Materials science and engineering

Academic Year: (2021 / 2022) **Review date: 09-07-2021**

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

Coordinating teacher: RABANAL JIMENEZ, MARIA EUGENIA

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Basic Chemistry

OBJECTIVES

By the end of this content subject, students will be able to have:

1. Knowledge and understanding of key aspects of materials science, technology and chemistry.
2. The ability to apply their knowledge and understanding to identify, formulate and solve problems of materials science, technology and chemistry using established methods;
3. The ability to design in Engineering under specific requirements
4. The ability to design and conduct appropriate experiments of materials science, technology and chemistry, interpret the data and draw conclusions;
5. Workshop and laboratory skills in materials science, technology and chemistry.
6. The ability to select and use appropriate equipment, tools and methods to solve problems of materials science, technology and chemistry;
7. The ability to combine theory and practice to solve problems of materials science, technology and chemistry;
8. An understanding of applicable techniques and methods in materials science, technology and chemistry, and of their limitations.
9. Awareness of the multidisciplinary context of Engineering

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Materials Science and Engineering
1.1. Materials Science and Engineering Framework. Concept
1.2. Types of Materials: Classification
1.3. Selection of materials
1.4. Relationship between structure, properties and processing
2. Bonding in solids
2.1. Types and nature of bonding in solids
2.2. Ionic bond
2.3. Covalent bond.
2.4. Metallic bond. Band theory and other theories
3. Crystalline structures
3.1. Energy and crystalline lattices
3.2. Description of the crystalline structure
3.3. Main metallic structures.
3.4. Interstitial and hole positions
3.5. Atomic positions, directions, and crystallographic planes
3.6. Comparison between FCC, HCP and BCC crystalline structures
3.7. Atomic density in crystals: linear, planar and volumetric
3.8. Packing factor: occupied volume/total volume
4. Defects in solids
4.1. Perfect and imperfect crystals: thermodynamic considerations.
4.2. Types of defects
4.3. Classification of defects: point, lineal, planar and surface.
4.4. Solid solutions in metals and ceramics.
5. Mass transport: diffusion.
5.1. Definition and mechanism of solid state diffusion.
5.2. Mechanism of solid state diffusion
5.3. Macroscopic laws governing diffusion.
5.4. Factors that influence the diffusion process

6. Phase equilibrium diagrams.
6.1. General concepts. Constituents, phases and components
6.2. Phase diagrams of one-component systems and Binary Systems
6.3. Ceramic phase diagrams
7. Charge Transport: Electrical Properties
7.1. Classification of materials based on their electrical properties.
7.2. Resistivity in Conductive Materials (metals)
7.3. Semiconductor materials.
7.4. Insulators and dielectric materials.
7.5. Application
8. Mechanical properties
8.1. Methods and Types of mechanical tests
Different mechanical test: Uniaxial tensile test: nominal stress and strain, Charpy method, flexion test,¿.
8.2. Hardening mechanisms
8.3. Hardness
9. Metallic Materials
9.1. Classification. Ferrous and non-ferrous alloys. General characteristics of:
9.2. Obtaining metallic materials: Solidification: Nucleation and Growth
9.3. 3.Forming by plastic deformation: Strain hardening
9.4. Steels: Transformations in equilibrium in the Fe-C system.
9.5. Steels: Transformations out of equilibrium in the Fe-C system.
10. Ceramic materials
10.1. General and particular properties and Classification.
10.2. Main ionic crystalline structures.
10.3. Structure of covalent ceramics.
10.4. Non-crystalline ceramic materials: glasses.
10.5. Fabrication and Processing of ceramic materials
11. Polymeric materials
11.1. Bond and general Characteristics
11.2. Reaction of synthesis: Polymerization
11.3. Thermal behaviour: thermal transitions: Tm and Tg
11.4. Classification of polymers: Thermoplastics, thermosets and elastomers
11.5. Mechanical behavior.
11.6. Processing of polymer materials
12. Composite materials.
12.1. Classification according to the type of reinforcement and matrix
12.2. Rule of mixtures
12.3. MC reinforced with particles (by dispersion and with particles)
12.4. Fiber-reinforced MC
12.5. Elastic properties (MC with polymeric matrix and continuous fibers)
12.6. Structural materials (laminates and sandwich structures)
12.7. Synthesis and Applications of MC
12.8. 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 the subject program (3 ECTS credits).

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 chemistry/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.

ASSESSMENT SYSTEM

Continuous evaluation (40-60% of final weight) will have a minimum of three parts: (i) a minimum of three exercises, during classes, with 10% weight (30-50%% of final mark); (ii) laboratory practices, solving a questionnaire or test at the end, with a 10% weight.

Assessable activities will be carried out during the lectures, which will account for 10-15% of the continuous assessment.

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 chemistry/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.

It is necessary to get at least a 4 on the final exam to pass the course.

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

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.

ADDITIONAL BIBLIOGRAPHY

- ASHBY MF, JONES DRH Materiales para Ingeniería 1. Introducción a las propiedades, las aplicaciones y el diseño¿, Reverté, 2008
- J.M. Montes, F.G. Cuevas, J. Cintas Ciencia e Ingeniería de los Materiales, Paraninfo, 2014