PERSONA CIÈNCIA EMPRESA
UNIVERSITAT RAMON LLULL

COURSE: SCIENCE AND TECHNOLOGY OF MATERIALS

SUBJECT MATTER: Materials Science and Technology
MODULE: Core Topics of Industrial Engineering
PROGRAM: Degree in Chemical Engineering

GENERAL CHARACTERISTICS

Type: ☐ Basic Formation, ☑ Compulsory, ☐ Elective
☐ Final Degree Project, ☐ Internship

Duration: Semestral **Semester/s**: 5
Number of ECTS credits: 6
Language/s: Catalan, (Spanish, English)

DESCRIPTION

SHORT DESCRIPTION AND JUSTIFICATION

This course is designed to be a one-year introduction to Materials Science and Technology. The course is focused on emphasizing the relationship between structure and properties in materials. In the first part of the course, the topics related to the structure of the materials are presented. Also included are solid state diffusion and concepts and kinetics of phase transformations and microstructure formation. The principles of thermodynamics are applied to materials and special attention is paid to the description, construction and applications of phase diagrams. Finally, the properties of the materials are presented and a brief introduction is given to the characterization of materials and their behaviour in service.

In the second part, a description is presented, based on the structure-properties relationship, of the potential application of the most commonly used metallic, ceramic and polymeric materials.

COMPETENCES

- To be able to understand and apply technical knowledge of materials, for the application in the field of Chemical Engineering. (CB1, E2).
- To be able to use systems, components or processes to achieve the requirements established in the activity to be carried out in the field of Chemical Engineering. (CB2, E6)
- To be able to identify, formulate and solve basic problems in in the fields of Chemistry and Engineering (CB2, E7).
- That students are able to convey information, ideas, problems and solutions to both specialized and non-specialized audiences (CB4).
- Knowledge of the fundamentals of science, technology and chemistry of materials. Understand the relationship between microstructure, synthesis or processing and material properties. (CRI3)

PREREQUISITES

According to the program planning and academic regulations.

CONTENTS

1.- Why to study Materials Science
   1.1. Material definition
   1.2. Relationship between structure and properties in.
   1.3. The circle of Materials.
   1.4. Materials cycle and development.
2.- Solid State
   2.1. Physical states of materials.
   2.2. Order and disorder in materials.
   2.3. Crystalline state.
   2.4. Structure of the main materials.
3.- Defects in the crystalline structure of materials
   3.1. Atomic defects.
   3.2. Dislocations.
   3.3. Bidimensional defects.
4.- Diffusion in the solid state
   4.1. Diffusion mechanism
   4.2. Steady state diffusion. 1ª Fick's Law
   4.3. Non-steady state diffusion. 2ª Fick's Law
   4.4. Diffusion dependence.
5.- Solidification
   5.1. Homogeneous and heterogeneous solidification
   5.2. Thermal and constitutional undercooling
   5.3 Solidification in a mold.
6.- Alloys and phase diagrams
   6.1. Alloys.
   6.2. Phase diagrams theory.
   6.3. Phase equilibrium in binary systems. Use in materials science.
   6.4. Phases transformations
   6.5. Microstructures
7.- Mechanical properties of materials
   7.1.: Cohesion, elasticity, plasticity and toughness.
   7.2. Stress-strain diagram.
   7.3. Hardness: definition and measuring.
   7.4. Resilience: definition and measure

8.- Mechanical behavior of materials in service.
  8.1. Brittle Fracture
  8.2. Ductile Fracture
  8.3. Creep.
  8.4. Fatigue.
9.- Metallic Materials I. Ferrous materials.
  11.1. Fe/C diagram
  11.2. Steels.
  11.3. Cast Irons.
10.- Metallic Materials II. Non-ferrous materials.
  12.1. Aluminum-based alloys.
  12.3. Copper-based alloys.
11.- Polymeric organic materials.
  11.1. Thermoplastics.
  11.2. Thermosets.
  11.3. Elastomers.
12.- Ceramic materials.
13.- Biomaterials Introduction
    13.1: Biomaterials and Biomimesis
    13.2. Bioactive surfaces
    13.3. Hydrogels for tissue engineering

METHODOLOGY

LEARNING ACTIVITIES

Learning activities	Hours	ECTS Credits	Competences
Lectures	43	1,6	CB1, E2, CRI3
Case and Problem-Solving Sessions	14	0,5	CB2, E7, CRI3
Seminars	--	--	--
Practical & Lab Work	--	--	--
Presentations	5	0,2	CB1, E2, CB4, CRI3
Personal study	95	3,5	CB1, E2, CB2, E6, E7, CRI3
Assessment Tasks (Exams, Continuous Assessment...)	5	0,2	CB1, E2, CB2, E6, E7, CRI3
TOTAL	**162**	**6**	

The practical work of materials science is qualified in the subject Chemical and Engineering Laboratory III.

TEACHING METHODOLOGY

The methodology combines master classes with work in the Laboratory and interactive work using the Internet.

Students carry out Materials Science and Technology practical work within the framework of the Chemical and Engineering Laboratory III.

