Course guide
220303 - 220303 - Aerospace Materials

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.
Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Compulsory subject).
Academic year: 2022 ECTS Credits: 5.0 Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Miguel Sánchez Soto

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE15. MUEA/MASE: Sufficient knowledge of the materials and manufacturing processes used in propulsion systems.
CG09-MUEA. (ENG) Competència en totes aquelles àrees relacionades amb les tecnologies aeroportuàries, aeronàutiques o espacials que, per la seva naturalesa, no siguin exclusives d'altres branques de l'enginyeria.

Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

Basic:
CB06. Manage original concepts in research projects.
CB08. Generate decision from incomplete information assuming its social and ethical responsibilities.
CB09. Improve technical communication of results.
CB10. Improve self-learning capacity

TEACHING METHODOLOGY

The teaching methodology consists in three parts:
- Face-to-face sessions of exposition - participation in the contents of the course and exercises.
- Face-to-face sessions of laboratory work.
- Autonomous study and proposed activities

In the exposition sessions - participation of the contents, the teaching staff will introduce the theoretical bases of the subject, concepts, methods and results, illustrating them with suitable examples and requesting, where appropriate, exercises to facilitate their understanding. Activities will be proposed to solve by students either in the classroom or outside the classroom.

In the laboratory work sessions, the teaching staff will guide the students in the application of theoretical concepts to solve experimental activities. Activities will be proposed for the student to solve either in the classroom and outside the classroom.

The students, autonomously, will work with the material provided by the teaching staff to assimilate and fix the concepts. The teaching staff will provide a study plan and follow-up activities (ATENEA).
LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student must:
- Know the different groups and types of materials used in aeronautical applications.
- To know the relations and influences between the microstructure, the manufacturing processes and the final properties of the materials.
- Understand the technological capacities, their limits of application and the ways for optimizing the material properties in aerospace applications.
- Acquire experience and ability to properly select materials according to the requirements of the component or application.
- To know and understand the causes of failure of the components in service and to have the capacity to apply predictive tools for estimate the life in service of components and to foresee solutions to possible failures.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>15,0</td>
<td>12.00</td>
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<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>24.00</td>
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Total learning time: 125 h

CONTENTS

Block 1: Introduction

Description:

Related activities:
Theoretical session.

Full-or-part-time: 4h
- Theory classes: 2h
- Self study : 2h

Module 2: Criteria for the selection of materials in the design of aircraft and engines

Description:
Main parameters and equations for design. Material selection criteria. Ashby charts. Selection of materials for structures and engines. Examples

Related activities:
Theoretical and problems session-
Activity 1: Materials selection proposal
Activity 8: Work group proposal

Full-or-part-time: 12h
- Theory classes: 2h
- Laboratory classes: 2h
- Self study : 8h
Modul 3: Ferrous metallic alloys and thermal treatment

Description:
3.1. Steels. Types of steels. Iron-carbon diagram. Steels for aeronautical applications (stainless steel, precipitation hardening, HSLA, Dual Phase TRIP etc.)
3.3. Thermal treatment of steels

Related activities:
Theoretical and problems session.
Activity 2: Lab practical activity
Activitat 8: Development of work in group.

Full-or-part-time: 21h
Theory classes: 4h
Laboratory classes: 2h
Self study: 15h

Module 4: Non-ferrous metal alloys.

Description:
4.3. Magnesium and its alloys Characteristic properties. Main magnesium alloys
4.4. Other metals and alloys. Superalloys. Microstructure and properties. Aerospace applications

Related activities:
Theoretical and problems session.
Activity 3: Lab practical activity
Activitat 8: Development of work in group.

Full-or-part-time: 14h
Theory classes: 4h
Laboratory classes: 2h
Self study: 8h

Block 5: Ceramic materials for engineering

Description:
Advanced structural ceramics. Coatings. Thermal barriers. Applications in aeronautics. The failure in ceramics (Weibull)

Related activities:
Theoretical session.
Activity 4: Lab practical activity
Activitat 8: Development of work in group.

Full-or-part-time: 13h
Theory classes: 3h
Laboratory classes: 2h
Self study: 8h
Block 6: Composite materials

Description:

Specific objectives:
Theoretical and problems session.
Activity 5: Lab practical activity
Activitat 8: Development of work in group.

Full-or-part-time: 23h
Theory classes: 4h
Laboratory classes: 4h
Self study: 15h

Module 7: Behavior in service: Structural integrity

Description:

Related activities:
Theoretical and problems session.
Activity 6: Lab practical activity
Activity 8: Development of work in group.

Full-or-part-time: 28h
Theory classes: 8h
Laboratory classes: 2h
Self study: 18h

Block 8: Non destructive analysis

Description:

Related activities:
Theoretical session.
Activity 7: Project presentation
Activity 8: Development of work in group.

Full-or-part-time: 10h
Theory classes: 3h
Laboratory classes: 1h
Self study: 6h
<table>
<thead>
<tr>
<th>Name</th>
<th>English</th>
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<tbody>
<tr>
<td><strong>Full-or-part-time:</strong></td>
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<td><strong>Laboratory classes:</strong></td>
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<td><strong>Self study:</strong></td>
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<td><strong>Full-or-part-time:</strong></td>
<td>6h</td>
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<tr>
<td><strong>Laboratory classes:</strong></td>
<td>2h</td>
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<tr>
<td><strong>Self study:</strong></td>
<td>6h</td>
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<td><strong>Full-or-part-time:</strong></td>
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<td><strong>Laboratory classes:</strong></td>
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<tr>
<td><strong>Self study:</strong></td>
<td>3h</td>
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<tr>
<td><strong>Full-or-part-time:</strong></td>
<td>10h</td>
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<tr>
<td><strong>Self study:</strong></td>
<td>10h</td>
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GRADING SYSTEM

First exam: 20%
Second exam: 20%
Deliverables: 20%
Case Studies: 20%
Proposed work: 10%
Lab activities: 10%

Note:
Deliverables: These are short application problems or questions proposed by the teacher in the field of the subject.
Case Studies: These are practical cases of application of the concepts of the course, proposed by the teaching staff to be solved outside the classroom.
Attendance at the lab activities and the presentation of the work are necessary conditions to pass.
Any student may recover the marks through the corresponding final exam. In this exam, the students could recover/improve their marks by carrying out a final exam, substituting the two previous first and second exam (total weight 40%). The mark obtained in this final exam will replace the ones previously obtained at first and second exams.

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
Journals of the UPC electronic library:
Journal of aerospace engineering
IEEE transactions on aerospace
Aircraft engineering and aerospace technology
Fracture mechanics