The course is centered on the numerical methods applied to the modeling of the behaviour of nonlinear materials in solids. It makes special emphasis on the integration of the constitutive models and the generalizations towards the nonlinear versions of the finite element method. The course includes the essential theoretical aspects as well as their
The students will be able to understand and assimilate the foundations of the mechanics of solids, identifying the most important aspects of the modeling of a material, like the mechanisms of dissipation associated with nonlinear behaviour. They have to be able to interpret the physical meaning of the properties of a material and properly identify the numerical methods for the solution of problems of mechanics of solids with its application on elasticity and learn the foundations of fluid mechanics. To know the theoretical and practical foundations of the method of the finite elements for the analysis of structures submitted to dynamic and static loads; to identify the fundamental theoretical aspects for each structural topology and their inherent computational aspects. Identify properly the theories associated to each structural topology for the correct analysis with the finite elements method (FEM), to be able to analyse the structural topologies commonly found in practice by means of the FEM, using commercial codes and simultaneously develop a personal code with their basic aspects. To learn the foundations of the behaviour of the numerical approximations to the dynamics of fluids: Their equations, the spatial and temporal discretisations, and the most relevant mathematical aspects, such as the stabilisation of convection and incompressibility, understanding the most important aspects of spatial and temporal discretisation as well as identifying the correct conditions for boundaries and methods but adapted to the solution for dynamics of fluids problems. The students will develop practical skills to work with tensors and formulate and develop the analysis of diverse problems of solids and fluids in engineering.

- Constitutive modeling of materials.
- Elasticity and visco elasticity.
- Continuum damage and visco-damage.
- Plasticity And visco plasticity.
- Material stability.
- Computational techniques for the modeling of non-linear materials in solids.

Advanced subjects: Mechanics of contact and extension to finite deformations.

Learning resources:
- Belytschko T., Liu W.K., Moran B., Non-linear Finite Elements for Continua and Structures, Wiley, 2002

<table>
<thead>
<tr>
<th>Study load</th>
<th>Theory classes:</th>
<th>Practical classes:</th>
<th>Laboratory classes:</th>
<th>Guided activities:</th>
<th>Self study:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total learning time:</strong> 125h</td>
<td>7h 30m</td>
<td>15h</td>
<td>17h 30m</td>
<td>5h</td>
<td>80h</td>
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# Content

<table>
<thead>
<tr>
<th>Module</th>
<th>Learning time</th>
<th>Description</th>
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</thead>
</table>
| **Introduction** | **2h 24m** | Laboratory classes: 1h  
Self study: 1h 24m |
| **Description:** | | Introduction to the course |
| **Thermodynamic foundations of constitutive modelling** | **7h 11m** | Theory classes: 3h  
Self study: 4h 11m |
| **Description:** | | Fundamentals of thermodynamics constitutive models |
| **Continuum damage models** | **28h 47m** | Theory classes: 1h 30m  
Practical classes: 5h  
Laboratory classes: 5h 30m  
Self study: 16h 47m |
| **Description:** | | Continuum damage models  
Continuum damage models  
Algorithms and Implementation |
| **Plasticity models** | **28h 47m** | Theory classes: 1h 30m  
Practical classes: 5h  
Laboratory classes: 5h 30m  
Self study: 16h 47m |
| **Description:** | | Plasticity models  
Plasticity models  
Algorithms and Implementation |
The course grade will be obtained from weighted average of the continuous assessment marks. The continuous assessment consists of different additive and formative activities (individual assignment) done during the course (in the classroom and outside of it).

### Bibliography

**Basic:**


**Complementary:**