### [MHH100] MATERIAL FORMING

#### GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Studies</th>
<th>UNIVERSITY MASTER IN INDUSTRIAL ENGINEERING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semester</td>
<td>2</td>
</tr>
<tr>
<td>Character</td>
<td>OPTIONAL</td>
</tr>
<tr>
<td>Plan</td>
<td>2017</td>
</tr>
<tr>
<td>Subject</td>
<td>MANUFACTURING PROCESS ENGINEERING</td>
</tr>
<tr>
<td>Mention / Field of specialisation</td>
<td>ENGLISH</td>
</tr>
<tr>
<td>Language</td>
<td>ENGLISH</td>
</tr>
<tr>
<td>Credits</td>
<td>5</td>
</tr>
<tr>
<td>Modality</td>
<td>Face-to-face</td>
</tr>
<tr>
<td>Hours/week</td>
<td>2.33</td>
</tr>
<tr>
<td>Total hours</td>
<td>42 class hours + 83 non-class hours = 125 total hours</td>
</tr>
</tbody>
</table>

**Note:** Considerations concerning the assessment system: Assessment criteria percentages or the assessment criteria itself can be modified due to the COVID, if the online context prevails over the physical presence.

#### PROFESSORS

- GALDOS ERRASTI, LANDER
- OTEGI MARTINEZ, NAGORE

#### REQUIRED PREVIOUS KNOWLEDGE

<table>
<thead>
<tr>
<th>Subjects</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>(No specific previous subjects required)</td>
<td>(No previous knowledge required)</td>
</tr>
</tbody>
</table>

#### SKILLS

**VERIFICA SKILLS**

**SPECIFIC**

- MHC02 - To be able to plan, calculate and design integrated manufacturing systems
- MHC03 - To be able to design and test machines

**CROSS**

- MHC47 - To select one measure or idea out of several and implement them in response to the needs or circumstances emerging in the work process
- MHC48 - To work with people, getting them involved and guiding them towards the achievement of a common goal, with a global vision of work and its characteristics (quality, deadlines, etc.), taking individual and group interests into account

**BASIC**

- M_CB10 - To have learning skills and the capacity for self-guided or independent subsequent learning.
- M_CB7 - To know how to apply the acquired knowledge and competencies and the ability to solve problems in new or unfamiliar contexts within wider (or multidisciplinary) environments related to their field of study
- M_CB8 - To be able to integrate different types of knowledge and make complex judgements based on information that, in spite of being partial or limited, includes ideas on the social and ethical responsibilities associated with the application of knowledge
- M_CB9 - To share knowledge, conclusions and their rationale with specialised and lay audiences in a clear, unambiguous manner

#### ENAEE LEARNING RESULTS

<table>
<thead>
<tr>
<th>ECTS</th>
<th>ENA124 - Knowledge and comprehension: Deep knowledge and comprehension of the engineering disciplines of their speciality, at the level necessary to acquire the rest of the competencies of the degree.</th>
<th>0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENA128 - Analysis in engineering: Ability to conceive new products, processes, and systems.</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>ENA133 - Research and innovation: Ability to identify, find and obtain the required data.</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>ENA134 - Research and innovation: Ability to carry out bibliographic searches and consult and use databases and other information sources with discretion, in order to carry out simulations with the aim of conducting research on complex topics of their speciality.</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>ENA136 - Research and innovation: High-level capacity and ability to project and carry out experimental investigations, interpret data with criteria, and draw conclusions.</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>ENA137 - Research and innovation: Ability to investigate the application of the most advanced technologies in their speciality.</td>
<td>0.6</td>
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<tr>
<td></td>
<td>ENA139 - Practical application of engineering: Practical skills, such as the use of computer tools to solve complex problems, carry out complex engineering projects, and design and guide complex investigations.</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>ENA140 - Practical application of engineering: Complete knowledge of application of materials, equipment and tools, engineering technology and processes, and their limitations.</td>
<td>0.8</td>
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<tr>
<td></td>
<td>ENA146 - Communication and Teamwork: Ability to employ different methods to communicate their conclusions, clearly and unambiguously, and the knowledge and logical foundations that support them, to audiences specialised and not specialised in the issue, in domestic and international contexts.</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Total:** 5

#### LEARNING RESULTS

- **RA151** Acquires deep skills about industrial sheet metal forming and forging processes as well as the fundamental concepts to optimise these processes by numerical simulation using FEM
LEARNING ACTIVITIES

Individual study and work, tests and evaluations and check points

CH | NCH | TH
---|-----|-----
14 h. | 21 h. | 35 h.

