

## Calculus 2

Code: 104845  
ECTS Credits: 6

**2024/2025**

Degree	Type	Year
2503852 Applied Statistics	FB	1

### Contact

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### Teachers

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### Teaching groups languages

You can view this information at the [end](#) of this document.

### 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.). This knowledge is classified into four sections:

1. Complex numbers.
2. Integral transforms.
3. Differential calculus in several variables.
4. Integral Calculus in several variables.

### Learning Outcomes

1. KM01 (Knowledge) Recognise the language and basic tools of calculus in one and various variables.
2. SM03 (Skill) Solve, using numerical methods, optimisation problems, linear algebra and analysis in general that appear in science and, especially, in statistics.
3. SM04 (Skill) Resolve problems associated with the extreme points of functions of one and several variables, and the calculation of moments.

## Content

### 1. Complex numbers.

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

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

Differentiation and integration of complex-valued functions.

### 2. Power series

Taylor's formula. Concept of power series.

Power series expansions. Examples.

Euler's formula, the complex exponential.

### 3. Improper integrals.

Different kinds of improper integrals. Probability laws. Expected value.

The Gaussian law.

Convergence criteria for positive functions. Convergence criteria for (complex) valued functions.

Laplace transform and characteristic function of a density. The domain of definition, examples.

Moment generating function.

### 4. Integral calculus in several variables.

Coordinate systems in Euclidean space. Polar, cylindric and spherical coordinates.

Functions of several variables, representation methods (graphics, level sets).

Curves and surfaces, parametric and continuous form.

Riemann sums in several variables. Multiple integrals.

Calculus of integrals: Fubini's theorem and change of variable.

### 5. Differential calculus in several variables.

Linear approximation at a point: differential and tangent plane.

Partial derivatives, gradient, the chain rule.

Non constrained optimization.

Implicit functions.

Constrained optimization.

## Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Solving problems sessions	15	0.6	
Theory class	30	1.2	
Type: Supervised			
Seminars	5	0.2	
Type: Autonomous			
Personal Study	30	1.2	
Solving problems	62	2.48	

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:* By completing 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 on in group on more complex practical problems. Some seminars will deal with computer-aid approach to solving problems.

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.

## Assessment

### Continuous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First mid-term exam	40%	2.5	0.1	KM01, SM03, SM04
First submission of exercises	10%	1.5	0.06	KM01, SM03, SM04

Second mid-term exam	40%	2.5	0.1	KM01, SM03, SM04
Second submission of exercises	10%	1.5	0.06	KM01, SM03, SM04

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 mandatory with no resit assesment.

If both P1, P2 have been attended, a grade C1 is generated according to  $C1 = (0,1)(LL1+LL2) + (0,4)(P1+P2)$ . If C1 is at least 5, the final grade is C1.

In order to pass the subject, the each one of the qualifications P1 and P2 has to be greater or equal to 3.

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

Single evaluation: see catalan version.

The final grade C2 after the resit exam is  $C2 = (0,1)(LL1+LL2) + (0,8) R$ .

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

## 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

### Language list

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	second semester	afternoon
(PAUL) Classroom practices	2	Catalan	second semester	afternoon
(TE) Theory	1	Catalan	second semester	afternoon