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340040 - CIMA-F2O02 - Materials Science

Coordinating unit: 340 - EPSEVG - Vilanova i la Geltrú School of Engineering

Teaching unit: 702 - CMEM - Department of Materials Science and Metallurgy

Academic year: 2019

Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Catalan, Spanish

Teaching staff

Coordinator: Baile Puig, M. Teresa
Martin Fuentes, Enric

Degree competences to which the subject contributes

Specific:

1. CE9. Baisc knowledge of science, technology and material chemistry. Understand relation between microstructure, synthesis or processing and material properties.
2. CE25. Knowledge and ability to apply material engineering.

Transversal:

3. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 2. Using strategies for preparing and giving oral presentations. Writing texts and documents whose content is coherent, well structured and free of spelling and grammatical errors.
5. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.
6. EFFECTIVE USE OF INFORMATI0N RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.

Teaching methodology

In the theory classes the basic concepts of the subject will be explained. In the classes of problems the basic techniques for the resolution of problems will be explained and the proposed problems will be discussed, from the student's contributions. In the practical exercises will explain the basic knowledge to perform the different proposed tests and the obtained results will be interpreted and discussed.
In the out-class activities the professor supervises the student's work by means of the analysis of his evolution through the evaluation activity and the guided activities.

Learning objectives of the subject

1. Understand and contrast the fundamental concepts of crystalline structure and microstructure of the different types of materials
2. Select the chemical/physical/mechanical magnitudes of the materials necessaries in accordance with the specifications of a product.
3. Understand the relation between the microstructure, the processing and the materials properties.

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4. Know the effect the material microstructure in its mechanical, electrical and magnetic behavior.
5. Select of materials based on their chemical, thermal, electrical, magnetic and mechanical properties
6. Applies the standards of tests.
7. Be able to adapt to the new technologies and new materials.

Study load

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours medium group:	0h	0.00%
	Hours small group:	30h	20.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

1. Introduction to Science and Engineering of Materials

Learning time: 10h

Theory classes: 2h
Laboratory classes: 4h
Self study : 4h

Description:
1.1 Science, Technology and Engineering of materials
1.2 Types of materials. Structural materials. Functional materials
1.3 Historical perspective

Related activities:
Activity 1: Expositive class.
Activity 2: Welcome plan.
Activity 3: Bibliographical research
Activity 17. Partial test
Activity 18: Final test

Specific objectives:
Introduce to the student in the science and engineering of materials
Understand the types of materials and their classification.
Know the historical evolution of materials.

2. Crystalline structure of materials

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

Description:
2.1 Crystalline structure. Crystallographic parameters and Bravais lattices 2.2 Spots, directions and planes. Indexes of Miller.
2.3 Crystalline structures of metals; CC, CCC i HC. Factor of packing.
2.4 Main crystalline structures of the ceramic materials.
2.5 Polymorphism and Allotropy.
2.6 Density: linear, planar and volumetric
2.7 X-ray diffraction: Bragg law
2.8 Crystal defects: punctual, linear or dislocations and superficial.

Related activities:
Activity 1: expositive class
Activity 4. Problems of crystallography (indexes of Miller, densities, etc.)
Activity 17. Partial test
Activity 18: Final test

Specific objectives:

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3. Types of Materials

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

Description:
3.1 Metallic materials: Metallic alloys; Main processes of conformation.
3.2 Ceramic materials: crystalline and non-crystalline (glasses) ceramics; Processes of conformation.
3.3 Polymeric materials: Polymer synthesis; Types of polymers (thermoplastics, thermostables and elastomers).
3.4 Composites: General characteristics; Types of composites.

Related activities:
Activity 1: expositive class
Activity 5. Practice of laboratory: Metallography (preparation of metallographic samples and observation by optical microscopy).
Activity 17. Partial test
Activity 18: Final test

Specific objectives:

4. Properties of materials

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

Description:
4.1 Mechanical properties. Tensile/compression tests, hardness, toughness.
4.2 Plastic deformation Mechanisms. Hardening mechanisms.
4.3 Electrical properties. Electrical behavior and chemical bonds. Conductors, semiconductors and insulators or dielectrics,
4.4 Magnetic properties. Types of magnetic behaviors. Magnetic domains. Cycle of magnetic hysteresis. Magnetic hardening mechanisms.
4.5 Thermal properties. Heat transfer.

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Related activities:
Activity 1. expositive class
Activity 6. Problems related to the tensile test. Graphic stress-strain.
Activity 7. Practice of laboratory: Tensile test
Activity 8. Practice of laboratory: Hardness test (Brinell, Vickers, Rockwell) and micro-hardness test
Activity 9. Practice of laboratory: Charpy impact test.
Activity 10. Problems of electrical and magnetic properties
Activity 11. Practice of laboratory: Measures of resistivity
Activity 12. Practice of laboratory: Magnatest
Activity 17. Partial test
Activity 18: Final test

Specific objectives:

5. Diffusion and solidification

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

Description:
5.1 Diffusion mechanisms.
5.2 Fick's laws
5.3 Diffusion and treatments of materials (applications)
5.4 Solidification of a pure metal.

Related activities:
Activity 1: expositive class
Activity 13. Problems of diffusion. Applications of the Fick's laws to practical examples.
Activity 18: Final test

Specific objectives:

6. Equilibrium diagrams or phase diagrams

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

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Description:
6.1 Equilibrium diagrams of pure substances.
6.2 Construction of equilibrium or phase diagrams
6.3 Binary isomorphic diagram
6.4Calculation of the chemical composition of phases (Rule of the horizontal) and calculation of the proportion of phases (Rule of the Handle or the inverse segment)
6.5Types of diagrams and interpretation. Examples of metallic alloy diagrams.
6.6 Invariant reactions.
6.7 Examples of diagrams of ceramic materials.

Related activities:
Activity 1: Expositive class
Activity 14. Problems of equilibrium diagrams.
Activity 15: Practice of laboratory: equilibrium diagrams (software)
Activity 18: Final test

Specific objectives:

7. Heat treatments of metallic materials

Degree competences to which the content contributes:
1 (Specific)
2 (Specific)
3 (Transversal)
4 (Transversal)
5 (Transversal)
6 (Transversal)

Description:
7.1 Types of heat treatments
7.2 Steel heat treatments: quenching and tempering
7.3 Aluminium alloy heat treatments: solution and aging.

Related activities:
Activity 1: expositive class
Activity 16. Problems of heat treatments.
Activity 18: Final test

Specific objectives:

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Planning of activities

ACTIVITY 1: EXPOSITIVE CLASS

Hours: 13h
Theory classes: 13h

Description:
Expositive class with some solved practical exercises by the professor.

Support materials:
Provided material by the professor via Digital Campus, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The acquired knowledge would be evaluated in the first and the second exams (activities 17 and 18).

Specific objectives:
Fundamental knowledge acquisition that it would be used in the other activities.

ACTIVITY 2: WELCOME PLAN

Hours: 2h
Laboratory classes: 2h

Description:
Welcome to the new students. To inform about the Department and about the facilities that will be used. To inform about the general and specific risks of the Laboratories where the Department conducts specific teaching. Inform about the emergency plan.

Support materials:
Nothing

Descriptions of the assignments due and their relation to the assessment:
Test

Specific objectives:
See the equipment used in the EPSEVG to the material characterization.

ACTIVITY 3: PRACTICE OF LABORATORY: BIBLIOGRAPHICAL RESEARCH

Hours: 4h
Laboratory classes: 2h
Self study: 2h

Description:
The student will learn how looking for information related to the subject, both in the library of the EPSEVG or by Internet search in specialized journals, data bases, etc.

Support materials:
Practice dossier (available in the digital campus), bibliography.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know where it is the recommended bibliography in the library of the EPSVG.
Learn to look for information in bases of the UPC.
Learn to look for information in data bases external to the UPC or in specialized journals.

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ACTIVITY 4: PROBLEMS OF CRYSTALLOGRAPHY (INDEXES OF MILLER, DENSITIES, ETC.)	Hours: 11h Theory classes: 4h Self study: 7h

Description:
The student will have to solve the problems proposed by the professor.

Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the first and second exams that among others evaluate this subject (Activities 17 and 18).

Specific objectives:
Know the main crystallographic parameters.
Learn the form to identify: crystallographic spots, directions and planes (Indexes of Miller) To calculate the linear, superficial or volumetric density.

ACTIVITY 5: PRACTICE OF LABORATORY: METALLOGRAPHY	Hours: 4h Laboratory classes: 2h Self study: 2h

Description:
The student will have to learn prepare a metallographic sample and use an optical microscope.

Support materials:
Practice dossier (available in the digital campus), bibliography.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Learn to prepare metallographic samples for its observation.
Observation of the microstructure of different materials.

ACTIVITY 6: PROBLEMS RELATED TO THE TENSILE TEST.	Hours: 9h Theory classes: 3h Self study: 6h

Description:
The student will have to solve the problems proposed by the professor.

Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the first and second exams that among others evaluate this subject (Activities 17 and 18).

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Specific objectives:
Acquire ability in the use of stress ¿ strain graphics.
Calculate the mechanical properties that are derived from a tensile test: maximum resistance, elastic limit, elastic module and elongation.
Determine the coefficient of hardening of a metal from the data of a tensile test.

ACTIVITAT 7: PRACTICE OF LABORATORY: TENSILE TEST

Hours: 4h
Laboratory classes: 2h
Self study: 2h

Description:
The student will perform a tensile test in two different materials: an aluminium alloy and steel.

Support materials:
Practice dossier (available in the digital campus), bibliography, standards to carry out the test, specific software.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know the procedure of a tensile test machine
Learn to determine the mechanical properties of a material from a real tensile test.
Determine the coefficient of hardening of a metal from the real data of a tensile test.
Interpret and analyze the results.
Apply standards to carry out the test.

ACTIVITY 8: PRACTICE OF LABORATORY: HARDNESS TEST (BRINELL, VICKERS, ROCKWELL) AND MICROHARDNESS

Hours: 4h
Laboratory classes: 2h
Self study: 2h

Description:
The student will perform a hardness test in different materials: an aluminum alloy, a copper alloy and steel.

Support materials:
Practice dossier (available in the digital campus), bibliography and standards to carry out the test.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know the procedure of a hardness equipment
Learn to determine the hardness of a material by means of the different types of hardness: Brinell, Vickers, Rockwell
Learn to determine the micro-hardness of a material by means of a micro-hardness Vickers test.
Interpret and analyze the results.
Apply standards to carry out the test.

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ACTIVITY 9: PRACTICE OF LABORATORY: CHARPY IMPACT TEST.	Hours: 5h Laboratory classes: 2h Self study: 3h

Description:
The student will perform an impact test in steels with and without heat treatment (quenching and tempering).

Support materials:
Practice dossier (available in the digital campus), bibliography and standards to carry out the test.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know the procedure of a Charpy pendulum
Learn to determine the Resilience of a material.
Learn the concepts of toughness and fragility
Interpret and analyze the results.
Apply standards to carry out the test.

ACTIVITY 10: PROBLEMS OF ELECTRICAL AND MAGNETIC PROPERTIES	Hours: 6h Theory classes: 2h Self study: 4h

Description:
The student will have to solve the problems proposed by the professor.

Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the first and second exams that among others evaluate this subject (Activities 17 and 18).

Specific objectives:
Know the main concepts of electrical conductivity and magnetism.
Learn how determine the resistivity of materials and alloys.
Calculate the main magnetic variables (permeability, magnetization, etc.)

ACTIVITY 11: PRACTICE OF LABORATORY: MEASURES OF RESISTIVITY	Hours: 4h Laboratory classes: 2h Self study: 2h

Description:
The student will determine the electrical resistivity of different steels and will evaluate the effect of the heat treatment in resistivity.

Support materials:
Practice dossier (available in the digital campus) and bibliography.

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Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know the use of a voltmeter/ammeter.
Learn how to determine the electrical conductivity of a material
Interpret and analyze the results.

ACTIVITY 12: PRACTICE OF LABORATORY: MAGNATEST

Hours: 4h
Laboratory classes: 2h
Self study: 2h

Description:
The student will evaluate the microstructural differences between steel with different heat treatments from his different magnetic behavior.

Support materials:
Practice dossier (available in the digital campus) and bibliography.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Know the use of the Magnatest equipment.
Evaluate the effect of the microstructure in the electrical and magnetic properties of a metallic material.
Know the applications of the equipment in the quality control of industrial processes.
Interpret and analyze the results.

ACTIVITY 13: PROBLEMS OF DIFFUSION. APPLICATIONS OF THE FICK'S LAWS TO PRACTICAL EXAMPLES.

Hours: 8h
Theory classes: 3h
Self study: 5h

Description:
The student will have to solve the problems proposed by the professor.

Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the second exam that among others evaluate this subject (Activity 18).

Specific objectives:
Know the main diffusion concepts.
Determine the diffusivity and evaluate the temperature effect.
Analyze and understand the solution of the Fick's laws and its application to real situations.

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ACTIVITY 14: PROBLEMS OF EQUILIBRIUM DIAGRAMS.	Hours: 12h Theory classes: 5h Self study: 7h

Description:
The student will have to solve the problems proposed by the professor.

Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the second exam that among others evaluate this subject (Activity 18).

