200151 - ALN - Numerical Linear Algebra

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2017
Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 7.5
Teaching languages: Catalan

Teaching staff
Coordinator: MARIA MERCEDES OLLE TORNER
Others: Segon quadrimestre:
GUILLEM BLANCO FERNÁNDEZ - A, B
JOSE TOMAS LAZARO OCHOA - B
MARIA MERCEDES OLLE TORNER - A, B
JUAN RAMON PACHA ANDUJAR - A

Degree competences to which the subject contributes

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
2. CE-3. Have the knowledge of specific programming languages and software.
3. CE-4. Have the ability to use computational tools as an aid to mathematical processes.

General:
4. CB-1. Demonstrate knowledge and understanding in Mathematics that is founded upon and extends that typically associated with Bachelor's level, and that provides a basis for originality in developing and applying ideas, often within a research context.
5. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
6. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
7. CG-1. Show knowledge and proficiency in the use of mathematical language.
8. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
9. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
10. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
11. 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.
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Teaching methodology

(Section not available)

Learning objectives of the subject

(Section not available)

Study load

<table>
<thead>
<tr>
<th>Total learning time: 187h 30m</th>
<th>Hours large group:</th>
<th>45h</th>
<th>24.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours medium group:</td>
<td>0h</td>
<td></td>
<td>0.00%</td>
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<tr>
<td>Hours small group:</td>
<td>30h</td>
<td></td>
<td>16.00%</td>
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<tr>
<td>Guided activities:</td>
<td>7h 30m</td>
<td></td>
<td>4.00%</td>
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<tr>
<td>Self study:</td>
<td>105h</td>
<td></td>
<td>56.00%</td>
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### Content

<table>
<thead>
<tr>
<th>Introduction and errors</th>
<th>Learning time: 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 12h</td>
</tr>
</tbody>
</table>

**Description:**
- Exact arithmetics and finite arithmetics
- Truncation error, rounding error and inherent error
- Absolute error and relative error. Correct significant digits
- Error propagation. Conditioning of a problem
- Introduction to numerical methods and programming language

<table>
<thead>
<tr>
<th>Linear systems of equations: direct methods</th>
<th>Learning time: 10h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
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</table>

**Description:**
- Basic concepts (symmetry, positive definiteness, orthogonality)
- Systems with trivial solution (diagonal matrices D and triangular matrices L, U)
- Methods of Gaussian elimination, application to the computation of the determinant
- Factorisation methods: LU, Cholesky (LLT), generalised versions (LDU, LDLT)
- Conditioning of a linear system. Condition number of a matrix
- Orthogonalisation methods (QR), over-determined systems

<table>
<thead>
<tr>
<th>Linear systems of equations: iterative methods</th>
<th>Learning time: 7h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 7h</td>
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</tbody>
</table>

**Description:**
- Introduction and preconditioning
- Convergence of an iterative method
- Method of Jacobi, Gauss-Seidel and over-relaxation

<table>
<thead>
<tr>
<th>Eigenvalues and eigenvectors</th>
<th>Learning time: 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 12h</td>
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</tbody>
</table>

**Description:**
- Basic concepts
- Power methods (direct and inverse)
- Other methods: Jacobi, Hyman, QR
There will be two practical assignments (to be done in pairs) and they are essential to have a final grade of the course. There will be a practical exam (with grade AC), a partial exam in the middle of the semester and a final one (both consisting of a theoretical part and some problems).

The final grade is
NOTA=0.15AC+0.85\max(FINALEX,0.2PARTIALEX+0.8FINALEX)

An extra exam will take place on July for students that failed during the regular semester.

Bibliography

Basic:

Complementary: