

**Functions of a Real Variable**

Code: 100087  
ECTS Credits: 12

Degree	Type	Year	Semester
2500149 Mathematics	FB	1	A

**Contact**

Name: Josep Maria Burgues Badia  
Email: josepmaria.burgues@uab.cat

**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**

Artur Nicolau Nos  
Juan Eugenio Mateu Bennassar  
Joaquin Martín Pedret

**Prerequisites**

It is essential that the students are able to handle with algebraic manipulation of fractions, expressions that contain roots and powers, resolution of linear systems and basic arithmetic of numbers and polynomials. It is also recommended to know the elementary properties of trigonometrical functions. Finally, we hope that the student can do, without much difficulty, the graphic representation of relatively simple functions of one variable. We also presume that the person who attends this course is familiar with logical reasoning and who knows how to deny sentences or proposals.

The most important requirement is, however, a great curiosity to understand and deepen the concepts that will be studied.

**Objectives and Contextualisation**

The objective of the subject is that the student learns solidly the basic concepts of the Infinitesimal Calculus: functions of discrete variable (sequences) or continuous, the concepts of limit, derivative and the theory of integration. It is also a basic objective to achieve a certain skill in the manipulation and calculation of limits, derivatives and integrals and to know how to apply the fundamental theorems of this theory. Finally, there is also a generic educational objective: that the student begin to develop the ability to analyze and to reason rigorously.

**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.
- Calculate and reproduce certain mathematical routines and processes with agility.
- Formulate hypotheses and devise strategies to confirm or reject them.
- 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.
- Understand and use mathematical language.
- Use computer applications for statistical analysis, numeric and symbolic calculus, graphic display, optimisation or other purposes to experiment with Mathematics and solve problems.

## 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. Assimilate the mathematical concepts and objects of the subject as described in its contents.
4. Calculate and study the extrema of functions.
5. Calculate derivatives of functions using the chain rule, the implicit function theorem, etc.
6. Calculate integrals of functions of a variable.
7. Contrast, if possible, the use of calculus with the use of abstraction in order to solve a problem. Evaluate the advantages and disadvantages of the two methods.
8. Deal with inequalities and successions, analyse and draw functions, deduce the properties of a function on the basis of the graph, understand and work intuitively, geometrically and formally with the notions of limit, derivative and integral.
9. Demonstrate knowledge of the inherent objects of calculus with functions of a real variable and of its properties and uses.
10. Develop autonomous strategies for problem-solving such as identifying the field of course-related problems, discriminating routine problems from non-routine ones, designing an a priori strategy to solve a problem, evaluating a strategy and modifying it if necessary and in the context of a specific problem translate theoretical results that could be useful for resolving it.
11. Draft short, orderly and accurate mathematical texts (exercises, resolution of theoretical questions, etc.)
12. Follow and understand an oral explanation of a mathematical subject related with the course.
13. Know how to explain ideas and concepts from the course, and know how to communicate one's own reasoning to third parties.
14. Read and understand course level mathematical texts.
15. Solve problems that imply the use of integrals (longitudes, areas, volumes, etc.).
16. 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.

## Content

### I. The real line.

### II. Sequences of real numbers.

- Sequences. Limit. Monotonicity
- Accumulation points. Subsequences.
- The Bolzano-Weierstrass theorem
- Cauchy sequences.

### III. Continuity of one variable functions.

- Functions of one variable. Limits.
- Continuity..

- Bolzano and Wierstrass theorems
- Monotone functions. Inverse function.

#### IV. Differential Calculus.

- Derivative of a function at a point. Derivative of a function. Algebraic properties.
- The chain's rule. Derivative of the inverse.
- Critical points, maxima and minima.
- Rolle's theorem. Mean value theorem. L'Hopital's rule.

#### V. Aproximation by Taylor's polinomial

- Contact order between fonctions
- Taylor polynomial. Properties
- Local study of a function.

#### VI. Riemann integral

- Computing areas. Lower and upper sums. Integrability. Integral
- Fundamental Theorem of Calculus
- Calculation of primitives
- Geometric and phisic applications of the integral

## Methodology

The subject has one group of theory, two problem groups and four seminars-practicals.

The group to which the student belongs can be consulted on the website of the degree course

<http://mat.uab.cat/gmat>.

There will be two sessions of one hour a week of theory and two sessions of problems. This time distribution may be affected by measures against COVID. The Seminars will be devoted to work in a tutored group. The hours and classrooms must be consulted on the website of the degree. In the Moodle of the subject, the student will have at his disposal the necessary material to follow all the sessions There you can find, notes, lists of problems, observations made by teachers or teacheews that may be relevant to the development of the subject.

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			
Theory classes	59	2.36	
Type: Supervised			
Classes of problems	30	1.2	
Tutored activities	25	1	
Type: Autonomous			
Realization of problems	100	4	
Test Preparation	22	0.88	

## Assessment

The subject has a single call that closes in July. There will be two short tests, one per semester, which will provide a qualification T. some seminars (between two and four depending on the criterion of the teacher responsible) will include an assessable activity. The evaluated seminars will provide a qualification S. There will be two partial tests at the end of each semester with qualifications P1, P2. Based on these activities, a continuous evaluation note C will be obtained, given by

$$C = 0.15 T + 0.15 S + 0.35 P1 + 0.35 P2$$

Finally the June qualification will be

$$J = \text{Max} \{C, 0.5 P1 + 0.5 p2\}$$

If J is greater than or equal to 5, the student has passed the subject. Students who have not passed the subject may submit to a proof of recovery, with contents of the whole course. The final qualification in case of succeed, will be 5. In case of fail will be J.

There will NOT be an exam for improvement of improvement of J.

At least one of the P1 or P2 must be delivered, or the final result will be NOT QUALIFIABLE.

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous evaluation	30	10	0.4	
Semester exam February	35	2	0.08	2, 3, 5, 4, 7, 1, 9, 10, 14, 8, 16, 11, 13, 12
Semester exam June	35	2	0.08	2, 3, 5, 4, 6, 7, 1, 9, 10, 14, 8, 16, 11, 15, 13, 12

## Bibliography

M. Spivak. Calculus. Càlcul Infinitesimal. Ed. Reverté, Barcelona 1995.

F. Mañosas Apunts de Funcions de variable Real. Campus Virtual

R. Larson, R. P. Hostetler, B. Edwards. Cálculo I. Ediciones Pirámide. 2002.

J. M. Ortega. Introducció a l'Anàlisi Matemàtica. Manuals de la Universitat Autònoma de Barcelona 4, Bellaterra 1990.

W. Rudin. Principios de Análisis Matemático. Ed. McGraw-Hill. 1980.

## Software

The use in this course of any special software or other informatic resources is not under scope