220331 - Composite Materials

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 737 - RMEE - Department of Strength of Materials and Structural Engineering
Academic year: 2017
Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: José Ignacio Velasco, Joaquin Hernandez
Others: José Ignacio Velasco, Joaquin Hernandez

Teaching methodology
The course is divided into parts:
- Theory classes
- Practical classes
- Self-study and work by teams for doing exercises and activities.

In the theory classes, teachers will introduce the theoretical basis of the concepts, methods and results and illustrate them with examples appropriate to facilitate their understanding.
In the practical classes (in the classroom and/or in the laboratory), teachers guide students in applying theoretical concepts to solve problems, always using critical reasoning. We propose that students solve exercises in and outside the classroom, to promote contact and use the basic tools needed to solve problems.
Students, independently, need to work on the materials provided by teachers and the outcomes of the sessions of exercises/problems, in order to fix and assimilate the concepts.
The teachers provide the syllabus and monitoring of activities (by ATENEA).

Learning objectives of the subject
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.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 30h</th>
<th>24.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>12.00%</td>
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<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
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# 220331 - Composite Materials

## Content

<table>
<thead>
<tr>
<th>Module 1: Introduction to composite materials for aerospace applications</th>
<th>Learning time: 6h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 3h</td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
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<tr>
<td>- Theory and practical classes</td>
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<thead>
<tr>
<th>Module 2: Raw materials for aerospace composites</th>
<th>Learning time: 15h</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 4h</td>
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<tr>
<td><strong>Related activities:</strong></td>
<td>Self study: 9h</td>
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<tr>
<td>- Theory and practical classes</td>
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<tr>
<td>- Laboratory session: Physic-chemical analysis of components of composites</td>
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<tr>
<th>Module 3: Processing routes of composites</th>
<th>Learning time: 15h</th>
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</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td><strong>Related activities:</strong></td>
<td>Self study: 9h</td>
</tr>
<tr>
<td>- Theory and practical classes</td>
<td></td>
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<tr>
<td>- Laboratory session: Fabrication of composites</td>
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## Module 4: Inspection and testing

**Learning time:** 10h  
Theory classes: 2h  
Practical classes: 2h  
Self study: 6h

**Description:**  

**Related activities:**  
- Theory and practical classes  
- Laboratory session: Mechanical characterization of composites

## Module 5: Bibliographic research project

**Learning time:** 17h  
Theory classes: 2h  
Practical classes: 2h  
Self study: 13h

**Description:**  
Bibliographic research by teams on suggested topics of the course subject. Writing of a bibliography-based document on suggested topics. Presentation of bibliography-based works made by teams.

**Related activities:**  
- Bibliographic research-based work on a proposed topic, realised by teams.  
- Workshop of bibliographic research about project topics.  
- Delivering and oral presentation of bibliographic research works

## Module 6: Micromechanical analysis

**Learning time:** 16h  
Theory classes: 5h  
Practical classes: 1h  
Self study: 10h

**Description:**  
6. Micromechanical approaches (mechanistic, analytics and empirics); Volume and mass fractions; Representative volume element RVE; Serial-parallel rule of mixtures and modified; Evaluation of the composite elastic properties; Ultimate strengths; Micromechanical failures; Damage models; Hygrothermoelastic (HTE) effects.

**Related activities:**  
Theory and practical classes
Module 7: Mesomechanical analysis

**Description:**
Terminology and notation; Compatibility, constitutive and equilibrium equations; Generalized Hook's Law; Stress-strain relations of elastic materials; Degrees of anisotropy; Engineering constants; Plane stress state and constitutive relations; Constitutive relations of unidirectional ply; Stiffness of on-axis ply; Engineering constants of on-axis ply; Global and local coordinate references; Multiangle transformation matrices; Coupling effects; Mutual influence coefficients; Hygrothermoelastic (HTE) effects; Ply strength; Failure theories; Polynomial criteria; Failure envelopes.

**Related activities:**
Theory and practical classes

**Learning time:** 23h
- Theory classes: 5h
- Practical classes: 3h
- Self study: 15h

Module 8: Macromechanical analysis

**Description:**
Stacking sequence and laminate code; Classical laminated plate theory; Kirchhoff hypothesis; Strain-stress relations; In-plane force and moment resultants; General load-deformation relations; Laminate stiffnesses; ABD matrices; Laminate coupling relationships; Classification of laminates; Effective engineering constants; Design considerations; Normalized matrices; Laminate effective engineering constants; Sandwich laminates.

**Related activities:**
Theory and practical classes

**Learning time:** 23h
- Theory classes: 5h
- Practical classes: 3h
- Self study: 15h

Qualification system

Part 1 (50%): Exam 1 (40%) + Practical work (10%)
Part 2 (50%): Exam 2 (40%) + Practical work (10%)

Eventually low marks obtained in the first exam, will be able to recuperate by means of a procedure that will be provided.
Bibliography

**Basic:**


**Complementary:**
