Degree competences to which the subject contributes

Specific:
13368. Mathematically modelling structural engineering problems.
13369. To apply methods and advanced design software and structural calculations, based on knowledge and understanding of forces and their application to the structural types of civil engineering.

General:
13360. To conceive, design, analyze and manage structures or structural elements of civil engineering or building, encouraging innovation and the advance of knowledge.
13361. To develop, improve and use conventional materials and new construction techniques to ensure the safety requirements, functionality, durability and sustainability.

Teaching methodology

The course consists of 2.7 hours a week of classes in the classroom where the teacher presents the concepts and basics of the course. Also 0.9 hours per week is spending in a middle group format, to problem solving with more interaction with the student. Practical exercises are solved to consolidate the general and specific learning objectives. Support material is used in the form of detailed teaching plan stored at the Virtual Center http://www.cimne.com/cdl1/ctrhome/2: content, programming and evaluation activities directed learning and literature.

Learning objectives of the subject
## Study load

<table>
<thead>
<tr>
<th></th>
<th>Total learning time: 150h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>25h 58,8m 17.32%</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>13h 01,2m 8.68%</td>
</tr>
<tr>
<td>Laboratory classes:</td>
<td>13h 01,2m 8.68%</td>
</tr>
<tr>
<td>Guided activities:</td>
<td>1h 58,8m 1.32%</td>
</tr>
<tr>
<td>Self study:</td>
<td>96h 64.00%</td>
</tr>
</tbody>
</table>
# 250725 - Structural Engineering

## Content

<table>
<thead>
<tr>
<th>Introduction</th>
<th>Learning time: 4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 2h 48m</td>
</tr>
</tbody>
</table>

### Specific objectives:
Describe the course and present the analogy with discrete and bar systems.

<table>
<thead>
<tr>
<th>2D Solids</th>
<th>Learning time: 28h 47m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 16h 47m</td>
</tr>
</tbody>
</table>

### Specific objectives:
Structural analysis in plane stress and strain assumptions as well in axisymmetric 3D structures.
Introduction to Programming the FEM in MATLAB
Learning a finite element program
Solution of two-dimensional structures using FEM

<table>
<thead>
<tr>
<th>3D Solid</th>
<th>Learning time: 9h 36m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 5h 36m</td>
</tr>
</tbody>
</table>

### Specific objectives:
Define the finite element method in three-dimensional elasticity problems.
Solution of 3D structures using the FEM

### Specific objectives:
Consolidate the MEF study by its matrix formulation.
Consolidate the use of computers to solve problems by the FEM
### Beams

**Learning time:** 14h 23m  
- Theory classes: 6h  
- Self study: 8h 23m

**Description:**  
Study the theories of Timoshenko and Euler_Bernulli for solving bending beams.

**Specific objectives:**  
- Studying higher-order elements and know the complications that can present the numerical solution of a problem by the FEM

### Evaluation

**Learning time:** 9h 36m  
- Laboratory classes: 4h  
- Self study: 5h 36m

### Plates

**Learning time:** 19h 12m  
- Theory classes: 6h  
- Practical classes: 2h  
- Self study: 11h 12m

**Description:**  
Further application of FEM for thin and thick plates analysis using the Kirchhoff and Reissner-Mindlin theories.  
Analyse the application to composite materials.  
Solving plate structures using the FEM

**Specific objectives:**  
- Extending theories of beams to two-dimensional case  
- Consolidate the use of computers to solve problems by the FEM

### Shells

**Learning time:** 24h  
- Theory classes: 8h  
- Practical classes: 2h  
- Self study: 14h

**Description:**  
Develop the FEM to the analysis of thin and thick shells extending Kirchoff theories and Reissner-Mindlin as well as the 2D plane stress to the 3D flat shells analysis.  
Shells structures solution using the FEM

**Specific objectives:**  
- Expanding and combining elasticity theories applied to the FEM  
- Consolidate the use of computers to solve problems using the FEM
### Real Examples

**Description:**
Presentation of real studies conducted by engineering firms.

**Specific objectives:**
Knowing the actual use of the method and its scope.

### Introduction to Dynamic Analysis

**Learning time:** 4h 48m
- Theory classes: 2h
- Self study: 2h 48m

**Description:**
Introduction to dynamic analysis of structures using the FEM

**Specific objectives:**
- show the scope of the FEM in the structures design.

### Introduction to Nonlinear Problems

**Learning time:** 4h 48m
- Theory classes: 2h
- Self study: 2h 48m

**Description:**
Introduction to nonlinear analysis and coupled problems, using the FEM

**Specific objectives:**
- show the scope of the FEM in structural design.

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### Qualification System

The mark will be obtained from continuous assessment (40%) and the average of two exams (60%).
Continuous assessment involves solving individual exercises. These exercises will be graded with a maximum score of four (4) points: One (1) point for the practical exercises solved at class time and three (3) points for the finite element method applied to a practical case.
The exams consist of a questionnaire to be answer individually, without the help of any literature. Each questionnaire adheres to the concepts taught in the course. This exams have a maximum mark of six (6) points.

### Regulations for Carrying out Activities

If there is any exam or continuous assessment within the scheduled period, a zero score will be considered.
Bibliography

Basic:

