## 220126 - Thermodynamics of Materials

### Coordinating unit:
205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering

### Teaching unit:
724 - MMT - Department of Heat Engines

### Academic year:
2019

### Degree:
- BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional)
- BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Optional)
- BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Teaching unit Optional)

### ECTS credits:
3

### Teaching languages:
English

### Teaching staff

#### Coordinator:
Frida Roman

#### Others:
John M. Hutchinson, Yolanda Calventus

### Teaching methodology

The course is divided into parts:
- **Theory classes**
- **Practical classes**

Self-study 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 appropriate examples to facilitate their understanding.

The practical classes will take place in the Laboratory, and in them, students will observe the different phenomena presented in the theory classes.

Students need to work independently on the materials provided by teachers in order to assimilate the concepts. The teachers provide the syllabus and monitoring of activities (by ATENEA).

### Learning objectives of the subject

- Understanding of Thermodynamics applied to the phase transitions and its application to polymeric materials.
- Learn some experimental techniques for detecting phase transitions in polymeric materials.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 75h</th>
<th>Hours large group: 30h</th>
<th>40.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study: 45h</td>
<td></td>
<td>60.00%</td>
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</table>
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## Content

<table>
<thead>
<tr>
<th>Module 1: Thermodynamic Property Relations</th>
<th>Learning time: 15h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Self study : 9h</td>
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</tbody>
</table>

**Description:**
- Review of The Laws of Thermodynamics
- Gibbs Equation
- Fundamental Thermodynamics relationships
- Maxwell's Equations
- General equations for internal energy, enthalpy and entropy in terms of P, v, T and specific heats
- Equilibrium and stability criteria

**Related activities:**
- Theory classes

<table>
<thead>
<tr>
<th>Module 2: First and Second order phase transitions</th>
<th>Learning time: 7h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 3h</td>
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<tr>
<td></td>
<td>Self study : 4h</td>
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</tbody>
</table>

**Description:**
- First order phase transitions
- Second order phase transitions

**Related activities:**
- Theory classes

<table>
<thead>
<tr>
<th>Module 3: First order phase transitions: crystallization and melting in polymeric materials</th>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 8h</td>
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<tr>
<td></td>
<td>Self study : 12h</td>
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**Description:**
- Introduction and concepts of morphology
- Crystallisation kinetics. Nucleation and Growth
- Factors which affect the crystallisation process
- Properties related to the crystalline structure
- Melting temperatures, enthalpies and entropies of Fusion

**Related activities:**
- Theory classes
- Practical classes
## Qualification system

The final grade depends on the following criteria:

- Final exam: 50%
- Coursework: 50%

Students that fail or do not present to the final exam (50%) that will take place at the end of the elective classes, will have the chance to repeat it in January, but, in this case, the maximum grade which can be awarded is 5/10.

### Module 4: Glass transition phenomena in polymeric materials

| Description: |
| - Pseudo second order transitions
| - Glass transition
| - Effect of different parameters in glass transition
| - Physical aging.

| Related activities: |
| Theory classes
| Practical classes

| Learning time: |
| 13h |
| Theory classes: 5h |
| Self study : 8h |

### Module 5: Curing reactions in thermosetting polymers

| Description: |
| - Curing reactions
| - Curing reactions of thermosetting materials
| - Vitrification and devitrification
| - Curing kinetics
| - Characterisation techniques

| Related activities: |
| Theory classes
| Practical classes

| Learning time: |
| 20h |
| Theory classes: 8h |
| Self study : 12h |
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Bibliography

Basic:

Complementary: