GUÍA DOCENTE
2020 - 2021

FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura	
Nombre completo	Introduction to Materials and their Applications
Código	DIM-SAP-337
Cuatrimestre	Semestral
Créditos	6,0 ECTS
Carácter	Optativa (Grado)
Departamento / Área	Departamento de Ingeniería Mecánica
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DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura

Aportación al perfil profesional de la titulación

The course introduces the student to the following topics: structure of materials and defects in solids; diffusion processes in solid state; chemical composition and phase transformations; mechanical properties of metals; properties and applications of metal alloys, ceramics, polymers, composites and biomaterials: and

mechanisms of degradation of materials. Methodologies for material selection in engineering applications is also emphasized. In addition to lectures, students will carry out lab activities and practical sessions to solve real problems, which will be fundamental and mandatory to a better understanding of the concepts covered in the lectures.

This subject contributes to the profile of an engineering by the acquisition of an exhaustive knowledge about the properties of the materials, and their different families. At the end of the course, the students will be able to know, understand, manage and relate the connection between the nano, micro and macroscopic structure of the materials and their mechanical, thermal, electrical and magnetic properties, as well as their behaviour under the service conditions.

Prerequisitos

A basic knowledge of introductory engineering design and calculus is needed and, in particular, basic knowledge of chemistry, chemical bonding and crystalline systems.

Competencias - Objetivos

Competencias

BLOQUES TEMÁTICOS Y CONTENIDOS

Contenidos – Bloques Temáticos

Unit 1: OVERVIEW OF MATERIALS

1.1 Atomic structure.

1.2 Electrons in atoms.

1.3 Periodic table.

1.4 Chemical bonding.

1.5 Crystalline structures.

Unit 2: DEFECTS IN SOLIDS AND DIFFUSION

2.1 Point defects.

2.2 Dislocations.

2.3 Surface defects.

2.4 Volume defects.

2.5 Diffusion.

2.6 Types and mechanisms of diffusion.

2.7 Steady-state and non-steady-state diffusion.

2.8 Diffusion factors.

2.9 Structure and diffusion.

2.10 Diffusion applications.

Unit 3: PHASE DIAGRAMS

3.1 Fundamental concepts.

3.2 Complete solid solutions.

3.3 Completely soluble (liquid) and completely insoluble (solid) solid solutions.

3.4 Solid solutions with limited solubility.

3.5 Phase transformations.

3.6 Iron cementite phase diagram.

3.7 Other diagrams.

Unit 4: MECHANICAL PROPERTIES

4.1 Material testing.

4.2 Stress-strain curve.

4.3 Mechanical parameters.

4.4 Types of materials.

4.5 Plastic deformation.

4.6 Fracture.

4.7 Hardness.

Unit 5: METAL ALLOYS

5.1 Ferrous alloys.

5.2 Aluminium alloys.

5.3 Copper alloys.

5.4 Magnesium alloys.

5.5 Titanium alloys.

5.6 Other alloys.

5.7 Processing.

Unit 6: CERAMICS

6.1 Crystal structure, defects and diffusion.

6.2 Phase diagrams.

6.3 Mechanical properties.

6.4 Types and applications.

6.5 Processing.

Unit 7: POLYMERS

7.1 Structure.

7.2 Molecular weight and degree of polymerization.

7.3 Crystallinity.

7.4 Mechanical properties.

7.5 Influence of the temperature.

7.6 Processing.

7.7 Applications.

Unit 8: COMPOSITES & BIOMATERIALS

8.1 Introduction.

8.2 Classification.

8.3 Properties.

8.4 Rule of mixtures.

8.5 Processing.

8.6 Applications.

8.7 Biomaterials.

Unit 9: DEGRADATION OF MATERIALS

9.1 Failure.

9.2 Fatigue.

9.3 Corrosion.

9.4 Corrosion types.

9.5 Electrochemical corrosion.

9.6 Control of the corrosion.

9.7 Oxidation.

9.8 Polymer degradation.

Unit 10: OTHER PROPERTIES

10.1 Electrical properties.

10.2 Thermal properties.

10.3 Magnetic properties.

10.4 Optical properties.

METODOLOGÍA DOCENTE

Aspectos metodológicos generales de la asignatura

Both classroom sessions and independent study are developed to imply the students within the learning activities. The contents have been developed in order to maintain student attention and facilitate the acquisition of the skills mentioned above. Student activities are key factors in the developing this course. To achieve the objectives set in the subject, the following methodology will be used:

