Degree competences to which the subject contributes

Specific:
8226. Comprehension and mastery of the laws governing the thermomechanics of continuous media for their application in fields of engineering such as fluid mechanics, the mechanics of materials, structural theory, etc.

Transversal:
8562. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
8563. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Teaching methodology

The course uses the "flipped classroom" methodology where the student, by means of specific group-dynamics techniques, extends and consolidates the knowledge acquired during the out-of-class preparation, in advance, of basic elements corresponding to the following classes. The out-of-class preparation is carried out by the student, supported by videos, transparencies, books and bibliographic material, provided on the website of the course, and according to the directions of the teacher. Then, the in-class group dynamics consists of providing the group of students the required additional knowledge, according to the possible weaknesses identified by the teacher, perform practical exercises, answer questions, deepen the students knowledge on the subject and promote teamwork.

Learning objectives of the subject

Students will acquire advanced knowledge of the laws of thermodynamics for continuous media and learn how they apply to engineering disciplines such as fluid mechanics, mechanics of materials and structural theory.

Upon completion of the course, students will be able to:

Describe motion, deformation and stress;
Apply conservation equations to structural problems in hydraulics and geotechnics;
Model the behaviour of solid and fluid materials and interpret the results.
History of the mechanics of continuous media in the context of civil engineering; Describing motion: Lagrange-Euler formulation; Deformations of a continuous medium and compatibility equations; Motion and deformations in cylindrical and spherical coordinates; Cauchy stress, postulates and equations; Mohr's circle stress analysis; Equations of conservation of mass, momentum and energy; Thermodynamics of continuous media; Fundamentals of constitutive equations; Theory of elasticity, plasticity, fracture criteria and viscoplasticity; Principle of virtual work; Fluid constitutive behaviour; Fluid mechanics; Equations of motion; Turbulence.

### Study load

<table>
<thead>
<tr>
<th>Total learning time: 225h</th>
<th>Hours large group: 38h 58,2m 17.32%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 19h 31,8m 8.68%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 19h 31,8m 8.68%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 2h 58,2m 1.32%</td>
</tr>
<tr>
<td></td>
<td>Self study: 144h 64.00%</td>
</tr>
<tr>
<td>Section</td>
<td>Learning time: 4h 48m</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Introduction                 | Theory classes: 2h  
Self study : 2h 48m                                                                     |

| Description                  | Introduction to the course and review of tensor algebra.                               |

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 14h 23m</th>
</tr>
</thead>
</table>
| Description of Motion        | Theory classes: 3h 30m  
Practical classes: 2h 30m  
Self study : 8h 23m                                                                     |

| Description                  | Theory  
Problems                                                                       |

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 24h</th>
</tr>
</thead>
</table>
| Deformation and Strain       | Theory classes: 7h 30m  
Practical classes: 2h 30m  
Self study : 14h                                                                     |

| Description                  | Theory  
Problems                                                                       |

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time: 7h 11m</th>
</tr>
</thead>
</table>
| Compatibility Equations      | Theory classes: 2h  
Laboratory classes: 1h  
Self study : 4h 11m                                                                    |

| Description                  | Theory and problems                                                                |

### Stress

**Description:**
- Theory
- Problems

**Learning time:** 21h 36m
- Theory classes: 7h 30m
- Practical classes: 1h 30m
- Self study: 12h 36m

### Conservation and Balance Equations

**Description:**
- Theory
- Problems

**Learning time:** 31h 12m
- Theory classes: 9h
- Practical classes: 3h
- Laboratory classes: 1h
- Self study: 18h 12m

### Linear Elasticity

**Description:**
- Theory
- Problems

**Learning time:** 27h 36m
- Theory classes: 7h 30m
- Practical classes: 4h
- Self study: 16h 06m

### Plane Linear Elasticity

**Description:**
- Theory

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

<table>
<thead>
<tr>
<th>Learning time: 22h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>Practical classes: 3h 30m</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Self study: 13h 18m</td>
</tr>
</tbody>
</table>

**Description:**
- Theory
- Problems

### Constitutive Equations in Fluids

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

**Description:**
- Theory

### Fluid Mechanics

<table>
<thead>
<tr>
<th>Learning time: 19h 12m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 5h</td>
</tr>
<tr>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Self study: 11h 12m</td>
</tr>
</tbody>
</table>

**Description:**
- Theory
- Problems

### Variational Principles

<table>
<thead>
<tr>
<th>Learning time: 4h 48m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 1h</td>
</tr>
<tr>
<td>Laboratory classes: 1h</td>
</tr>
<tr>
<td>Self study: 2h 48m</td>
</tr>
</tbody>
</table>

**Description:**
- Theory and problems
The evaluation of the course will be made from two grades:

a) A grade based on the performance of midterms, multiple-question type. Four partial tests, on contents grouped by topics of the course, will be made. These tests will be about one hour long, and will be done along the course during lecture hours. The final mark of the assessment will result into a "Mid-terms evaluation mark" (NAP) to be obtained as a combination of the arithmetic average (with a weight of 0.9) and the geometric average (with a weight of 0.1) of partial evaluations, on 10 points.

b) A grade based on individual perception, by the lecturer, about the "global" knowledge of the subject by each student, the involvement in the learning dynamics proposed in classes and the group-work skills acquired over the course. This assessment will be done on the basis of the continuous in-class lecturer-students interaction throughout the course and the final perception of the lecturer. The grading will result in a "teachers perception mark" (NP) on 10 points.

The final mark (NF) will be weighted between the two marks as
\[ NF = \max(NAP; 0.8 \times NAP + 0.2 \times NP) \]
rounded to the lower multiple of 0.1.

To pass the course, the student will need to obtain a mark (NF) equal to or greater than 5.

If any of the ongoing evaluation activities are not performed in the scheduled period a zero mark will be assigned to that activity.

In case of failure to attend an assessment test due to a justifiable reason, the student must notify the professor in charge of the course BEFORE OR IMMEDIATELY AFTER THE TEST and hand in an official certificate excusing his absence. In this case, the student will be allowed to take the test another day, ALWAYS BEFORE THE FOLLOWING ASSESSMENT.

Bibliography

Basic:


Complementary:


