34959 - CM - Computational Mechanics

Teaching unit: 751 - DECA - Department of Civil and Environmental Engineering
749 - MAT - Department of Mathematics

Academic year: 2018

Degree: MASTER'S DEGREE IN ADVANCED MATHEMATICS AND MATHEMATICAL ENGINEERING (Syllabus 2010). (Teaching unit Optional)

ECTS credits: 7,5

Teaching languages: English

Teaching staff

Coordinator: JOSE JAVIER MUÑOZ ROMERO

Others: Segon quadrimestre:
SONIA FERNANDEZ MENDEZ - A
JOSE JAVIER MUÑOZ ROMERO - A

Prior skills

Basic knowledge of numerical methods
Basic knowledge of partial differential equations

Degree competences to which the subject contributes

Specific:
1. RESEARCH. Read and understand advanced mathematical papers. Use mathematical research techniques to produce and transmit new results.
2. MODELLING. Formulate, analyse and validate mathematical models of practical problems by using the appropriate mathematical tools.
3. CALCULUS. Obtain (exact or approximate) solutions for these models with the available resources, including computational means.
4. CRITICAL ASSESSMENT. Discuss the validity, scope and relevance of these solutions; present results and defend conclusions.

Transversal:
5. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.
6. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
7. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
8. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
9. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.
The main objective is to provide a general perspective of the broad field of computational mechanics, covering both the modelling and the computational aspects. A broad range of problems is addressed: solids, fluids and fluid-solid interaction; linear and nonlinear models; static and dynamic problems. Some emphasis is put on applications in biomechanical problems. By the end of the course, the students should:

- Be able to choose the appropriate type of model for a specific simulation
- Be familiar with the mathematical objects (mainly tensors) used in computational mechanics
- Be aware of the different level of complexity of various problems (e.g. linear vs. nonlinear, static vs. dynamic).

**Learning objectives of the subject**

**Teaching methodology**

Four elements will be combined:
- Theory classes, where the main concepts will be presented.
- Practical classes with Matlab code in the computer room, with emphasis on the computational aspects.
- Lists of short assignments.
- Course projects in groups to be presented orally at the end of the course.

Students will work on the assignments and course projects individually or in groups.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group:</th>
<th>60h</th>
<th>32.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study:</td>
<td>127h 30m</td>
<td>68.00%</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th><strong>Content</strong></th>
<th><strong>Learning time:</strong> 31h 15m</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONTINUUM MECHANICS</strong></td>
<td>Theory classes: 8h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 21h 15m</td>
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</tbody>
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<table>
<thead>
<tr>
<th><strong>COMPUTATIONAL ELASTICITY</strong></th>
<th>Theory classes: 8h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 21h 15m</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>COMPUTATIONAL DYNAMICS</strong></th>
<th>Theory classes: 8h</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 21h 15m</td>
</tr>
<tr>
<td><strong>Description:</strong></td>
<td>Weak form. Dynamic equation. Space discretisation (finite elements) and time discretisation. Solution methods: generalised eigen value problem and direct time integration. Euler, centred differences, HHT and Newmark methods. Stability, consistency and accuracy of numerical techniques in elastodynamics. Applications.</td>
</tr>
</tbody>
</table>
## Computational Plasticity and Viscoelasticity

**Learning time:** 31h 15m  
Theory classes: 8h  
Practical classes: 2h  
Self study: 21h 15m

**Description:**  

## Computational Fluid Dynamics

**Learning time:** 31h 15m  
Theory classes: 8h  
Practical classes: 2h  
Self study: 21h 15m

**Description:**  

## Computational Methods for Wave Problems

**Learning time:** 31h 15m  
Theory classes: 8h  
Practical classes: 2h  
Self study: 21h 15m

**Description:**  

### Qualification system

Final exam, assigned problems, and course project.
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Bibliography

Basic:


Complementary:


