Course guide
19899 - AM - Aerospace Materials

Last modified: 09/06/2023

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 702 - CEM - Department of Materials Science and Engineering.

Degree: MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2015). (Compulsory subject).
MASTER'S DEGREE IN AEROSPACE SCIENCE AND TECHNOLOGY (Syllabus 2021). (Optional subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: 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

Specific:
CE3 MAST21. Carry out, present and publicly defend a research work carried out in a group, on a research topic in the aerospace field.

Generical:
CG2 MAST. Identify and apply the fundamental theoretical, experimental and numerical analyzes currently used in aerospace engineering.

Transversal:
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.

Basic:
CB9. Students will be able to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous manner.

TEACHING METHODOLOGY

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

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	45,0	36.00

Total learning time: 125 h

CONTENTS

Introduction and structure of materials

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

Full-or-part-time: 25h
Theory classes: 7h 12m
Guided activities: 1h 48m
Self study : 16h

Mechanical properties

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.

Full-or-part-time: 33h 20m
Theory classes: 9h 36m
Guided activities: 2h 24m
Self study : 21h 20m

Materials for aeronautical structures

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

Full-or-part-time: 41h 40m
Theory classes: 12h
Guided activities: 3h
Self study : 26h 40m

Materials for aeronautical engines

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.

Full-or-part-time: 25h
Theory classes: 7h 12m
Guided activities: 1h 48m
Self study : 16h

GRADING SYSTEM

Defined in the course webpage at the EETAC website.

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] [on line]. Amsterdam [etc.]: Elsevier, cop. 2006 [Consultation: 15/04/2020]. Available on: https://www.sciencedirect.com/science/book/9781856174954. ISBN 1856174956.