240151 - Technology and Selection of Materials

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 702 - CMEM - Department of Materials Science and Metallurgy
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4,5
Teaching languages: Catalan, Spanish

Coordination:
ANTONIO MANUEL MATEO GARCIA (Q1)
ELISA RUPÉREZ (Q2)

Degree competences to which the subject contributes

Specific:
1. Knowledge of science, technology and materials' chemistry fundaments. Understanding the relation between microstructure, synthesis or processing and materials' properties.

Teaching methodology

During the course there are classroom and laboratory practices, together with independent learning, relating the theoretical and practical knowledges.

There are two exams

Hours:
Theory: 45 h (3h/week = 2 sessions of 1.5 hour)
Laboratories: 10 h (5 sessions of 2 hours, 1 session per week. Groups of up to 15 students)

Learning objectives of the subject

At the end of the course, the student should be able to:
- Implement methodologies to select materials and forming processes for industrial applications.
- Knowing the basics of the most common processing techniques (forming, heat treatment and welding) for the different families of materials and assess their suitability depending on application.
- Knowing how processing affects the structure and properties of materials.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 40h 30m</th>
<th>36.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours small group:</td>
<td>4h 30m</td>
<td>4.00%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study:</td>
<td>67h 30m</td>
<td>60.00%</td>
</tr>
</tbody>
</table>
## Content

### 1. MATERIALS SELECTION

**Learning time:** 23h  
Theory classes: 5h  
Laboratory classes: 6h  
Self study: 12h

**Description:**
- Presentation of the topic, evaluation information and schedule.
- Design process
- Design methods
- Design tools
- Interactions between function, material, shape and process
- Materials properties plots
- Materials properties
- Representation of materials in Ashby plots
- Materials selection
- Strategies for selection
- Performances index
- Influence of shape on the selection

### 2. RAW MATERIALS

**Learning time:** 7h  
Theory classes: 2h  
Self study: 5h

**Description:**
- Steel processing:
- Blast furnace
- Oxygen steelmaking
- Electric arc furnace
- Secondary steelmaking
- Continuous casting
- Cupola
- Aluminium production:
- Bayer process
- Electrolysis
- Metallic powder production
- Powder characteristics
- Atomization
- Ceramic raw materials
- Polymer raw materials
- Synthesis of polymers: polymerization
- Additives
### 3. METAL CASTING

**Learning time:** 6h  
Theory classes: 2h  
Self study: 4h

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Solidification</td>
</tr>
<tr>
<td>- Defects</td>
</tr>
<tr>
<td>- Moulding technology</td>
</tr>
<tr>
<td>- Types of moulds</td>
</tr>
<tr>
<td>- Filling systems and risers</td>
</tr>
<tr>
<td>- Other technologies</td>
</tr>
<tr>
<td>- Shell moulding</td>
</tr>
<tr>
<td>- Lost-wax casting</td>
</tr>
<tr>
<td>- Injection moulding</td>
</tr>
<tr>
<td>- Advantages and limitations of metal casting</td>
</tr>
</tbody>
</table>

### 4. PLASTIC FORMING OF METALS

**Learning time:** 25h 30m  
Theory classes: 7h 30m  
Laboratory classes: 1h 30m  
Self study: 16h 30m

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Softening mechanisms</td>
</tr>
<tr>
<td>- Static recovery and recrystallization</td>
</tr>
<tr>
<td>- Dynamic recovery and recrystallization</td>
</tr>
<tr>
<td>- Cold working versus hot working</td>
</tr>
<tr>
<td>- General classification of plastic forming processes</td>
</tr>
<tr>
<td>- Rolling</td>
</tr>
<tr>
<td>- Mills</td>
</tr>
<tr>
<td>- Problems and defects</td>
</tr>
<tr>
<td>- Forging</td>
</tr>
<tr>
<td>- Open-die versus closed-die</td>
</tr>
<tr>
<td>- Defects</td>
</tr>
<tr>
<td>- Extrusion</td>
</tr>
<tr>
<td>- Drawing</td>
</tr>
<tr>
<td>- Sheet forming</td>
</tr>
<tr>
<td>- Shearing</td>
</tr>
<tr>
<td>- Bending</td>
</tr>
<tr>
<td>- Deep drawing</td>
</tr>
</tbody>
</table>
### 5. POWDER METALLURGY

**Description:**
- Pressing
- Sintering
- Advantages and limitations of powder metallurgy

**Learning time:** 1h 30m  
Theory classes: 0h 30m  
Self study: 1h

### 6. POLYMER FORMING

**Description:**
- Injection
  - Injection machine, process variables, molds
  - Defects in molded parts
  - Morphologies induced by processing
  - Advanced processing based on injection
- Extrusion
  - Extruder, process parameters, nozzles
  - Defects in extruded parts and morphology induced by processing
  - Processing techniques based on extrusion
- Other processing techniques
  - Thermoforming
  - Rotational Molding
  - Processes for cellular plastics (foam)
  - Processing of thermosets and composites

**Learning time:** 16h 30m  
Theory classes: 5h  
Laboratory classes: 1h 30m  
Self study: 10h
### 7. CERAMIC FORMING

**Description:**
- Glass forming
- Viscosity & temperature curve
- Pressing
- Blowing
- Drawing
- Glass-ceramics
- Forming of clay products
- Pressing
- Hydroplastic forming
- Barbotine casting
- Firing
- Cement
- Tape casting

**Learning time:** 6h  
Theory classes: 2h  
Self study: 4h

### 8. HEAT TREATMENTS

**Description:**
- Metallurgical theory for heat treatments of steels
- General classification of heat treatments
- Isothermal transformations: TTT diagrams
- Continuous cooling transformations: CCT diagrams
- Bulk heat treatments
- Annealings: normalized, total and isothermal
- Sub-critical treatments: spheroidizing, recrystallization and stress relieve
- Austempering and martempering
- Quench and temper: quenchability concept and cooling media
- Surface heat treatments
- Induction
- Flame
- Cementation
- Carbonitriding
- Nitriding
- Heat treatments of cast irons: austempering
- Heat treatments of non iron-based alloys: aging

**Learning time:** 20h  
Theory classes: 4h  
Laboratory classes: 6h  
Self study: 10h
9. WELDING

| Description: |
| - Advantages and limitations of welds |
| - Zones of a weld |
| - Thermal cycle and thermal distribution curves |
| - Weldability |
| - Defects |
| - Pores |
| - Hot cracks |
| - Hydrogen embrittlement |
| - Lamellar tearing |
| - Classification of welding processes |
| - Solid - Solid: friction |
| - Liquid - Liquid: resistance, gas, arc, others |
| - Solid - Liquid: brazing and soldering |

Learning time: 7h
- Theory classes: 2h
- Self study: 5h

Planning of activities

| (ENG) LABORATORI DE SELECCIÓ DE MATERIALS | Hours: 14h |
| - Laboratory classes: 6h |
| - Self study: 8h |

| (ENG) PRÁCTICAS DE LABORATORIO DE TECNOLOGÍA DE MATERIALES | Hours: 12h |
| - Laboratory classes: 9h |
| - Self study: 3h |

| (ENG) CUESTIONARIOS | Hours: 3h |
| - Self study: 3h |


## Bibliography

### Basic:


### Complementary:


### Others resources:

- **Hyperlink**

- [http://www.steeluniversity.org/](http://www.steeluniversity.org/)

- **Audiovisual material**
  - Apuntes en PDF en Atenea elaborados por los profesores