Course guide
34962 - HS - Hamiltonian Systems

Unit in charge: School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics.

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

Academic year: 2023  ECTS Credits: 7.5  Languages: English

LECTURER
Coordinating lecturer: PAU MARTIN DE LA TORRE
Others: Segon quadrimestre:
AMADEU DELSHAMS I VALDES - A
PAU MARTIN DE LA TORRE - A

PRIOR SKILLS
Knowledge of calculus, algebra and ordinary 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.

TEACHING METHODOLOGY
Standard exposition in front of the blackboard, resolution of exercices, completion of a project and attendance to the JISD summer school http://www.ma1.upc.edu/recerca/jisd

LEARNING OBJECTIVES OF THE SUBJECT
To comprehend the basic foundations of the theory of Hamiltonian systems, and to understand its applications to Celestial Mechanics and other fields.
### Study Load

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>127.5</td>
<td>68.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>60.0</td>
<td>32.00</td>
</tr>
</tbody>
</table>

**Total learning time:** 187.5 h

### Contents

#### Hamiltonian formalism

**Description:**
Hamiltonian dynamical systems: symplectic maps, symplectic manifolds. Linear Hamiltonian systems and their application to the study of stability of equilibrium points. Canonical transformations.

**Full-or-part-time:** 28h
- Theory classes: 10h
- Self study: 18h

#### Celestial mechanics

**Description:**

**Full-or-part-time:** 34h
- Theory classes: 12h
  - Self study: 22h

#### Geometric theory and invariant objects of Hamiltonian systems

**Description:**

**Full-or-part-time:** 24h
- Theory classes: 8h
  - Self study: 16h

#### Integrable systems

**Description:**

**Full-or-part-time:** 10h
- Theory classes: 4h
  - Self study: 6h
Quasi-integrable Hamiltonian systems

Description:

Full-or-part-time: 26h
Theory classes: 8h
Self study: 18h

Lagrangian systems and variational methods

Description:

Full-or-part-time: 12h
Theory classes: 4h
Self study: 8h

Hamiltonian Partial Differential Equations

Description:

Full-or-part-time: 4h
Theory classes: 2h
Self study: 2h

- Interactions between Dynamical Systems and Partial Differential Equations

Description:
Summer School and Research workshop on topics between Dynamical Systems and Partial Differential Equations

Full-or-part-time: 49h 30m
Theory classes: 12h
Self study: 37h 30m

ACTIVITIES

JISD summer school

Description:
Attendance to the JISD summer school

Specific objectives:
To learn from outstanding researchers a view of the state of the art in several research topics, interacting with students of the rest of Spain and of the World.
GRADING SYSTEM

The students have to do some problems (60%) and a research work (25%). There will be also a final exam covering on the theoretical part of the subject (15%). Moreover, they will attend the JISD.

BIBLIOGRAPHY

Basic:

RESOURCES

Hyperlink:
- Grup de sistemes dinàmics: https://recerca.upc.edu/sd. Pàgina web del Grup de Sistemes Dinàmics de la UPC on es descriuen diversos projectes i els investigadors que hi treballen així com diverses activitats relacionades