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: 2017
Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Teaching unit Compulsory)
ECTS credits: 4.5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: ANTONIO MANUEL MATEO GARCIA (Q1)
JESSICA CALVO (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: 30 h (2h/week = 2 sessions of 1 hour)
Laboratories: 15 h (5 sessions of 3 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:</th>
<th>31h 30m</th>
<th>28.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
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<tr>
<td>Hours small group:</td>
<td>13h 30m</td>
<td>12.00%</td>
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<tr>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td>Self study:</td>
<td>67h 30m</td>
<td>60.00%</td>
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### Content

<table>
<thead>
<tr>
<th>1. MATERIALS SELECTION</th>
<th>Learning time: 23h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td></td>
<td>Laboratory classes: 6h</td>
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<tr>
<td></td>
<td>Self study: 12h</td>
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</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>2. RAW MATERIALS</th>
<th>Learning time: 7h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h</td>
</tr>
</tbody>
</table>

**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

**Description:**
- Solidification
- Defects
- Moulding technology
- Types of moulds
- Filling systems and risers
- Other technologies
- Shell moulding
- Lost-wax casting
- Injection moulding
- Advantages and limitations of metal casting

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

### 4. PLASTIC FORMING OF METALS

**Description:**
- Softening mechanisms
- Static recovery and recrystallization
- Dynamic recovery and recrystallization
- Cold working versus hot working
- General classification of plastic forming processes
- Rolling
- Mills
- Problems and defects
- Forging
- Open-die versus closed-die
- Defects
- Extrusion
- Drawing
- Sheet forming
- Shearing
- Bending
- Deep drawing

**Learning time:** 25h 30m  
- Theory classes: 7h 30m  
- Laboratory classes: 1h 30m  
- Self study: 16h 30m
## 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:**
- Reology
- 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: spherodizing, 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

Planning of activities

<table>
<thead>
<tr>
<th>(ENG) LABORATORI DE SELECCIÓ DE MATERIALS</th>
<th>Hours: 14h</th>
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<tbody>
<tr>
<td></td>
<td>Laboratory classes: 6h</td>
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<td></td>
<td>Self study: 8h</td>
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<thead>
<tr>
<th>(ENG) PRÁCTICAS DE LABORATORIO DE TECNOLOGÍA DE MATERIALES</th>
<th>Hours: 12h</th>
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<tr>
<td></td>
<td>Laboratory classes: 9h</td>
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<td>Self study: 3h</td>
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<thead>
<tr>
<th>(ENG) CUESTIONARIOS</th>
<th>Hours: 3h</th>
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<td>Self study: 3h</td>
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Qualification system

1. A compulsory partial test (PP) at mid-semester with a duration of an hour.
2. A compulsory final exam (EF) by the end of the semester with a duration of over 1.5 hours.

La nota final (NF) serà calculada a partir de la següent expressió:

\[
NF = 0.5 \text{ NEF} + 0.3 \text{ NPP} + 0.2 \text{ NAC}
\]

NAC (Nota d’avaluació continuada) = 0.75TR + 0.25PR

NF = Nota Final
NEF = Nota Examen Final
NPP = Nota Prova Parcial
NAC = Nota Avaluació Continuada
TR = Nota treball
PR= Nota informe prácticas

Regulations for carrying out activities

Practice: Attendance at activities 1 and 2 is mandatory, and also the presentation of the corresponding reports.
Questionnaires: To be answered individually "on line" within the deadline. Omission of any of them invalidates the note of the activity (NCA).
Written work + oral + debate: The performance (in groups of 3 to 4 people) and assistance to the established session for activity is mandatory. The theme of the work to be presented will be proposed by the working group in the first 3 weeks of the semester.
Partial Test: Duration 1 hour. Not allowed to use notes, mobile devices and programmable calculators.
Final exam: Mandatory. Duration 1.5 h. An evaluation of all the topics covered throughout the semester. Not allowed to use notes, mobile devices and programmable calculators.

Omission of any of the mandatory activities will automatically invalidate the assessment item which is affected.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

http://science.discovery.com/tv/how-its-made/

http://www.steeluniversity.org/

Audiovisual material

Apuntes en PDF en Atenea elaborados por los profesores