COURSE DATA

Data Subject	
Code	34180
Name	Differential geometry
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1107 - Degree in Mathematics	Faculty of Mathematics	4	First term

Subject-matter

Degree	Subject-matter	Character
1107 - Degree in Mathematics	18 - Seminar on Topology and differential geometry	Optional

Coordination

Name	Department
MIQUEL MOLINA, VICENTE FELIPE	205 - Geometry and Topology

SUMMARY

Introduction to Riemannian Geometry, metric, lengths, angles, volumes, Levi-Civita connection, curvature, the relation of curvature with geometry and topology. Special emphasis on the EXAMPLES to illustrate concepts and theorems, to see how those are performed in models of geometry or physics, with approaches that may be more algebraic or more analytical.

For an exposition for the non mathematician we recommend the page of Christine Sormani: http//comet.lehman.cuny.edu/sormani/research/riemgeom.html

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The course will start from scratch, so you do not need to have passed the course on Classical Differential Geometry (GDC), although more you can enjoy this optional if at least GDC has already been followed, or attended simultaneously. Other related subject is the Analysis III , not all, but the part that refers to the integration on manifolds, because in that course it is explained what are the submanifolds of a Euclidean space, which are immediate examples of Riemannian manifolds .

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OUTCOMES

1107 - Degree in Mathematics

- Capacity for analysis and synthesis.
- Capacity for criticism.
- Solve problems that require the use of mathematical tools.
- Ability to work in teams.
- Learn autonomously.
- Possess and understand the mathematical knowledge.
- Apply the knowledge in the professional world.
- Expressing mathematically in a rigorous and clear manner.
- Knowing the time and the historical context in which occurred the great contributions of women and men in the development of mathematics.
- Visualize and interpret the solutions obtained.

LEARNING OUTCOMES

a) discovery of the infinite number of non-Euclidean geometries that, however, is possible to easily study: the Euclidean space is not the most common space,

b) ability to go from the abstract and universal theorems to the concrete examples,

c) improvement in the use of the literature,

d) contribute to the realization that it is not enough to handle the literature: one must also to think on the problem to be solved

e) use of analysis and algebra in other fields,

f) understand something of the presence of geometry in everyday life ,

g) introductory knowledge of the existence of a broad spectrum of topics and research in Geometry and of the mixing of areas in many fields of mathematics .

DESCRIPTION OF CONTENTS

0. Differential Geometry

Chapter 0: Preliminaries:
01. Practical Vision of what is a differentiable manifold and a differentiable map.
02. Vector fields on a manifold and its integral curves from a conceptual and practical point of view.

1. Riemannian metrics

Motivation: metric on the plane and flat torus. Metric on a manifold. Lengths, angles and volumes. Existence of Riemann metrics. Examples

3. Geodesics.

Geodesics. Good and bad parametrizations of geodesics. Exponential map. Normal coordinates. Geodesic spherical coordinates and Gauss´Lemma.

4. Curvature

Curvature tensor. Sectional curvature. Cartan´s formalism. The curvature tensor of a submanifold.

5. Ricci curvature and Einstein manifolds.

Ricci curvature and scalar curvature. Constant sectional curvature. Einstein spaces.

6. Jacobi fiels.

Geometric interpretation of curvature. Conjugate points. Jacobi fields determine the metric.

7. Complete Manifolds.

Distance associated to a Riemann metric. Geodesic completeness. Theorem Hopf-Rinow. Completeness of examples.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Other activities	15,00	100
Classroom practices	15,00	100
TOTAL	**60,00**	

TEACHING METHODOLOGY

The course will be developed in

-Theoretical classes with no compulsory attendance. Student participation will be encouraged, trying to correct two defects that students have often: afraid to ask and fear of being ridiculed when they give a wrong answer .

-Practical classes given by the students themselves. They consist of detailed exposition of the examples that have been previously prepared individually, under the guidance of the teacher.

- Discussion seminars on the examples explained by the students, with questions, suggestions and corrections by the students who have not explained that example and by the teacher.

EVALUATION

The evaluation will be conducted by:

- Exposure of the examples by students in practical classes and seminars. The rate at which this test will influence the final grade will be 50 %, of which 75% (that is, 37.5% of the total) will correspond to the exposure in the practical classes and 25% (that is, the 12.5% of the total) will correspond to the exhibition in the seminars. These percentages correspond to the percentages of practical classes and seminars.

-Theoretical and practical written exam, where the exposure of the examples made by each student will be taken into account. The rate at which this test will influence the final grade is 50 %.

REFERENCES

Basic

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Referencia b1: John M. Lee, Riemannian geometry, an introduction to curvature, Graduate Texts in Mathematics, 176. Springer-Verlag, New York, 1997.

Referencia b2: M. P. do Carmo, Riemannian Gometry, Birkhauser, 1992.

Referencia b3: N. J. Hicks, Notes on Differential Geometry, Van Nostrand, 1965.

Referencia b4 B. O'Neill, Semi-Riemannian Geometry with applications to relativity, Pure Appl. Math., 103. Academic Press, New York-London, 1983.

Referencia b5: S. Sternberg, Semi-Riemann Geometry and General Relativity http://www.math.harvard.edu/~shlomo/docs/semi_riemannian_geometry.pdf

Additional

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Referencia c1: I. Chavel, Riemannian geometry, a modern introduction, Cambridge Tracts in Mathematics, 108. Cambridge University Press, Cambridge, 1993.

Referencia c2: S. Sternberg, Curvature in Mathematics and Physics Dover, 2012.

Referencia c3: P. Petersen, Riemannian Geometry Springer, 2006.

Referencia c4: M. Spivak, A comprehensive introduction to Differential Geometry vol. 1 a 5, Publish or Perish 1975, 1999.

Referencia c5: T. Sakai, Riemannian Geometry, American Math. Soc., 1996.

Referencia c6: M. Berger, A Panoramic View of Riemannian Geometry, Springer, 2003.

Refrencia c7: M. Berger, P. Gauduchon, E. Mazet, Le spectre dune variété riemanniene, Springer, 1971.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

English version is not available

En caso de que se produzca un cierre de las instalaciones por causas sanitarias que afecto total o parcialmente las clases de la asignatura, estas serán sustituidas por sesiones no presenciales siguiendo los horarios establecidos. Si el cierre afectara alguna prueba de evaluación presencial de la asignatura, esta será sustituida por una prueba de naturaleza similar que se realizará en modalidad virtual a través de las herramientas informáticas soportadas por la Universitat de València. Los porcentajes de cada prueba de evaluación permanecerán invariables, según aquello establecido por esta guía