Universitat Autònoma de Barcelona

2021/2022

Calculus 2

Code: 104845
ECTS Credits: 6

Degree	Type	Year	Semester
2503852 Applied Statistics	FB	1	2

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: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Teachers

Magdalena Caubergh

Bogdan Vasile Crintea

Prerequisites

The student should have completed the course "Càlcul 1". It is required to have practice in differentiating and integrating one-variable functions.

Objectives and Contextualisation

The objective of this subject is that the student assimilates and learns the concepts and tools in analysis that will be necessary to understand important results in Statistics (least-square minimization, joint probability densities, central limit theorem, simulation of variables, determination of laws through moments or the characteristic function, stochastic equations, etc.). These knowledge is classified into four sections:

1. Complex numbers.

2. Integral transforms.

3. Differential calculus in several variables.

4. Integral Calculus in several variables.

Competences

- Calculate and reproduce certain mathematical routines and processes with agility.
- Critically and rigorously assess one's own work as well as that of others.
- Make efficient use of the literature and digital resources to obtain information.

- 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.
- Use quality criteria to critically assess the work done.

Learning Outcomes

1. Calculate and study extrema of functions.
2. Critically assess the work done on the basis of quality criteria.
3. Make effective use of references and electronic resources to obtain information.
4. Master the basic language and tools of calculus (one or more variables).
5. Reappraise one's own ideas and those of others through rigorous, critical reflection.
6. 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.
7. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

Content

Unless the requirements enforced by the health authorities demand a prioritization or reduction, the contents are the following:
1. Complex numbers.

The imaginary unit. Complex arithmetic .Fundamental theorem of algebra.

Polar form of a compex number, roots. Exponential and logarithmic function.

Review of the Taylor formula and power series.

Complex power series. The power series of exp(z).
Differentiation and integration of complex-valued functions.

2. Differential calculus in several variables

Functions of several variables, representation methods (graphs, curves and level surfaces).

Linear approximation at one point: differential and tangent plane.

Partial derivatives, gradient, chain rule. Partial antiderivatives..

Changes of coordinates.

Quadratic functions, Gaussians, properties.

Optimization without constraints.

Concept of implicit function, constrained optimization.

3. Integral calculus in several variables

Riemann sums in several variables. Idea of the multiple integral.

The fundamental theorem of calculus in several variables: the integral as inverse of density. Mass densities, densities of probability, joint laws.

Practical computation of integrals: Fubini's theorem and change of variables.

Law of the sum of non-independent variables.

Review of improper integrals. Unidimensional laws.

Double improper integrals. The bidimensional Gaussian. Marginals.

4. Integral transforms

Discrete case, the Z-transform.

Continuous case, the Fourier-Laplace transform. Moments and derivatives.

Law of the sum of independent variables, convolution and TFL.

Inversion formula, determination of the law fby the TFL and the moments.

The central limit theorem.

Methodology

In the learning process it is fundamental the own work of the student, who at all times will have the help of the professor.

The hours of class are distributed in:

Theory: The teacher introduces the basic concepts corresponding to the subject, showing examples of their application. The student will have to complement the explanations of the professors with the personal study.

Problems: Bycompleting sets of exercises, the comprehension and application of the concepts and tools introduced in the theory class is attained . The student will have lists of problems, a part of which will be solved in the problem classes. Students should work on the remaining ones as part of their autonomous work.

Seminars: to reach a deeper understanding of the subject the students work o in group on more complex practical problems. Some seminars will deal with computer-aid approach to solving problems.

The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

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			
Solving problems sessions	15	0.6	5, 2, 1, 4, 7, 6, 3
Theory class	30	1.2	5, 2, 1, 4, 7, 6, 3
Type: Supervised			
Seminars	5	0.2	5, 2, 1, 4, 7, 6, 3
Type: Autonomous			
Personal Study	30	1.2	5, 2, 1, 4, 7, 6, 3
Solving problems	62	2.48	5, 2, 1, 4, 7, 6, 3

Assessment

A continuous assessment is performed based on:

a) Two written tests combining theory and problems, with grades P1 and P2

b) Submission of two sets of exercises, with grades LL1,LL2. Can be completed at home and uploaded to Campus Virtual.

Submissions in b) are manadatory with no resit assesment.

If both P1,P2 have been attended, a grade C1 is generated according to C1=(0,15)(LL1+LL2)+(0,35)(P1+P2).If C1 is at least 5, the final grade is C1.

Students with C1<5 and having submitted b), and students willing to improve their grade, may attend a resit exam, with grade R.

The final grade C2 after the resit exam is C2=(0,15)(LL1+LL2)+(0,70) R.

For students improving their grade, the final score is MAX(C1,C2).

Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First mid-term exam	35%	2.5	0.1	5, 2, 1, 4, 7, 6, 3
First submission of exercises	15%	1.5	0.06	5, 2, 1, 4, 7, 6, 3
Second mid-term exam	35%	2.5	0.1	5, 2, 1, 4, 7, 6, 3
Second submission of exercises	15%	1.5	0.06	5, 2, 1, 4, 7, 6, 3

Bibliography

The professor in charge will publish studying material in the online campus CV. Besides, at the website

https://mirades.uab.cat/ebs/

the following books are recommended:

1. M. Brokate, P.Manchanda,A.H.Siddiqi, Calculus for Scientists and Engineers, http://link.springer.com/openurl?genre=book&isbn=978-981-13-8464-6

2. A.I. Khuri, Advanced Calculus with Applications in Statistics, https://onlinelibrary.wiley.com/doi/book/10.1002/0471394882

3. P. Dyke, Two and three dimensional Calculus with applications in science and engineering, https://onlinelibrary.wiley.com/doi/book/10.1002/9781119483731

Other useful references are:

4. A.Reventos, Temes diversos de fonaments de les Matemàtiques, pdf accessible al CV.

S. L. Salas, E. Hille. Cálculo de una y varias variables. Ed. Reverté, 1994.

Software

No software is needed