COURSE DATA

Data Subject	
Code	34925
Name	Materials science
Cycle	Grade
ECTS Credits	6.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
1404 - Degree in Industrial Electronic Engineering	School of Engineering	2	Second term

Subject-matter

Degree	Subject-matter	Character
1404 - Degree in Industrial Electronic Engineering	10 - Equipment design and materials	Obligatory

Coordination

Name	Department
FERNANDEZ DOMENE, RAMON MANUEL	245 - Chemical Engineering

SUMMARY

The discipline Materials and Process Equipment Design establish the principles and basic procedures to make the mechanical design of process equipments and facilities. It looks for the foundations to choose the material appropriate to each process equipment, in function of the chemical products that will be in contact with them, as well as of the atmosphere that will support and the work conditions. Also the practical application of the basic principles of design, to the different process equipments and systems in an industry.

In the development of the program of the subject, in addition to its descriptors, it has been taken account the rest of the imparted subjects, as well as their contents, to the object of getting a complete formation of the future Graduated in Industrial Electronic Engineering, including basic contents of Resistance of Materials and Corrosion that allow to approach in an appropriate way the later development of the different process equipments that will be part of the installation (as well as to establish their conditions of security and good operation).

The development of the program of the subject should be based on already acquired knowledge, deepening in the materials more employees in electronic equipments, mainly valuing its mechanical performance and its resistance to the corrosion. Also, it will be a complement of the subjects, developed in other modules of the degree, where the factors to consider in the design of different electronic elements has been already described.

The aim is to have some wide bases about the design of the electronic facilities of an industrial plant, which will be developed in a project of design, which will combine the technical data with reasons both economic and environmental efficiency.

The Materials Science subject is a compulsory subject that is imparted in the second course of the degree in Industrial Electronic Engineering during the second quarter. In the plan of studies of the Universitat of València, it consists of a total of 6 credits ECTS.

It is a subject with a great practical component in which, after the introduction of the concepts, the students will carry out numerous practical exercises.

The objective of the matter is that the students acquire the basic knowledge of Materials Science necessary for the study, design and/or operation of the most frequent systems in the electronic industry.

The contents of the subject are: Technology, chemistry, synthesis and processing of the materials. Types and structural characteristics. Properties and applications of the metallic materials, polymers, ceramics and composites. Corrosion. Performance and control of materials. Degradation and failure of materials. Inspection and testing. Elasticity and resistance of the materials.

The theory classes will be taught in Spanish and practical classes as stated in the course information available on the website of the degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

To successfully tackle the subject, the student must have prior knowledge corresponding to the level required in subjects taken in the first and second year. Such prior knowledge includes: Mathematics, Physics and Chemistry.
In addition, a basic level of English reading is suggested.

OUTCOMES

1404 - Degree in Industrial Electronic Engineering

- CG3 - Knowledge of basic and technological subjects that allows students to learn new methods and theories and provides them with versatility to adapt to new situations.
- CG4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering (with specific industrial electronics technology).
- CG6 - Ability to deal with specifications, regulations and mandatory standards.
- CG8 - Ability to apply the principles and methods of quality control.
- CG10 - Ability to work in a multilingual and multidisciplinary environment.
- CG11 - Knowledge, understanding and ability to apply the necessary legislation for practising professionally as a qualified industrial engineer.
- CG20 - Understanding of the basics of materials science, technology and chemistry. Understand the relationship between microstructure, synthesis or processing and the properties of materials.
- CG25 - Knowledge and use of the fundamentals of the strength of materials.

LEARNING OUTCOMES

- To understand the relationship of the microscopic structure, the type of chemical bonds, the synthesis and the processing with the properties and characteristic of the materials. (CG20)
- To know the properties (chemical, mechanical, thermal and electric) and industrial applications of different types of materials: ceramics, metals, glasses, polymers, and composites, as well as their degradation processes, life and use prevention. (CG3, CG10, CG20)
- To select the good material for a certain application and to justify their choice. (CG4, CG6, CG25)
- To determine the mechanical properties of the materials and the types of tests are used. (CG4, CG6, CG25)
- To know the mechanisms of corrosion and fracture, and to know how to avoid them. (CG4, CG6, CG25)
- To know the bases of static, elasticity and resistance of the materials and their application to the analysis of industrial equipments. (CG4, CG6, CG25)
- To know the types, bases and functionality of the more frequent equipments and elements in the industry. (CG10, CG20)
- To select the appropriate equipment and/or element for a certain application and to justify their choice. (CG4, CG6, CG25)
- To know and to apply regulations and industrial codes in the mechanical design of equipments and simple structural elements. (CG4, CG6, CG8, CG11, CG25)
- To know and to apply the principles of security in mechanic design of equipments and simple structural elements. (CG4, CG6, CG8, CG25)
- To be able to analyze the predictable failures in industrial facilities. (CG4, CG6, CG8,CG25)
- To prepare and to edit written reports.
- To carry out designs in an individual way and in group. (CG10)

Skills to acquire

The student should be able:

- To know the properties (chemical, mechanical, thermal and electric) and industrial applications of different types of materials: ceramics, metals, glasses, polymers, and composites.
- To determine the mechanical properties of the materials and the types of tests are used.
- To know the mechanisms of corrosion as well as their degradation processes and to know methods of prevention.
- To know the fracture types, and to know how to avoid them.
- To know the bases of elasticity and resistance of the materials and their application in industrial equipments.
- To know the types, bases and functionality of the more frequent equipments and elements in the electronic industry.
- To select the good material for a certain application and to justify their choice.
- To know and to apply regulations and industrial codes in the mechanical design of equipments and simple structural elements.
- To know and to apply the principles of security in the mechanic design of equipments and simple structural elements.
- To be able to analyze the predictable failures in industrial facilities.
- To prepare and to edit reports writings.
- To carry out designs in an individual way and in group.

