200203 - VD - Differentiable Manifolds

Coordinating unit: 200 - FME - School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics
Academic year: 2019
Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6 Teaching languages: Catalan

Teaching staff
Coordinator: FRANCESC XAVIER GRACIA SABATE
Others: Primer quadrimestre:
JAIME FRANCH BULLICH - M-A
FRANCESC XAVIER GRACIA SABATE - M-A

Prior skills
All the capacities included in the subjects of Linear Algebra, Multilinear Algebra, Calculus, Differential Calculus, Integral Calculus, Topology, Differential Geometry and Ordinary Differential Equations.

Requirements
Having passed the subjects listed in the section on previous skills.

Degree competences to which the subject contributes

Specific:
3. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
4. CE-4. Have the ability to use computational tools as an aid to mathematical processes.
5. Ability to solve problems from academic, technical, financial and social fields through mathematical methods.

Generical:
1. CB-4. Have the ability to communicate their conclusions, and the knowledge and rationale underpinning these to specialist and non-specialist audiences clearly and unambiguously.
2. To have developed those learning skills necessary to undertake further interdisciplinary studies with a high degree of autonomy in scientific disciplines in which Mathematics have a significant role.
6. CG-1. Show knowledge and proficiency in the use of mathematical language.
7. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
8. 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.
9. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
10. 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. 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.
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12. 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.

Teaching methodology

The course content will be presented and developed in the lectures. Most topics will be presented by the instructors, but there may be some specially selected sessions devoted to student presentations. A list of problems will be designed to help students to deepen and extend their command of concepts and techniques presented in the lectures. Some problems will be solved in class and others by the students, who will deliver their solutions. These solutions will form part of the assessment process. Some of the problems solved in class will be presented by students.

Learning objectives of the subject

The main objectives of the course are:

- To understand and master the basic concepts of differential geometry: differentiable manifolds, differentiable mappings, tangent and cotangent spaces, tangent mapping, submanifolds, vector fields and differential 1-forms, tensor fields, etc.
- To perform basic calculations with the objects mentioned in both coordinate form and intrinsically.
- To understand the geometric interpretation of the objects studied and relate them to previously studied subjects, such as differential calculus, integral calculus, linear and multilinear algebra, differential geometry of curves and surfaces and differential equations, as well as those implemented in parallel such as topology or algebraic geometry.

Furthermore, at the end of the course, students should:

- Be able to find appropriate literature and understand the scientific literature on the subject.
- Be able to apply the concepts studied in other areas, such as theoretical mechanics, control theory, mathematical physics or geometry of dynamical systems.
- Be aware of the wide range of fields and problems where the results of differential geometry can be applied.
- Be able to join a research group on these topics and their applications.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 30h 20.00%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h 0.00%</td>
</tr>
<tr>
<td></td>
<td>Hours small group: 30h 20.00%</td>
</tr>
<tr>
<td></td>
<td>Guided activities: 0h 0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study: 90h 60.00%</td>
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</tbody>
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**Content**

<table>
<thead>
<tr>
<th>Basic topics.</th>
<th>Learning time: 60h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 30h</td>
</tr>
<tr>
<td></td>
<td>Practical classes: 30h</td>
</tr>
</tbody>
</table>

**Description:**

2. Introduction to Lie groups and Lie algebras. Classical Lie groups and Lie algebras.
3. Tangent distributions and foliations. Frobenius theorem and applications.

**Qualification system**

The evaluation of the work done by students will include a final exam and lecture presentations and solved problems that have been delivered during the course.

In the case of a small group, it will be considered the possibility of replacing the written exam by personal work and oral presentations. In particular, the submissions of parts of the various topics, solved problems, as well as scientific or bibliographical research will be considered as potential supplementary evaluation activities.
Bibliography

Basic:


Complementary:


Others resources:

Hyperlink

- Pàgina amb informació i materials del curs
  http://www-ma4.upc.edu/ xgracia/vardif/