EVALUATION SYSTEM

Individual written and oral tests to assess technical skills of the subject

Comments: All activities (control points, individual and group assignments, etc...) must have a minimum mark (5 minimum) and there will be an opportunity to retake every activity. In case of retake of the control point, the final mark will be the mark of the retake.

MAKE-UP MECHANISMS

(No mechanisms)

CH - Class hours: 14 h.
NCH - Non-class hours: 21 h.
TH - Total hours: 35 h.

RA152

Is able to evaluate the feasibility of a metal forming process using numerical simulation as well as to propose alternative processes to achieve the desired component/process

LEARNING ACTIVITIES

Individual study and work, tests and evaluations and check points

CH | NCH | TH
---|-----|-----
6 h. | 16 h. | 22 h.

EVALUATION SYSTEM

Individual written and oral tests to assess technical skills of the subject

Comments: All activities (control points, individual and group assignments, etc...) must have a minimum mark (5 minimum) and there will be an opportunity to retake every activity. In case of retake of the control point, the final mark will be the mark of the retake.

MAKE-UP MECHANISMS

(No mechanisms)

CH - Class hours: 6 h.
NCH - Non-class hours: 16 h.
TH - Total hours: 22 h.

RA153

Has the capacity to design and analyse an industrial process and tooling to produce a component starting from a component CAD design

LEARNING ACTIVITIES

Individual and team exercises

CH | NCH | TH
---|-----|-----
20 h. | 38 h. | 58 h.

EVALUATION SYSTEM

Individual written and oral tests to assess technical skills of the subject

Reports of solving exercises, case studies, computer practices, simulation practices and laboratory practices

Comments: All activities (control points, individual and group assignments, etc...) must have a minimum mark (5 minimum) and there will be an opportunity to retake every activity. In case of retake of the control point, the final mark will be the mark of the retake. Failed assignments, practices, etc... must be retaken and will be graded with a maximum mark of 5.

MAKE-UP MECHANISMS

(No mechanisms)

CH - Class hours: 20 h.
NCH - Non-class hours: 38 h.
TH - Total hours: 58 h.

RA154

Recognises the experimental tests to be performed to develop advanced material and contact models needed for feeding a numerical FEM model

[MMH100] MATERIAL FORMING

## LEARNING ACTIVITIES

<table>
<thead>
<tr>
<th>Activity</th>
<th>CH</th>
<th>NCH</th>
<th>TH</th>
</tr>
</thead>
</table>
| Individual or team workshop and/or lab practice                         | 2 h.| 8 h. | 10 h.

### EVALUATION SYSTEM

<table>
<thead>
<tr>
<th>Reports of solving exercises, case studies, computer practices, simulation practices, laboratory practices</th>
<th>W 100%</th>
<th>MAKE-UP MECHANISMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comments</strong>: The failed tasks, training, etab. must be retaken and they will be valued with a maximum of a 5.</td>
<td></td>
<td>(No mechanisms)</td>
</tr>
</tbody>
</table>

CH - Class hours: 2 h.
NCH - Non-class hours: 8 h.
TH - Total hours: 10 h.

## CONTENTS

1st MODULE. Introduction and industrial use of FEM
- Subject introduction
- Why manufacturing process simulation?
- Importance of the virtual manufacturing

2nd MODULE. Virtual manufacturing techniques
- How to simulate the reality?
- Agreement between accuracy and computational time
- Numerical simulation commercial codes

3rd MODULE. Numerical methods
- How to solve the problem using a computer?
- Time discretization
- Spatial discretization

4th MODULE. Material behavior
- How does the material behavior affect the result?
- Metal forming plasticity model
- Relevant material parameters

5th MODULE. Tribology
- How to simulate the contact between bodies?
- Contact algorithms
- Characterization methods
6th MODULE. Machines and tool construction
Industrial machines for metal forming
Sheet metal forming tool materials and design
Forging tool materials and design

7th MODULE. Stamping software
Commercial stamping software
Simulation methodology
Results analysis

8th MODULE. Practical project
Real problem analysis
Application of the studied concepts
Real manufacturing virtual analysis

<table>
<thead>
<tr>
<th>Learning resources</th>
<th>Bibliography</th>
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