Besides the specific objectives pointed out previously, during the course the development of diverse social and technical skills will be fomented, among which include:

- Ability for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to transmit ideas, problems and solutions.
- Ability to argue from rational and logical criteria.
- Ability to speak in a correct and organized way.
- Ability to develop a problem in a systematic and organized way.
- Ability to critically analyze the results of a problem.
- Ability to work in an autonomous way.
- Ability to be integrated and to participate actively in group tasks.
- Ability to distribute the time appropriately for the development of individual and group tasks.

DESCRIPTION OF CONTENTS

1. Science and Engineering of the Materials

Introduction. Materials science and engineering. Materials properties. Materials classification. Materials in electronic engineering. Modern materials need.

2. Mechanical Properties of Materials

Stress and strain. Elastic deformation. Hooke's law. Deformation in shear or torsion. Stress-strain curve. Plastic Deformation. Engineering parameters: ductility, resilience and toughness. Hardness.
Bending and beams analysis. Axial compression in columns.
Service behavior: materials failure. Fundamentals of simple fracture. Ductile and brittle fracture. Griffiths theory of brittle fracture. Fracture toughness. Inspection. Impact fracture tests. Fatigue. Cyclic stresses. Creep.
Mechanical behavior of metals, ceramics, polymers (viscoelasticity) and composites.

3. Thermal Properties of Materials

Service temperatures. Heat capacity. Thermal expansion. Thermal conductivity. Thermal diffusivity. Design aspects.

4. Electrical, Magnetic and Optical properties of Materials

Electrical conduction. Dielectric behavior. Semiconductors. Other electrical characteristics of materials. Diamagnetism and paramagnetism. Ferromagnetism. Ferrimagnetism. Soft and hard magnetic materials. Superconductivity.
Interaction between materials and light. Design of optic characteristics. Applications of optic phenomena.

5. Corrosion and Degradation of Materials

Fundamentals of electrochemical corrosion of metals. Electrode potentials. Corrosion cells. Corrosion rate. Polarization curves. Passivity. Types of corrosion. Protection. Degradation of ceramics and polymers.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	40,00	100
Classroom practices	20,00	100
Development of individual work	10,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	30,00	0
Preparation of practical classes and problem	30,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

The development of the subject is structured around the classes of theory and problems, and the completion of assignments.

In the theory classes the lecture model will be used. The teaching staff will present through presentation and / or explanation the contents of each topic, focusing on those key aspects for understanding it.

The practical classes of problems will be developed following two models. In some of the classes it will be the teachers who solve a series of standard problems so that the students learn to identify the essential elements of the approach and resolution of the problem. In other kinds of problems, it will be the students, individually or distributed in groups, who will have to solve similar problems under the supervision of the teacher. The proposed works will consist of exercises of different complexity to be solved in class individually and in groups, to obtain immediate feedback.

The possibility of including a seminar is also foreseen, which will consist of one or two sessions in which the students will present as a group the results of a bibliographic research work.

In all aspects of this methodology, the aforementioned competencies (CG3, CG4, CG6, CG8, CG10, CG11, CG20, CG25) are involved to a greater or lesser extent.

EVALUATION

The evaluation of the subject is based on the following aspects:

EX: Exam, objective test. There will be a written exam that will consist of both theoretical-practical questions and problems.

TR: Works, consisting of a collection of problem delivery, online questionnaires and / or document preparation and group presentation of the same in a seminar. Non-recoverable activity between calls.

The qualification will be the maximum of the modalities presented below:

Mode A (Continuous assessment): EX (50%) + TR (50%)

Mode B (Exam): EX (90%) + TR (10%)

A minimum grade of 5.0 is considered in all sections (EX, TR). In case of not exceeding the minimum qualification in one of the sections, the qualification will be determined by the one obtained through modality B.

The evaluation methodology is valid for the first and second call.

In any case, the evaluation system will be governed by what is established in the Evaluation and Qualification Regulation of the University of Valencia for Degrees and Masters.

REFERENCES

Basic

- Ciencia e Ingeniería de Materiales, W.D. Callister y D.G. Rethawinsch. Ed. Reverté, 2016. Segunda edición (correspondiente a la 9ª edición original)
- Fundamentos de la Ciencia e Ingeniería de Materiales. W.F. Smith y J. Hashemi. Ed Mc Graw Hill, 2014. 5ª edición.
- Introducción a la Ciencia de los Materiales para ingenieros. J.F. Shackelford, Ed. Prentice Hall, 4ª edición. 1998.
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- Corrosión y degradación de materiales. E. Otero Huerta. Ed. Síntesis (Madrid) 1997.
- Corrosión, R.M. Fernández Domene, R. Sanchez Tovar, B. Lucas Granados, J. García Antón. Ed. Universitat Politècnica de València, 2018.

Additional

- Materials Selection in Mechanical Design. M.F. Ashby. Ed Butterworth & Heinemann. 1993.
- Mecánica de materiales, F.B. Beer, E. Russell Johnston, Jr., J.T. Dewolf, D.F. Mazurek. Ed. McGraw-Hill, 2009. 5ª edición.
- An Introduction to Materials Engineering and Science for Chemical and Materials Engineers, B.S. Mitchell. Ed. John Wiley & Sons, 2004.
- Corrosion Engineering: Principles and Practice, P.R. Roberge. Ed. McGraw-Hill, 2008.