34963 - ACPDE - Advanced Course in Partial Differential Equations

**Coordinating unit:** 200 - FME - School of Mathematics and Statistics

**Teaching unit:** 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:** XAVIER CABRE VILAGUT

**Others:**
- Segon quadrimestre:
  - XAVIER CABRE VILAGUT - A
  - GYULA CSATO - A

### Prior skills

Basic knowledge of Partial Differential Equations.
Basic knowledge of Mathematical Analysis (undergraduate level).

### Requirements

Undergraduate courses in Partial Differential Equations and in Mathematical Analysis.

### 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.
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Teaching methodology

Classes will combine theoretical aspects and proofs with resolution of concrete problems and exercises. Further reading from the bibliography will be given often.

Learning objectives of the subject

Understand the classical methods to solve the Laplace, heat, and wave equations.
Understand the role of Sobolev norms and compact embeddings to solve PDEs and find spectral decompositions.
Learn the main methods available to solve nonlinear PDEs, through simple cases.

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>
<td></td>
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</tbody>
</table>
### Content

<table>
<thead>
<tr>
<th>Classical methods for the Poisson and heat equations</th>
<th>Learning time: 47h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 15h</td>
</tr>
<tr>
<td></td>
<td>Self study: 32h</td>
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</tbody>
</table>

**Description:**
Maximum principles and Green’s functions for the Poisson and heat equations.

<table>
<thead>
<tr>
<th>Sobolev spaces and variational methods</th>
<th>Learning time: 47h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 15h</td>
</tr>
<tr>
<td></td>
<td>Self study: 32h</td>
</tr>
</tbody>
</table>

**Description:**
Basic properties of Sobolev spaces. Weak or variational formulation of boundary problems for linear elliptic PDEs.

<table>
<thead>
<tr>
<th>Evolution equations</th>
<th>Learning time: 46h 45m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 15h</td>
</tr>
<tr>
<td></td>
<td>Self study: 31h 45m</td>
</tr>
</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Introduction to nonlinear PDEs</th>
<th>Learning time: 46h 45m</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 15h</td>
</tr>
<tr>
<td></td>
<td>Self study: 31h 45m</td>
</tr>
</tbody>
</table>

**Description:**

### Qualification system

The evaluation of the course is based:
- on the weekly resolution of problems proposed in class (15%);
- a midterm exam (35%);
- a final comprehensive exam (50%).
- eventually, there could be the possibility of a final project in order to improve the grade.
- the active participation during the course will be a requirement for the evaluation of the final exam.
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Bibliography

Basic:


Complementary:


