19899 - AM - Aerospace Materials

Coordinating unit: 300 - EETAC - Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 702 - CMEM - Department of Materials Science and Metallurgy
Academic year: 2019
Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Teaching unit Compulsory)
ECTS credits: 5
Teaching languages: English

Teaching staff

Coordinator: Defined in the course webpage at the EETAC website.
Others: Defined in the course webpage at the EETAC website.

Degree competences to which the subject contributes

Basic:
CB6. (ENG) CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.
CB7. (ENG) CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.
CB9. (ENG) CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.
CB10. (ENG) CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

Specific:
CE1 MAST. (ENG) CE1: Identificar los diferentes tipos de materiales que se utilizan para fabricar cada parte de los aviones, tanto fuselaje como motores y seleccionar el adecuado para cada aplicación, así como los que se utilizan en la construcción de vehículos aeroespaciales.
CG1 MAST. (ENG) CG1: Identificar y conocer las principales actividades de I+D+i en el campo aeroespacial que se llevan a cabo actualmente a nivel internacional en el ámbito académico, la industria y las mayores agencias espaciales.
CG2 MAST. (ENG) CG2: Identificar y aplicar los análisis teóricos, experimentales y numéricos fundamentales de uso actual en ingeniería aeroespacial.
CG4 MAST. (ENG) CG4: Participar en un proyecto de I+D+i del ámbito aeroespacial aportando una visión y conocimientos novedosos asociados con las técnicas de uso más puntero en el campo.

Generical:
CT1b. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding the mechanisms on which scientific research is based, as well as the mechanisms and instruments for transferring results among socio-economic agents involved in research, development and innovation processes.
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.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.
Learning objectives of the subject

To review fundamental aspects concerning materials science, especially those related to microstructure and mechanical properties.
To introduce and describe the different families of structural materials which are commonly used in the manufacture of aircrafts, both for airframe and for propulsion system.
To explain design requirements of structural components, and link these requirements with properties aiming to optimize material selection.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group:</th>
<th>45h</th>
<th>36.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>0h</td>
<td>0.00%</td>
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<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
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### Content

<table>
<thead>
<tr>
<th>Introduction and structure of materials</th>
<th>Learning time: 25h</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 7h 12m</td>
</tr>
<tr>
<td>This module introduces key concepts involved in materials science to cover general aspects and applications of metallic, polymeric and inorganic materials. Topics covered include: chemical bonding; basic crystallography of crystalline materials; crystal defects; phase diagrams and transformations; overviews of metals and alloys; polymers and inorganic solids.</td>
<td>Guided activities: 1h 48m</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Self study : 16h</td>
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<tr>
<td>To know and understand bonding, structure, defects, phase transformations and applications of metals, polymers and inorganic solids;</td>
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<td>To gain and use information on the construction and application of equilibrium phase diagrams to materials science</td>
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<tr>
<th>Mechanical properties</th>
<th>Learning time: 33h 20m</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 9h 36m</td>
</tr>
<tr>
<td>Deformation, fracture and fatigue are important mechanical phenomena in both metals processing and use. The role of dislocations in and the effects of microstructural features on the plastic deformation of metals is initially explored. Consideration of fracture includes linear elastic fracture mechanics concepts. Fatigue is considered in some detail. Both total lifetime approaches and damage tolerance approaches to fatigue are considered. Finally, creep damage is introduced as well as corresponding design criteria.</td>
<td>Guided activities: 2h 24m</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>Self study : 21h 20m</td>
</tr>
<tr>
<td>To develop students’ understanding of the theoretical principles used to describe the deformation, fracture and fatigue of metals.</td>
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<td>To enable students to undertake fracture mechanics based calculations utilising a stress intensity factor approach.</td>
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<tr>
<td>To enable students to undertake fatigue lifetime calculations based on both total lifetime approaches and damage tolerant approaches.</td>
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<tr>
<td>To enable students to undertake material selection on the basis of creep design criteria.</td>
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### Materials for aeronautical structures

**Learning time:** 41h 40m  
Theory classes: 12h  
Guided activities: 3h  
Self study: 26h 40m

**Description:**  
This unit covers engineering metallic alloys used for manufacturing aeronautical structures: light alloys (i.e. aluminium-, titanium- and magnesium- alloys), as well as high-strength steels and organic-matrix composites. Information centres on the physical metallurgy of such engineering alloys to demonstrate the effect of alloying and its implications for the processing, microstructure and performance of structural components in aerospace sector.

**Specific objectives:**  
To identify changes in microstructure and properties as related to different manufacturing techniques and thermomechanical routes are applied and the impact it will have on inspection and in-service performance;  
To demonstrate a basic knowledge of the materials used in the application being studied and why they are selected.

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### Materials for aeronautical engines

**Learning time:** 25h  
Theory classes: 7h 12m  
Guided activities: 1h 48m  
Self study: 16h

**Description:**  
This unit covers engineering materials used for manufacturing engines: Ni-base superalloys as well as thermal and environmental barrier coatings (resistant to corrosion and oxidation). Information centres on the physical metallurgy of such engineering alloys to demonstrate the effect of alloying and its implications for the processing, microstructure and performance of structural components in aerospace sector.

**Specific objectives:**  
To identify changes in microstructure and properties as related to different manufacturing techniques and thermomechanical routes are applied and the impact it will have on inspection and in-service performance;  
To demonstrate a basic knowledge of the materials used in the application being studied and why they are selected;  
To demonstrate a detailed knowledge of one aspect of high temperature materials in the application being studied e.g. single crystal turbine blades for gas turbine engines.

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**Qualification system**

Defined in the course webpage at the EETAC website.
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Bibliography

Basic:


Complementary:

