Universitat Autònoma de Barcelona

2023/2024

Topology

Code: 100106
ECTS Credits: 6

Degree	Type	Year	Semester
2500149 Mathematics	OB	3	1

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Teachers

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Prerequisites

Experience shows that it is extremely important for students to be familiar the basics of logic deduction. The students needs to feel comfortable with axiomatic methods, the basic principles of logic, and the different strategies and methods of proof (deduction, counterexamples,..). The student needs to know how to negate a proposition, how to use quantifiers (there exists, for all,...) and the idea of implication (if, only if, if and only if).The idea is to reformulate and generalize from a broader point of view several concepts which are known in the context of metric spaces, then the student should have a good background on the topology of metric spaces, specially euclidean spaces.

Objectives and Contextualisation

The main goal of the course is to understand that ia topology in a set is the right structure to understabd the notion of continuity.

Several problems stated in terms of geometric objects do not depend on rigid properties like distances, angles, ... but on some continuity of the shape of those. Those are topological problems. The concept of topological space wants to model geometric objects like surfaces in space but goes beyind and the topology became present in many areas of mathematics.

We will through known concepts for metric spaces: open subset, closed subse, continuity and compactness. But the student should understand that this new axiomatic point of view is more general and more flexible than the iodea from metric spaces.

Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
- Apply critical spirit and thoroughness to validate or reject both one's own arguments and those of others.
- Assimilate the definition of new mathematical objects, relate them with other contents and deduce their properties.
- Demonstrate a high capacity for abstraction.
- Identify the essential ideas of the demonstrations of certain basic theorems and know how to adapt them to obtain other results.
- Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.

Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
2. Apply critical spirit and thoroughness to validate or reject both one's own arguments and those of others.
3. Construct examples of topological spaces using the notions of topological subspace, product space and quotient space.
4. Students must be capable of applying their knowledge to their work or vocation in a professional way and they should have building arguments and problem resolution skills within their area of study.
5. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
6. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
7. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
8. Topologically recognise compact spaces and their classification.
9. Use the basic concepts associated to the notions of metric and topological space: compactness and connection.

Content

1. Topological properties of metric spaces.
   Open and closed balls, continuity, convergence and completion. Topology of normed vector spaces.
2. Topological spaces: axioms.
   Open and closed sets, neighbourhoods, closure and interior. Continuity.
3. Topological Subspaces.
4. Product topology.
5. Quotient Topology
6. Hausdorff spaces, axioms of separability.
7. Compact spaces.
8. Connectedness and path connectedness.
9. Fundamental group.
10. The classification of compact surfaces.

Methodology

There are three type of activities the student is supposed to attend: the lectures (2 hours /week) mainly concerned with the description of the theoretical concepts, problem solving sessions (1 hour/week) and seminars (6 hours on three weeks), similar to the problem solving sessions but where students work ingroups supervised by a teaching assistant.

The course has a web page in the UAB online campus gathering all information and communications between students and professors, and where all material, including problem sheets, some solutions, etc are published regularly.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lectures	30	1.2	
Problem session	14	0.56	
Working Seminars	6	0.24	
Type: Autonomous			
Studying theoretical concepts and solving problems	85	3.4	

Assessment

There will be a specific evaluation of the activity developed in the seminars, which will count 20% of the final grade. Assistance to the seminars is compulsory

There will be two written tests: a partial exam in the middle of the semester (30% of the final grade) and a final exam (50% of the final grade).

A student has to score at least 3.5 in the final exam to be allowed to pass with the continuous evaluation, otherwise the student has to go to the recovery exam. If not the final cualification will be the note of the final exam.

A student will be considered having attended the course if he takes part in evaluations that wight in total at least 50%.

The recovery exam replaces both the final and mid-term exams. A student taking the recovery exam and together with the seminar's note passing the course will be awarded the final note of 5.

Single-day assessement

Assistance to the seminars is compulsory, even for those students chosing the one-day assessement.

The single-day assessement consists of two evaluations. One writem exam, at the same time than the final exam and then an oral examination in which the student will have to solve a problem and then comment on one of the seminars. The student is requiered to handle fully redacted solutions to the seminars at the beginning of the written exam.

Both exams, written and oral will count for 50% of the final grade. If necessary the written exam can be re-evaluated. If a student passes with the recovery exam, then the final note will be a 5 independently of the actual note of th ewritten examination. The oral exam can not be re-evaluated.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final Exam	50%	3	0.12	3, 1, 7, 6, 5, 4, 8, 9
Mid-term exam	30%	3	0.12	3, 1, 7, 6, 5, 4, 9
Recovery exam	80%	3	0.12	2, 3, 1, 7, 6, 5, 4, 8, 9
Seminars	20%	6	0.24	2, 3, 1, 7, 6, 5, 4, 8, 9

Bibliography

Basic bibliography:

- Jaume Aguadé, *Apunts d'un curs de topologia elemental.* http://mat.uab.es/~aguade/teaching.html
- Czes Kosniowski, *A first course in algebraic topology*. Cambridge University Press 1980.

Bibliography relted to topological manifolds:

- William S. Massey, *A basic course in algebraic topology*. Springer-Verlag 1991.
- John M. Lee, *Introduction to topological manifolds*, Graduate Text in Mathematics 202, Springer, 2011

Bibliography:

- James Munkres, *General Topology*, Prentice-Hall, 2000.
- Rysarzd Engelking, *General Topology*, Sigma Series in Pure Mathematics 6, Heldermann Verlag, 1989.
- James Dugundji, *Topology,* Reprinting of the 1966 original. Allyn and Bacon Series in Advanced Mathematics. Allyn and Bacon, Inc., Boston. 1978.

Free textbooks online:

- Marta Macho-Stadler, *Topología*, https://www.ehu.eus/~mtwmastm/Topologia1415.pdf
- Jesper Moller, *General Topology*, http://web.math.ku.dk/~moller/e03/3gt/notes/gtnotes.pdf
- O. Viro, O Ivanov, N. Netsvetaev, V. Kharlamov, *Elementary Topology Problem Textbook*, http://www.pdmi.ras.ru/~olegviro/topoman/eng-book-nopfs.pdf

Topology from a different point of view:

- Colin Adams, Robert Franzosa, *Introduction to Topology: Pure and Applied*, Prentice-Hall, 2008

Software

Exercises are supposed to be written in TeX.