

## 27040 - Topology of Surfaces

### Información del Plan Docente

<b>Academic Year</b>	2017/18
<b>Faculty / School</b>	100 - Facultad de Ciencias
<b>Degree</b>	453 - Degree in Mathematics
<b>ECTS</b>	6.0
<b>Year</b>	4
<b>Semester</b>	Second semester
<b>Subject Type</b>	Optional
<b>Module</b>	---

### 1.General information

#### 1.1.Introduction

This subject is an introduction to Algebraic Topology that solves topological problems using algebraic methods, and viceversa, attacking algebraic problems using topological techniques. The fundamental group of a topological space will be defined and heavily applied to classify surfaces. Covering spaces in general and in particular covering spaces for surfaces will be considered in this course.

#### 1.2.Recommendations to take this course

Students are recommended to have acquired the competences associated with the [Fundamentos de Geometría y Topología](#) (Fundamentals in Geometry and Topology), in particular [Álgebra Lineal](#) , [Topología General](#) and [Estructuras Algebraicas](#) .

#### 1.3.Context and importance of this course in the degree

This subject is part of the módulo Ampliación de Geometría y Topología (Higher Geometry and Topology) As mentioned in section 1.1, it is recommended that the student is familiar with both algebraic and topological techniques, such as those provided in Algebra Lineal, Topología General, and Estructuras Algebraicas. This class will connect them considering certain topological invariants of an algebraic nature and applying them to solve concrete problems.

#### 1.4.Activities and key dates

A written test will be given at the end of the semester. This test will take place during the official test period. The place and time will be announced by the Facultad de Ciencias before the beginning of the course.

### 2.Learning goals

#### 2.1.Learning goals

In order to pass this class, the student should be able to show the following skills...

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Understand the notion of fundamental group and be able to compute it in some concrete situations.

Topologically recognize compact surfaces and classify them.

### 2.2.Importance of learning goals

The learning objectives provide basic skills within the Degree. (See Context and reasons behind the subject area in the Degree)

### 3.Aims of the course and competences

#### 3.1.Aims of the course

This subject and its syllabus have the following goals:

Give the student a topological sense of the study and classification of surfaces. The notion of topological invariant, such as the fundamental group, is relevant to the study of mathematical objects. In this class, a particular topological invariant, having an algebraic structure (a group) will be able to determine the topological structure of compact surfaces, and even determine their orientability.

#### 3.2.Competences

Upon successful completion of this subject the student will improve the following abilities...

Carry out the goals described in section 2.1

CG3. To have the ability to gather and interpret the relevant data, particularly in the field of Mathematics, in order to make statements using analytical methods as well as abstraction, containing insights on relevant topics, be it of a social, scientific, or ethical nature.

CG5: To develop learning skills that will be necessary to continue studies in Mathematics with a high degree of autonomy.

CT1. Be able to clearly state, both orally and in writing, the student's reasoning, problem solving techniques, reports, etc.

CE1. Understand and apply both mathematical language and methods. Learn rigorous proofs of the basic theorems in the different areas of Mathematics.

### 4.Assessment (1st and 2nd call)

#### 4.1.Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that they have achieved the learning objectives by means of the following evaluation activities:

After each chapter, students are asked to solve a problem and give an oral presentation on it in class. The total grade (A) of this part will add up to 60% of the total grade.

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The remaining 40% will come from the grade (B) of the final exam.

In addition, according to current bylaws, a student also has the right to show up to a final exam and complete the class upon passing the test (B).

The final grade will be the maximum between (B) and  $0,6(A)+0,4(B)$ .

### 5. Methodology, learning tasks, syllabus and resources

#### 5.1. Methodological overview

The general teaching methodology designed for this class is based on the following:

- Lectures
- Problem sessions in small groups
- Oral presentations of problems
- Office hours.
- Students' individual work.

#### 5.2. Learning tasks

In addition to the general teaching methodology activities students are afforded the opportunity to submit individual homework assignments on a weekly basis. These assignments are checked by the instructor and returned on a regular basis. This process allows students to pinpoint strengths/weaknesses and helps their learning process.

#### 5.3. Syllabus

Class syllabus:

1. Fundamental Group.
  1. Definition and Preliminaries.
  2. Calculations of Fundamental Groups.
  3. The Fundamental Group of the Circunference.
  4. Seifert-Van Kampen Theorem.
2. Classification of Surfaces.
  1. Connected Sum. Surgery.
  2. Triangulation. Euler Characteristic.
  3. Classification Theorem.
3. Covering Spaces.
  1. Definition and Motivation.
  2. Covering Spaces of Surfaces.

#### 5.4. Course planning and calendar

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See the academic calendar of the Universidad de Zaragoza and the class schedules published on the School of Sciences (Facultad de Ciencias) webpage. As a general rule, there are three lecture periods and one problem session a week. The exact deadlines for turning assignments in will be announced in class and posted on a bulletin board and on the online platform (Moodle). The same will be done with the date, place and time of the final exam.

### 5.5. Bibliography and recommended resources

Basic Bibliography:

- Massey, William S.. Introducción a la topología algebraica / William S. Massey . Barcelona[etc.] : Reverté, cop.1982
- Armstrong, M.A.. Topología básica / M.A. Armstrong . Barcelona [etc.] : Reverté, D.L. 1987