Asignatura: Differential Geometry
Código: 30070
Centro: Facultad de Ciencias
Titulación: Mathematics and applications Master
Nivel: Master M2
Tipo: Elective
Nº de créditos: 8

ASIGNATURA / COURSE TITLE

Geometría diferencial

1.1. Código / Course number

30070

1.2. Materia / Content area

Differential geometry

1.3. Tipo / Course type

Elective subject

1.4. Nivel / Course level

Master (second cycle)

1.5. Curso / Year

2011/2012

1.6. Semestre / Semester

1º (Fall semester)

1.7. Número de créditos / Credit allotment

8 ECTS credits

1.8. Requisitos previos / Prerequisites

It is required to have followed Geometry III, or a class of a similar content (more or less at the level o fan introductory class to manifolds and differential geometry. It is advisable to have taken Geometry IV, or at least to have some familiarity with differential forms in manifolds.

1.9. Requisitos mínimos de asistencia a las sesiones presenciales / Minimum attendance requirement

It is strongly recommended to attend class regularly.

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1.10. Datos del equipo docente / Faculty data

Professor(s): Fernando Chamizo Lorente
Department of Mathematics
Facultad de Ciencias
Office - Módulo 307 - 17
Telephone: +34 91 497 7640
Email: fernando.chamizo@uam.es
Homepage: http://www.uam.es/fernando.chamizo
Office hours: Tuesdays and Thursdays 17:30, or by arrangement.

1.11. Objetivos del curso / Course objectives

At the end of the course, the student should:

- have mastered the basic objects and techniques of differential geometry and the basis of general relativity (E1, E4);
- be able to solve hard problems on Riemannian geometry (E4, E6, E9);
- manage to relate different topics of the syllabus, realizing similarities and differences among them(E8, E11);
- be able to elaborate and develop the course material, using visual and technical aids that will improve effective communication of mathematics results (E14).

1.12. Contenidos del programa / Course contents

CHAPTER I: INTRODUCTION .

- Summary of basic differential geometry.
- Vectors, covectors and tensors.
- Differential forms.

CHAPTER II: FROBENIUS THEOREM

- Flows of vector fields.
- Lie derivative and Lie bracket.
- Distributions, integrability and Frobenius' theorem. Foliations.

CHAPTER III: RIEMANNIAN GEOMETRY.

- Riemannian manifolds. Examples. General relativity.
- The Levi-Civita connection. Covariant derivative. Parallel fields.
- Geodesics. Mechanical interpretation. The exponential map.
- The curvature tensor. Sectional curvature. The field equations.

CHAPTER IV: GLOBAL THEOREMS IN RIEMANNIAN GEOMETRY.

- Jacobi fields. Existence and relation to the exponential map.
- Completeness and Hopf-Rinow's and Hadamard's theorems.
- Variation formulae. Bonnet-Myers' and Synge's theorems.

Note: A possible complementary topic in the last chapter is "singularity theorems in general relativity".

1.13. Referencias de consulta / Course bibliography

Berger, Marcel. 2003. *A panoramic view of Riemannian geometry*. Springer.

Boothby, William Munger. 1975. *An introduction to differentiable manifolds and Riemannian geometry*. Academic Press.

Carmo, Manfredo Perdigão do. 1992. *Riemannian geometry*. Birkhäuser.

Chamizo, Fernando. 2007. «Geometría IV (tensores, formas, curvatura, relatividad y todo eso)». Available at: http://www.uam.es/fernando.chamizo/libreria/fich/apgeomiv08.pdf.

Foster, J., y J. D. Nightingale. 2006. *A short course in general relativity*. Springer Science & Business.

Naber, Gregory L. 1988. *Spacetime and singularities: an introduction*. Cambridge University Press.

Novikov, Sergeĭ Petrovich, y Iskander Asanovich Taĭmanov. 2006. *Modern geometric structures and fields*. American Mathematical Society.

O'Neill, Barrett. 1983. *Semi-Riemannian geometry: with applications to relativity*. Academic Press.

Petersen, Peter. 2006. *Riemannian geometry*. Springer.

Spivak, Michael. 1979. *comprehensive introduction to differential geometry*. Publish or Perish, inc.

Walschap, Gerard. 2004. *Metric structures in differential geometry*. Springer.

2. Métodos docentes / Teaching methodology

Group lectures (twice a week)

Problem set assignments: Regularly given, with a predetermined deadline for their completion.

Programmed office hours: once every six weeks, a small group of students will meet the instructor so that he can check the level of understanding of the subject.

Seminars and essays given by the student.

Note: The two later methods can suffer variations depending on the number of enrolled students.

3. Tiempo de trabajo del estudiante / Student workload

		Nº de horas	Porcentaje
Attendance activities	Class lectures	40h (20%)	70 h (35%)
	Problem sessions	10h (5%)	
	Programmed office hours	8h (4%)	
	Seminars and essays	10h (5%)	
	Others	-	
	Final exam	2h (1%)	
Non attendance activities	Problems preparation	78h (39%)	130 h (65%)
	Weekly study	46h (23%)	
	Exam preparation	6h (3%)	
Total workload: 25 horas x 8 ECTS		200	

4. Métodos de evaluación y porcentaje en la calificación final / Evaluation procedures and weight of components in the final grade

1) Home assignments: 40%.
2) Final exam or extra activities: 40%.
3) In-class exercises, participation: 20%

The extra activities can encompass student seminars, essays, higher difficulty exercises, etc. They can substitute to the final exam.

EVALUACIÓN EXTRAORDINARIA / Make up exam: Examen ante tribunal de Máster / Examination by a committee.

5. Cronograma* / Course calendar

Semana Week	Contenido Contents	Horas presenciales Contact hours	Horas no presenciales Independent study time
1	Basic differential geoemtry.	4	8
2	Vectors and tensors.	4	8
3	Differential forms.	4	10 Problem collection
4	Flows of vector fields	4	8
5	Lie derivative and Lie bracket.	4	8
6	Frobenius theorem.	4	10 Problem collection
7	Riemannian manifolds	4	8
8	Levi-Civita connection	4	8
9	Geodesics	4	8
10	The curvature tensor	4	10 Problem collection
11	Jacobi fields	4	8
12	Completeness, Hopf-Rinow.	4	8
13-14	Variation formulae, Bonnet-Myers' and Synge's theorems.	8	16 Problem collection
15-16	Examination period	14	12

*Este cronograma tiene carácter orientativo.