Course guides
220036 - 220036 - Lightweight Materials for Engineering Applications

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Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN MECHANICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL DESIGN AND PRODUCT DEVELOPMENT ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2020 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: MARCELO DE SOUSA PAIS ANTUNES

Others: DAVID ARENCÓN OSUNA - VERA CRISTINA DE REDONDO REALINHO - JOSÉ IGNACIO VELASCO PERERO

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. GrETA/GrEVA - Applied knowledge of materials science and technology; mechanics and thermodynamics; fluid mechanics; aerodynamics and flight mechanics; navigation systems and air traffic; aerospace technology; structural theory; economy and production; projects; environmental impact.

Transversal:
1. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

TEACHING METHODOLOGY

- Attending classes of exposition of the contents.
- Attending classes of practical work.
- Autonomous work of study and preparation of written reports.
- Autonomous work of study and preparation of oral presentations.
- Preparation and fulfillment of group activities.
- Visits to sector companies directly related to the subject matter.

In the attending classes of exposition of the contents, the teacher will introduce the theoretical bases of the subject, concepts, methods and results, illustrating them with convenient examples.

LEARNING OBJECTIVES OF THE SUBJECT

The main goal of this subject consists in offering to the students an opportunity to extend their academic and technical education concerning last generation lightweight materials, which have arisen as the result of new challenges and industrial requirements. These new requirements depend on one side on the research of new materials with pre-designed and controllable physical-chemical properties and, on the other, on the improvement of new processing and characterization techniques, which would enable to control and assess their properties. During the course of the subject, the students will gather new knowledge on the actual trends in the development of new lightweight cellular materials (foams), nano-structured and multifunctional materials for engineering applications, focusing on the improvement of their specific mechanical properties, fire retardancy, optical and transport properties, among many others, and advanced processing techniques. It is foreseeable the existence of theoretical-practical seminars, as well as visits to sector companies directly related to the subject matter.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: Introduction to lightweight materials for engineering applications

Full-or-part-time: 2h
Theory classes: 2h

Module 2: Novel composite and nanocomposite materials

Description:
Description:
1. Introduction
1.1. Overview: the concept of composite
1.2. Nanocomposites
1.2.1. Classification
1.2.2. Types of fillers: spherical, layered and fibre-like
2. Lightweight composites and nanocomposites
2.1. Lightweight metal and ceramic (nano)composites
2.2. Polymer-based nanocomposites
2.3. Natural nanobiocomposites
3. Properties and testing of (nano)composites
3.1. Mechanical properties
3.2. Transport properties
3.2.1. Thermal conductivity
3.2.2. Electrical conductivity
3.2.3. Permeability/gas diffusion
3.3. Flame retardancy of polymers
3.3.1. Fundamentals of polymer burning
3.3.2. Techniques to study the thermal stability and fire behavior of polymers
3.3.3. Regulation and testing
3.3.4. Strategies for improving fire resistance
3.3.5. Practical cases

Related activities:
Activity 1
Activity 2
Activity 3
Activity 4
Activity 5
Activity 6

Full-or-part-time: 27h
Theory classes: 8h
Practical classes: 4h
Self study : 15h

Module 3: Cellular materials/foams

Description:
1. Introduction
1.1. The concept of cellular material and basic cellular parameters
1.2. Classification of cellular materials
1.3. Main properties and applications
2. Stages in a foaming process
2.1. Cell nucleation
2.2. Foam growth: chemical foaming/physical foaming
2.3. Foam stabilization
3. Main foaming processes
3.1. Continuous/semi-continuous foaming processes
3.2. Batch-foaming processes
4. Physical properties of cellular materials
4.1. Mechanical properties: flexible/soft and rigid foams - impact absorption
4.2. Transport properties: thermal insulation
5. Examples of recent developments
5.1. Recent developments in materials
5.2. New foaming processes and innovations
5.3. Polymer nanocomposite foams

Related activities:
Activity 1
Activity 2
Activity 3
Activity 4
Activity 5
Activity 6

Full-or-part-time: 26h
Theory classes: 6h
Practical classes: 2h
Self study : 18h

Module 4: Recent developments in lightweight materials

Description:
1.Microcellular injection moulding and extrusion processing of lightweight plastic components. Lightweight sandwich structures
2. Liquid Crystal Polymers (LCP) for electro-optic applications
3. Lightweight metal alloys
4. Ultralight ceramics for high temperature applications
5. Aerogels
6. Novel applications of grapheme

Related activities:
Activity 1
Activity 2
Activity 4
Activity 5
Activity 6

Full-or-part-time: 20h
Theory classes: 6h
Practical classes: 2h
Self study : 12h

ACTIVITIES

ACTIVITY 0: CLASSES OF EXPOSITION OF THE CONTENTS, AND OF PRACTICAL WORK.