In-class activities

1. **Expository lessons:**

   The teacher will explain the concepts through presentations. The PDF versions of theses theoretical presentations will be accessible for students through the Moodlerooms platform. Students will be able to participate during the classes, asking for clarifications about the concepts presented in class, as well as asking questions about any aspect related to the subject. The subject also encourages students to take their own class notes in order to facilitate further study.

2. **Resolution of problems and exercises in class:**

   For those units with practical contents, some study-cases, exercises and problems will be explained, corrected and analysed in class with an increasing order of complexity. The cases will be previously proposed by the teacher and worked by the student before the correction session.

3. **Lab sessions:**

   The lab activities will help students to better understand the theoretical concepts learned in class, considering them from a more practical point of view. The students will carry out real tests on different materials by using industrial testing machines, as well as apply the theoretical knowledge acquired to real engineering materials and pieces. The students will be divided into groups of 3-4

people, all the lab activities will be carried out as a group, in order to favour team working. At the end of every activity they will learn how to properly write a single lab protocol, skill which is extensible for any experimental discipline.

4. **Tutorials:**

   In order to clarify any aspect of the subject, and only when those questions have not been previously solved in class, or during the lab sessions, students will be able to request individual tutorials (with no more than 3 people at the same time), both to the lab and theory teachers, upon previous request to them by mail. This office hours will be used also by the students to be guide by the teachers during their learning process.

Out-of-class activities

1. **Self-study on the concepts presented in class.**

   Materials to be used are slides, list of exercises, multimedia files, student class notes, and recommended books and magazines.

2. **Visits**

   Only if the University's agenda, the classes planning, and the availability of the centres allow it, 1 or 2 visits will be organized to Spanish research centres specializing in material science.

RESUMEN HORAS DE TRABAJO DEL ALUMNO

HORAS PRESENCIALES
HORAS NO PRESENCIALES
CRÉDITOS ECTS: 6,0 (0 horas)

EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Calificaciones

Regular assessment

The score for the **ordinary final** mark will be obtained by:

50% written examination,

30% follow-up examinations,

20% lab sessions (≥ 5.0),

* The lack of assistance to some of the activities is a 0 in that session.

* A delay in the delivery of reports means a minimum penalty of 2 points.

Retake

The score for the extraordinary final mark will be obtained by:

80% Written examination (≥ 5.0)

20% comes from the lab assessment,

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Universidad Pontifica Comillas and Article 6 of the Academic Rules (Normas Académicas) of the ICAI-School of Engineering. Not complying with this requirement may have the following consequences:
  - Students who fail to attend more than **15%** of the lectures may be denied the right to take the final exam during the regular assessment period.
  - Absence to more than **15%** of the lab sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.
  - Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

BIBLIOGRAFÍA Y RECURSOS

Bibliografía Básica

- The PDF versions of the rules of the subject, the presentations of the theoretical Units, the list of exercises and the lab protocols will be accessible for students through the Moodlerooms platform. The platform will also allow students to deliver their reports for the lab activities.
- Student class notes.

Bibliografía Complementaria

- *Materials Science and Engineering: An Introduction, William D. Callister, Jr., David G. Rethwisch. Wiley, 2018.*
- *Foundations of Materials Science and Engineering, William F. Smith, Javad Hashemi.*
- *McGraw-Hill, 2003.*
- *The Principles of Materials Selection for Engineering Design, P. L. Mangonon. Prentice Hall, 1999.*
- *Introduction to Materials Science for Engineers, James F. Shackelford. Prentice Hall, 2009.*