals.
RA1.4. Awareness of the wider multidisciplinary context of engineering.
RA2.1. The ability to apply their knowledge and understanding to identify, formulate and solve problems of materials science and engineering using established methods.
RA4.2. The ability to design and conduct appropriate experiments, interpret the data and draw conclusions.
RA4.3. Workshop and laboratory skills.
RA5.1. The ability to select and use appropriate equipment, tools and methods.
RA5.2. The ability to combine theory and practice to solve problems of materials science and engineering.
RA5.3. An understanding of applicable techniques and methods in materials science and engineering, and of their limitations.

OBJECTIVES

1. Have knowledge and understanding of the fundamentals of materials science, technology and chemistry.
2. Be aware of the multidisciplinary context of engineering.
3. Have the ability to apply their knowledge and understanding to identify, formulate, and solve materials science, technology, and chemistry problems using established methods.
4. Have the ability to design and perform experiments to solve materials science, technology, and chemistry problems, interpret data, and draw conclusions.

5. Have technical and laboratory competencies in materials science, technology and chemistry.
6. Have the ability to select and use appropriate equipment, tools, and methods to solve materials science, technology, and chemistry problems.
7. Have the ability to combine theory and practice to solve materials science, technology and chemistry problems.
8. Have an understanding of applicable methods and techniques in materials science, technology and chemistry and their limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

Introduction to Materials Science and Engineering
1. Materials Science and Engineering Framework. Concept
2. Types of Materials: Classification
3. Selection of materials
4. Relationship between structure, properties and processing
Bonding in solids
1. Types of bonding in solids
2. Bonding nature and types of materials
3. Ionic bond
4. Partial covalent bond.
5. Metallic bond. Band theory and other theories
Crystalline structures
1. Energy and crystalline lattices
2. Description of the crystaline structure
3. Main metallic structures.
4. Interstitial positions
5. Atomic positions, directions, and crystallographic planes
6. Comparison between FCC, HCP and BCC crystalline structures
7. Atomic density in crystals: linear, planar and volumetric
Defects in solids
1. Perfect and imperfect crystals: thermodynamic considerations.
2. Types of defects
3. Point defects.
4. Linear defects.
5. Planar defects.
6. Solid solutions in metals and ceramics.
Mass transport: diffusion.
1. Definition of solid state diffusion.
2. Diffusion mechanisms: substitutional and interstitial
3. Macroscopic laws governing diffusion.
4. Factors that influence the diffusion process:
5. Examples
Phase equilibrium diagrams.
1. Basic concepts. Constituents, phases and components
2. Phase diagrams of one-component systems.
3. Binary Systems
4. Ceramic phase diagrams
Charge Transport: Electrical Properties
1. Classification of materials based on their electrical properties.
2. Basic concepts.
3. Resistivity in Conductive Materials (metals)
4. Semiconductor materials.
5. Insulators and dielectric materials.
Mechanical properties
1. What are mechanical properties?
2. How are they evaluated? Concept of stress and strain
3. Types of mechanical tests
4. Uniaxial tensile test: nominal stress and strain.
5. Hardening mechanisms
Metallic Materials
1. Classification. Ferrous and non-ferrous alloys. General characteristics of:
2. Obtaining metallic materials: Solidification: Nucleation and Growth
3.Forming by plastic deformation: Strain hardening

4. Steels: Transformations in equilibrium in the Fe-C system.
5. Steels: Transformations out of equilibrium in the Fe-C system.
Ceramic materials
1. Classification.
2. Crystalline structures of ceramics:
3. Main ionic crystalline structures.
4. Structure of covalent ceramics.
5. Non-crystalline ceramic materials: glasses.
6. Behavior in service
7. Processing of ceramic materials
Polymeric materials
1. General Characteristics
2. Polymerization
3. General concepts
4. Thermal transitions: Tm and Tg
5. Thermoplastics, thermosets and elastomers
6. Mechanical behavior.
7. Processing of polymer materials
Composite materials.
1. Classification according to the type of reinforcement and matrix
2. Type of constituents:
3. MC reinforced with particles (by dispersion and with particles)
4. Rule of mixtures
5. Fiber-reinforced MC
6. Elastic properties (MC with polymeric matrix and continuous fibers)
7. Structural materials (laminates and sandwich structures)
8. Applications and Limitations of MC
9. Processing of Composite Materials

LEARNING ACTIVITIES AND METHODOLOGY

Masterly classes, classes to solve doubts in reduced groups, student presentations, individual tutorship and personal work of the student; oriented to acquire theoretical knowledge (3 ECTS credits).
Laboratory classes, classes for solving problems in reduced groups; individual tutorship and personal work of the student; oriented to acquire practical knowledge related to subject program (3 ECTS credits).

ASSESSMENT SYSTEM

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

The assistance to the laboratory sessions is MANDATORY. The entrance to the laboratory is enabled once the student has watched the general security video and the specific video for materials lab and answered both tests correctly. THE STUDENT CAN NOT ENTER THE LABORATORY IF HE/SHE HAS NOT ANSWERED THE TESTS. THE NON-ASSISTANCE TO THE LABORATORY WITHOUT JUSTIFIED CAUSE IMPLIES SUSPENDING THE CONTINUOUS EVALUATION.

40% of the continuous assessment will be given by:

30%: Three mid-term exams, each with an calification of 10%, which will be done during class time.
10%: Lab work done outside of class time. The final note of the laboratory will be given by the behavior in the laboratory, realization of lab work and realization of a questionnaire at the end of each session.
60% of the continous assessment will be given by the score of the final exam.
For continuous evaluation a minimum score of 4 is required on the final exam.

Normative continuous assessment:
https://www.uc3m.es/ss/Satellite/UC3MInstitucional/en/ListadoNormativas/1371206706530/Estudios_de_Grado

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

BASIC BIBLIOGRAPHY

- ASHBY MF, JONES DRH. Materiales para Ingeniería 1. Introducción a las propiedades, las aplicaciones y el diseño¿., Reverté. 2008.

- ASKELAND DR. "Ciencia e Ingeniería de los Materiales",, International Thomson, 4ª Edición, Madrid, 2001.

- CALLISTER WD. "Ciencia e Ingeniería de los Materiales". Vol. I,, Ed Reverté, 3ª Edición, Barcelona, 1995.

- MANGONON PL. ¿Ciencia de Materiales. Selección y Diseño¿., Prentice Hall, 1ª Edición, Méjico, 2001.

- SHACKELFORD JF. "Introducción a la Ciencia de Materiales para ingenieros",, Prentice Hall, 4ª Edición, Madrid, 1998.

- SMITH WF. "Fundamentos de la Ciencia e Ingeniería de Materiales",, McGraw-Hill, 3ª Edición, Madrid, 2003.