Full-or-part-time: 10h
Theory classes: 10h

ACTIVITY 1: REPORT/PRESENTATION ABOUT THE SELECTION OF A LIGHTWEIGHT FUNCTIONAL MATERIAL FOR A GIVEN APPLICATION (GROUP WORK).

Full-or-part-time: 14h
Theory classes: 2h
Self study: 12h

ACTIVITY 2: REPORT ABOUT RECENT DEVELOPMENTS IN LIGHTWEIGHT MATERIALS (INDIVIDUAL WORK).

Description:
Each student will prepare a report about new developments in the manufacturing and production of lightweight materials, focusing on their main characteristics, differences/advantages with existing technologies and innovations.

Specific objectives:
To learn about the importance of processing on attaining functional lightweight components for engineering applications.

Material:
Recommended bibliography.
Other sources: books, articles, internet, etc.

Delivery:
Written report.

Full-or-part-time: 12h
Self study: 12h

ACTIVITY 3: MATERIAL SELECTION: USE OF EDUPACK SOFTWARE. REPORT ABOUT THE SELECTION OF A MATERIAL OR GROUP OF MATERIALS FOR A CHOSEN ENGINEERING APPLICATION.

Description:
The students will prepare a report about the selection of a material or group of materials for a chosen engineering application using specific material selection software (Edupack software), explaining its characteristics, properties, processing methods and other applications.

Specific objectives:
To learn about the importance of an adequate material selection for a given application using a specific material selection software (Edupack software).

Material:
Edupack material selection software.

Delivery:
Written report.

Full-or-part-time: 14h
Theory classes: 2h
Self study: 12h

ACTIVITY 4: VISIT TO A SECTOR COMPANY.

Description:
Visit to a sector company directly related to the subject matter.

Specific objectives:
To get in touch with an industrial manufacturing company directly related to the subject matter.

Full-or-part-time: 2h
Theory classes: 2h

ACTIVITY 5: VISIT TO A RESEARCH AND DEVELOPMENT CENTER.

Description:
Visit to a research and development center directly related to the subject matter.

Specific objectives:
To understand the work behind the development of new functional materials for a given application.

Full-or-part-time: 2h
Theory classes: 2h

ACTIVITY 6: EXAMINATION.

Description:
Written test in which the student will have to show his/her knowledge of the contents learned in class.

Specific objectives:
To develop the contents learned in the theoretical and practical classes and demonstrate the level of knowledge.

Delivery:
Written exam.

Full-or-part-time: 11h
Theory classes: 2h
Self study: 9h

GRADING SYSTEM

The final degree of the subject will depend on four evaluation activities:
Activity 1: 25%
Activity 2: 25%
Activity 3: 10%
Activity 6 (exam): 40%

EXAMINATION RULES.

Activity 1 - Written report/oral presentation in groups formed by a minimum of 2 students and a maximum of 4.
Activity 2 - Individual written report.
Activity 3 - Individual written report.
Activity 6 - Individual written exam.

BIBLIOGRAPHY

Basic:
- Ajayan, P. M.; Schadler, L. S.; Braun, P. V. Nanocomposite science and technology [on line]. Weinheim: Wiley-VCH, 2003 [Consultation: 12/05/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=481284. ISBN 9783527303595.
- Sendijarevic, V.; Klempner, D. Handbook of polymeric foams and foam technology. 2nd ed. Munich: Hanser, 2004. ISBN 9781569903360.
- Blockley, R.; Shyy, W. Encyclopedia of aerospace engineering. Chichester: Wiley, 2010. ISBN 9780470754405.

Complementary:
- Advani, Suresh G. Processing and properties of nanocomposites [on line]. Singapore: World Scientific Publishing, 2006 [Consultation: 12/05/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1681685. ISBN 981270390X.
- L.J. Gibson, M.F. Ashby.. Cellular solids: structure and properties. 2nd ed. Cambridge: Cambridge University Press, 2001. ISBN 9780521499118.
- Troitzsch, Jurgen H. Plastics flammability handbook: principles, regulations, testing and approval. 3rd ed. Hanser Gadner, 2004. ISBN 3446213082.