Universitat Autònoma de Barcelona

2021/2022

Mathematical Reasoning and Concepts

Code: 106219
ECTS Credits: 6

Degree	Type	Year	Semester
2504235 Science, Technology and Humanities	FB	1	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: Yes

Prerequisites

There are no academic prerequisites for this course. Nonetheless it is basic to have the will to understand mathematical arguments, the logic and to sharpen one's critical thinking.

Objectives and Contextualisation

In the first part of the course we will introduce the basic language of mathematics and of propositional logic. A great deal of time will be dedicated to getting to handle this new language correctly, as it is essential to understand, produce and share mathematics. Particular stress will be put on the logic arguments (implication, equivalence, contraposition). The student will get acquainted to these through the diverse themes of the course: basic set theory, arithmetic, polynomials, etc.The discussion of one other's arguments, going back to previous proofs, to pay atttention to the details and enjoy the key points in a proof will be crucial all along this course.

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Sets and maps will be the main themes of this first part.

In the segond part of the course we will explore the integers and the polinomials. We will put an emphasis in how properly defining computational tools allow to manipulate this seemingly different objects in a unified way.

In the third part of the course we will explore two central notions from analisis: continuity and limit.

We hope that both the theorems and proofs will help our students develop the ability to prove theorems and think critically about mathematics.

Competences

- Analyse questions related to science and technology in society, using basic, essential forms of mathematical and statistical reasoning.
- Innovate in the methods and processes of this area of knowledge in response to the needs and wishes of society.
- Make critical use of digital tools and interpret specific documentary sources.
- Students must be capable of collecting and interpreting relevant data (usually within their area of study) in order to make statements that reflect social, scientific or ethical relevant issues.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- 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.
- Take sex- or gender-based inequalities into consideration when operating within one's own area of knowledge.

Learning Outcomes

1. Analyse data rigorously to draw conclusions from them.
2. Analyse the implications of integrating the gender perspective into the organisational aspect of statistics.
3. Conduct precise, efficient information searches that yield reliable results, making ethical use of information and avoiding plagiarism.
4. Explain some findings from the forefront of science in terms that are accessible to students without in-depth knowledge of the subject matter.
5. Explain the basic mathematical concepts and gain familiarity with mathematical reasoning.
6. Make competent use of software for analysing, synthesising and transmitting quantitative information, especially through graphs and computer graphics.
7. Make estimates of order of magnitude and avoid common fallacies and errors in the use of numerical information and in the interpretation of scientific results (diagnostic tests, clinical trials, etc.).

Content

I Logic and Set theory

I.1 Logic

I.2 Set theory
Complex numbers
Basic language of sets.
Peano Axioms. Induction.
Maps between sets. Equivalence and order relations. Quotient set.
Permutations. Decomposition in disjoint cycles, order and sign.

II. Algebraic structures

II.1 The ring of integers

Divisibility. Euclid's algorithm.
The notion of ideal.
Greatest common divisor and Least Common Multiple.
Bézout's identity.
Prime numbers, prime factorization.

II.2 Polynomial rings

Divisibility. Euclid's algorithm for polynomials
Greatest common divisor and Least Common Multiple.
Bézout's identity.
Irreducible polynomials
Roots and the fundamental theorem of algebra.

III Basics in analysis

Functions in one real variable.
Graph of a function.
Limits, continuity.
Basics in topology.
Derivability.

Methodology

In this course, we will follow the "flipped classroom" approach. Each week students will be provided with a few pages of reading and problems to be thoroughly studied before arriving to class. These pages will be accompanied by a reading guide and questions intended to stimulate the personal reflection of the students. The lecture will be used to understand the key concepts (solving any doubts that may exist), put them into practice through problem solving and analyze their importance or contextualize them. Students are expected to be the main participants in the discussion, while the role of the teacher will be to stimulate this discussion, contribute his experience and knowledge, and suggest possible directions. These discussions are expected to take place in small groups in the classroom (following the distancing measures recommended at the time) and then the progress made will be shared with the whole class.

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			
Debating the theory	33	1.32	4, 5
Problem sessions	16	0.64	5, 7
Type: Supervised			
Tutoring	4.5	0.18	1, 2, 5, 7
Type: Autonomous			
Self-study of the theory and preparing exercises	61	2.44	1, 2, 3, 6

Assessment

The final grading of this course rests on two types of evaluation. A substantial weight is given to your weekly work and there will be two classical exams: a mid-term and a final.

Weekly homework is divided into two types of exercices.

Exercices of type A. These will consist in a number of questions about the theroetical concepts and some very basic exercises. They will be due for Wednesday afternoon.

Exercices of type B. These will consist in practice exercises to help fixing the concepts. there will be due Monday at the begining of the class.

Grading

Exercices A). They will be graded weekly, between 0 and 10, there will be only 5 possible gradings: 0, 2.5, 5, 7.5 and 10. I will value the effort put into answering and that you took your work ernesty more than the mere correction of the answer. The average of your answers will give you a grade A.

Exercices B). Again they will be graded weekly between 0 an 10 with only 5 posible grades: 0, 2.5, 5, 7.5 y 10. Here again I will not expect fully answered exercises, I will value the effort you put, the quality of your mathematical writting more that getting the right answer. The average of your handlings will give you a grade B.

The mid-term exam will give you a grade P and the final exam a grade F. If F is less than 3 you have to take the re-examination.

The final grade will be computed as follows

0.2*A +0.2*B+ 0.2* P + 0.4 * F

A student that does not show-up at the final exam will be considered "No evaluable".

The grading of the re-evaluation substitutes the whole grading of the course. From this re-evaluation you can only get a "Pass" (numerical note 5) or a "Fail". You cannot use this re-evaluation to push-up your final grading.

In the event that tests or exams cannot be taken onsite, they will be adapted to an online formatmade available through the UAB's virtual tools (original weighting will be maintained). Homework, activities and class participation will be carried out through forums, wikis and/or discussion on Teams, etc. Lecturers will ensure that students are able to access these virtual tools, or will offer them feasible alternatives.

In the event of a student committing any irregularity that may lead to a significant variation in the grade awarded to an assessment activity, the student will be given a zero for this activity, regardless of any disciplinary process that may take place. In the event of several irregularities in assessment activities of the same subject, the student will be given a zero as the final grade for this subject.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Final exam	40%	3	0.12	2, 4, 5, 7, 3
Mid-term exam	20%	1.5	0.06	1, 4, 5
Re-evaluation	100%	3	0.12	1, 2, 4, 5, 7, 3
Reading assignment type B.	20%	14	0.56	1, 5, 7, 6
Weekly work mod. A	20%	14	0.56	2, 4, 5, 3

Bibliography

You will be provided at the beginning of the course with a copy of " *An Introduction to Proof via Inquiry-Based Learning*" from Dana C. Ernst, (translated into spanish by W. Pitsch). This is the only book requiered for this course.

Complementary material:

Chapter Zero: fundamental notions of abstract mathematics / Carol Schumacher | Addison-Wesley Longman | 2001 | 2nd ed.

La Matemática : su contenido, métodos y significado / A.D. Aleksandrov A.N. Kolmogorov, M.A. Laurentiev ... [et al.] ; versión esp. de Andrés Ruiz Merino, Alianza, 1973.
Analysis by its history / E. Hairer, G. Wanner, Springer, 2008.
Logicomix. Unabúsqueda épica de la verdad A. Doxiadis, C.H. Papadimitriou, A. Papadatos. | Ediciones Sins Entido| 2011

Software

No specific software is required.