Specific objectives:
Acquire ability in the use of binary equilibrium diagrams.
Calculate the chemical composition of phases (Rule of the horizontal)
Determine the proportion of phases (Rule of the Handle or the inverse segment)
Understand the invariant reactions.
Know the solidification process and cooling until room temperature of a metallic alloy and understand its microstructural evolution.

ACTIVITY 15: PRACTICE OF LABORATORY: EQUILIBRIUM DIAGRAMS.	Hours: 4h Laboratory classes: 2h Self study: 2h

Description:
The student will acquire the knowledge necessary to work and to obtain data of simple equilibrium diagrams.

Support materials:
Practice dossier (available in the digital campus), bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
When the student finishes the practice he/she will have to give the corresponding report. The evaluation of the task will contribute to a 20% of the final mark.

Specific objectives:
Acquire ability in the use of binary equilibrium diagrams.
Calculate the chemical composition of phases (Rule of the horizontal)
Determine the proportion of phases (Rule of the Handle or the inverse segment)
Understand the invariant reactions.
Know the solidification process and cooling until room temperature of a metallic alloy and understand its microstructural evolution.

ACTIVITY 16: PROBLEMS OF HEAT TREATMENTS.	Hours: 5h Theory classes: 2h Self study: 3h

Description:
The student will have to solve the problems proposed by the professor.

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Support materials:
List of problems, bibliography and specific software.

Descriptions of the assignments due and their relation to the assessment:
The students will have to present by oral or written form some of the resolute problems. The acquired knowledge would be evaluated in the second exam that among others evaluate this subject (Activity 18).

Specific objectives:
Acquire ability in the use of binary diagrams of balance.
Understand the main heat treatments.
To know the effect the heat treatments in the properties of a material.

ACTIVITY 17: PARTIAL TEST	Hours: 23h Theory classes: 3h Self study: 20h

Description:
The student will have to do a written test on contents 1, 2, 3 and 4, in which he/she will have to solve some exercises and questions.

Support materials:
Exam.

Descriptions of the assignments due and their relation to the assessment:
Individual resolution of the proposed questions and exercises contributes to a 30% of the final mark.

Specific objectives:
Consolidation of the knowledge acquired until the moment

ACTIVITY 18: FINAL TEST	Hours: 28h Theory classes: 3h Self study: 25h

Description:
Written test in which the student will have to demonstrate the degree of acquisition of the knowledge acquired on the subjects explained during the course. In this test acquired knowledge about different subjects will be interrelated.

Support materials:
Exam.

Descriptions of the assignments due and their relation to the assessment:
Individual resolution of the proposed questions and exercises contributes to a 30% of the final mark.

Specific objectives:
Consolidation of the knowledge acquired during the course and their interrelation.

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Qualification system

Individual written tests: 70%. There will be two partial exams (subject eliminatory) and a final exam. The second partial exam and the final exam are done simultaneously.
Report on laboratory practices: 20%
Presentation and evaluation of proposed problems (individual or in group): 10%
The laboratory practices, the tests carried out via Campus Digital and the activities carried out in the classroom during the regular period of classes (problems and / or presentations of work) will not be re-evaluated.
The evaluation of the course will be based on the following indicators:
T, Theory,: average midterm 1, PT1, and midterm 2, PT2.
P, Exercises or completed questionnaires: mean of the different performed exercises.
L Labs: weighted average of the different scheduled practices.
F, Final Theory Test.

The qualification of this matter will be obtained by applying the most favorable of the following ratios:
1.
Theory, T: 70% of the final note (average of the two partials)
Solved exercises, P: 10% of the final
Labs, L: 20% of the final
Final score T = 0.7T +0.2P +0.1 L

2.
Theory, F: 70% of the final exam)
Solved exercises, P: 10% of the final note
Labs, L: 20% of the final note
Final Score = 0.7 F +0.1 P +0.2 L

The laboratory practices, the tests carried out via Campus Digital and the activities carried out in the classroom during the regular period of classes (problems and / or presentations of work) will not be re-evaluated.

The completion and presentation of the corresponding reports of at least 75% of the laboratory practices will be a necessary condition for the approval of the subject.

Regulations for carrying out activities

All the planned activities in this subject have a part in which the students have to attend in person and another part in which the students have to do an independent learning. Before the classes of problems, the students will individually discuss individually or in small groups the proposed problems and will have to present their solution. The evaluation of this task will influence in the evaluation.
For the practical exercises in the laboratory, the students have to previously know the fundamentals of each test and knowledge that results are expected for each test. A pre-test may be required to access the laboratory.

The accomplishment of the individual tests will be carrie4d out in accordance with the course timetable.

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Complementary:

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