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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: 2018

Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Teaching unit Compulsory)
DOCTORAL DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2007). (Teaching unit Optional)

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.

Generical:

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.

Transversal:

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

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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

Total learning time: 125h	Hours large group:	45h	36.00%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	80h	64.00%

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Content

Introduction and structure of materials

Learning time: 25h

Theory classes: 7h 12m
Guided activities: 1h 48m
Self study : 16h

Description:
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.

Specific objectives:
To know and understand bonding, structure, defects, phase transformations and applications of metals, polymers and inorganic solids;
To gain and use information on the construction and application of equilibrium phase diagrams to materials science

Mechanical properties

Learning time: 33h 20m

Theory classes: 9h 36m
Guided activities: 2h 24m
Self study : 21h 20m

Description:
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

Specific objectives:
To develop students ' understanding of the theoretical principles used to describe the deformation, fracture and fatigue of metals.
To enable students to undertake fracture mechanics based calculations utilising a stress intensity factor approach.
To enable students to undertake fatigue lifetime calculations based on both total lifetime approaches and damage tolerant approaches.
To enable students to undertake material selection on the basis of creep design criteria.

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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

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 corrosión 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.

Qualification system

Defined in the course webpage at the EETAC website.

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Bibliography

Basic:

Callister, William D; Rethwisch, David G. Materials science and engineering : an introduction. 7th ed. New York [etc.]: John Wiley & Sons, cop. 2007. ISBN 0471736961.

Ashby, M. F; Jones, David R. H. Engineering materials. 3rd ed. Oxford: Elsevier Butterworth-Heinemann, 2005-2006. ISBN 9780750663816.

Askeland, Donald R; Wright, Wendelin J. The Science and engineering of materials. Seventh edition. Boston, Massachusetts: Cengage Learning, 2016. ISBN 9781305077102.

Complementary:

Flower, Harvey M. High performance materials in aerospace. London [etc.]: Chapman & Hall, 1995. ISBN 0412533502.

Polmear, I.J. Light alloys : metallurgy of the light metals. 3rd ed. London [etc.]: Edward Arnold, cop. 1995. ISBN 0340632070.

Campbell, F. C. Manufacturing technology for aerospace structural materials [Recurs electrònic]. Amsterdam [etc.]: Elsevier, cop. 2006. ISBN 1856174956.