When finalizing each chapter, the student realizes through the page of the subject in the Virtual Campus or of self-evaluation. To follow its evolution, the results are sent directly to the professor. Throughout the course, exercises are organized in the wiki format. Students must write, through a web application, the answer to a topic related to the subject. After the correction and evaluation by the professors of the subject, these chapters are available to students to prepare the exams of the subject. Within each chapter, a series of questions are raised that the student can answer to the professor through participation in the Forum of the subject and that allow to follow the learning of the student.

ASSESSMENT

ASSESSMENT METHODS

Assessment Methods	Weight	Competences
Final Exam	50%	CB1, E2, CB2, E7, CRI3
Midterm Exam/s	--	
Follow-up Activities	25%	CB1, E2, CB2, E6, E7, CRI3
Reports and Presentations	5%	CB1, E2, CB4, CRI3
Lab or Field Work	20%	CB1, E2, CB2, E6, E7, CRI3
Projects	-	
Host Student Evaluation	-	
Participation	-	

The practical work of materials science is qualified in the subject Chemical and Engineering Laboratory III.

LEARNING OUTCOMES

- The student will demonstrate a basic understanding of the relationship between structure and properties (CB1, E2).
- The student will demonstrate the ability to solve problems and cases in the field of Materials Science, as well as share ideas electronically (CB2, E7).

- The student will demonstrate oral and written ability to present their ideas in public (CB4).
- The student will demonstrate ability to test materials. (CB2, E6)

QUALIFICATION

A. At the end of the course the final exam is mandatory to pass the subject (50% of the final grade). The minimum mark to average with the remaining notes is 4 (40% of the total)
B. Tests: After each chapter a test is placed on the Virtual Campus page of the subject. The results are automatically sent to the professor.
C. Homework: Throughout the course, exercises are organized. Students must write, through a web application, the answer to a topic related to the subject. In addition, the professor proposes to the class, after each chapter, some specific questions. The student can comment with their classmates and the professor, using the online forum on the web page of the course on the Virtual Campus. The result of these exercises corresponds to 10% of the final grade
D. Class participation is promoted, but it has no influence on the final grade.
E. Materials Science practical work are carried out within the framework of the Chemical and Engineering Laboratory III. This subject contributes the corresponding qualification to the part of Science of the Materials that computes a 20% of the subject of Science of the Materials
F. In order to the continuous assessment exercises could average with the final exam, the average grade must be greater than 7 (70%).
G. The *pass* grade is obtained when the average between the final exam and the exercises of continuous evaluation is superior to 6 (60%). Otherwise the mark that will be obtained from the subject will be a 4.

ASSESSMENT OF THE COMPETENCES

- For the evaluation of the CB1 / E2 competence, the indicator used will be the final exam note and the follow-up activities.
- For the evaluation of the CB2 / E7 competence, the indicator used will be the final exam mark and the follow-up activities.
- For the evaluation of E6 competence, the indicator will be the note of follow-up activities.
- For the evaluation of the CB4 competence, the indicator will be the note of papers and presentations.
- For the evaluation of the CRI3 competence, the final grade of the subject will be used as an indicator.

BIBLIOGRAPHY

- Ashby, M.F., Jones, D. R., , P.L. Materiales para Ingeniería 1, Introducción a las propiedades, las aplicaciones y el diseño., Ed. Reverté, Barcelona, 2ª Edició 2015.
- Ashby, M.F., Jones, D. R., , P.L. Materiales para Ingeniería 2, Introducción a la microestructura, el procesamiento y el diseño., Ed. Reverté, Barcelona, 2ª Edició 2015
- Mangonon, P.L. Ciencia de Materiales, Selección y Diseño, , Ed. Prentice Hall, Mexico, 1ª Edition 2001
- Callister, W., Ciencia e Ingenieria de los Materiales, Ed. Reverté, Barcelona 3era Edition1999.
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- Kurs, W., et al., Introduction à la Science des Materiaux, Ed. Presses Polytechniques et Universitaires Romandes, Lausanne, 1993.
- Llasheras, J.M.; Carrasquilla, J., Ciencia de los Materiales, Ed. Donostiarra, San Sebastián 1991.
- Flinn, R., Trojan, P., Materiales de Ingenieria y sus aplicaciones, Ed. McGraw-Hill, Madrid 1999.
- Grossberg, Alexander Yu., Khokhlov, A.R., Giant Molecules, Here, There and Everywhere, 1a Edition, Ed. Academic Press, Nova York, 1997.

ADDITIONAL BIBLIOGRAPHY OR MATERIAL:

CD ROM

- University of Wisconsin, Solid State Resources JCE Software
- Russ, J.V., Materials Science: A multimedia approach PWS Publishing Company, 1995
- Mathias, L.J., et al. Macrogallery, , MRG Polymer Press, University of Southern Mississipi, Hattiesburg (MS), 1998

INTERNET:

- Visualizing Materials Science: vims.ncsu.edu/index.acgi

DOCUMENT HISTORY

PREVIOUS REVISIONS
September 2017, Dr. Salvador Borrós Gómez
September 2016, Dr. Salvador Borrós Gómez
September 2015, Dr Salvador Borrós Gómez
September 2011, Dr Salvador Borrós Gómez

CURRENT REVISION
March 2019, Dr Salvador Borrós Gómez