34964 - NMDS - Numerical Methods for Dynamical Systems

**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:** MARIA MERCEDES OLLE TORNER

**Others:** Primer quadrimestre:  
MARIA MERCEDES OLLE TORNER - A

### Prior skills

Good knowledge of a programming language.

### Requirements

Knowledge of theory of systems of differential equations, algebra, calculus and numerical analysis.

### Degree competences to which the subject contributes

#### Specific:

1. **MODELLING.** Formulate, analyse and validate mathematical models of practical problems by using the appropriate mathematical tools.
2. **RESEARCH.** Read and understand advanced mathematical papers. Use mathematical research techniques to produce and transmit new results.
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

Theoretical sessions (presence of the students is necessary) and weekly practical tutorized assignments.

Learning objectives of the subject

- To reach an advanced formation in using numerical methods applied to dynamical systems
- To carry out numerical simulations of particular examples
- To relate different aspects of the dynamics in order to have a global picture of the behavior of a given problem
- To learn different tools to analyse and deal with a problem
- Ability in programming algorithms designed to solve particular problems in dynamical systems

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></td>
<td>68.00%</td>
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</tbody>
</table>
# Content

<table>
<thead>
<tr>
<th>Description</th>
<th>Learning time:</th>
<th>Theory classes:</th>
<th>Practical classes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numerical (preliminary) tools for practical purposes: integrators for ODE and graphical interfaces. Examples.</td>
<td>4h</td>
<td>2h</td>
<td>2h</td>
</tr>
<tr>
<td>Dynamical systems: introduction, definitions. Continuous and discrete dynamical systems. Orbit generation. Numerical computation of Poincare maps. Examples.</td>
<td>6h</td>
<td>3h</td>
<td>3h</td>
</tr>
<tr>
<td>Computation and stability of fixed points. Vector fields and maps. Implementation and examples.</td>
<td>10h</td>
<td>5h</td>
<td>5h</td>
</tr>
<tr>
<td>Computation and stability of periodic orbits. Implementation, continuation of families, bifurcations. Multiple shooting.</td>
<td>10h</td>
<td>5h</td>
<td>5h</td>
</tr>
<tr>
<td>Computation of tori: representation, computation and continuation. Implementation and examples.</td>
<td>15h</td>
<td>7h 30m</td>
<td>7h 30m</td>
</tr>
<tr>
<td>Analysis of bifurcations. Some examples.</td>
<td>15h</td>
<td>7h 30m</td>
<td>7h 30m</td>
</tr>
</tbody>
</table>

Degree competences to which the content contributes:
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**Qualification system**

100% of the qualification will be obtained from the practical assignments done.

**Regulations for carrying out activities**

No rules, in principle.

**Bibliography**

**Basic:**


Particular articles related to the topics of the course and some notes from suitable web pages.