34962 - HS - Hamiltonian 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: MARCEL GUARDIA MUNARRIZ
Others: Segon quadrimestre:
AMADEU DELSHAMS I VALDES - A
MARCEL GUARDIA MUNARRIZ - 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

1 / 5  Universitat Politècnica de Catalunya
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To comprehend the basic foundations of the theory of Hamiltonian systems, and to understand its applications to Celestial Mechanics and other fields.

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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Learning time:</th>
</tr>
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<tbody>
<tr>
<td><strong>Hamiltonian formalism</strong></td>
<td>28h</td>
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<tr>
<td>Theory classes: 10h</td>
<td></td>
</tr>
<tr>
<td>Self study: 18h</td>
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<tr>
<td><strong>Description:</strong> Hamiltonian dynamical systems: symplectic maps, symplectic manifolds. Linear Hamiltonian systems and their application to the study of stability of equilibrium points. Canonical transformations.</td>
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<tr>
<td><strong>Celestial mechanics</strong></td>
<td>34h</td>
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<tr>
<td>Theory classes: 12h</td>
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<td>Self study: 22h</td>
<td></td>
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<tr>
<td><strong>Geometric theory and invariant objects of Hamiltonian systems</strong></td>
<td>24h</td>
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<tr>
<td>Theory classes: 8h</td>
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<tr>
<td>Self study: 16h</td>
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<tr>
<td><strong>Integrable systems</strong></td>
<td>10h</td>
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<td>Theory classes: 4h</td>
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<tr>
<td>Self study: 6h</td>
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<tr>
<td><strong>Description:</strong> Complete integrability and Liouville-Arnold theorem. Action-Angle coordinates. Quasi-periodic flows on a torus, resonances.</td>
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### Quasi-integrable Hamiltonian systems


**Learning time:** 26h  
- Theory classes: 8h  
- Self study: 18h

### Lagrangian systems and variational methods


**Learning time:** 12h  
- Theory classes: 4h  
- Self study: 8h

### Hamiltonian Partial Differential Equations


**Learning 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

**Learning time:** 49h 30m  
- Theory classes: 12h  
- Self study: 37h 30m
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Planning of 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.

Qualification system

The students have to do some problems and a project. There will be also an exam of the theoretical part of the course. Moreover, they will attend the JISD.

Bibliography

**Basic:**


**Others resources:**

**Hyperlink**

Grup de sistemes dinàmicshttps://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