Universitat Autònoma de Barcelona

2021/2022

One-Variable Calculus

Code: 104382
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	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

Name: Laura Prat Baiget
Email: Laura.Prat@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

Ignasi Guillén Mola

Prerequisites

Although there are no official prerequisites, it is recommended that students have good knowledge of basic Calculus: limits, continuity and derivability of real functions of one variable, notions of integral calculus and trigonometry. As well as the graphic representation of relatively simple functions of one variable. The most important requirement, however, is a great curiosity to understand and deepen the concepts that they will study.

Objectives and Contextualisation

Solve the mathematical problems that can arise in the degree they are studying.

Understand the concept of sequences and the computation of limits.

Know and work intuitively, geometrically and formally the notions of limit, continuity, derivative and integral.

Understand and know how to make Taylor's developments of functions of one real variable.

Acquire basic notions of numerical series and power series. Know the construction of the integral, know how to s

its applications to solving problems where the integral approach is necessary. Improper integrals will be also stu

Competences

- Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
- Calculate and reproduce certain mathematical routines and processes with ease.
- Demonstrate a high capacity for abstraction and translation of phenomena and behaviors to mathematical formulations.
- Formulate hypotheses and think up strategies to confirm or refute them.
- Make effective use of bibliographical resources and electronic resources to obtain information.
- Relate new mathematical objects with other known objects and deduce their properties.
- 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.
- Use computer applications for statistical analysis, numerical and symbolic computation, graphic visualisation, optimisation and other to experiment and solve problems.
- Using criteria of quality, critically evaluate the work carried out.
- Work cooperatively in a multidisciplinary context assuming and respecting the role of the different members of the team.

Learning Outcomes

1. "Explain ideas and mathematical concepts pertinent to the course; additionally, communicate personal reasonings to third parties."
2. Analyze and draw functions, and deduce the properties of a function from its graph.
3. Apply a critical spirit and rigour for the validation or rejection of your own arguments and those of others.
4. Calculate and study function endpoints.
5. Calculate derivatives of functions through string rule, implicit function theorem, etc.
6. Calculate function integrals for a variable.
7. Classify matrices and linear applications according to different criteria (rank, diagonal and Jordan forms).
8. Contrast, if possible, the use of calculation with the use of abstraction in solving a problem.
9. Describe the concepts and mathematical objects pertaining to the subject.
10. Develop autonomous strategies for solving problems such as identifying the ambit of problems within the course, discriminate routine from non-routine problems, design an a priori strategy to solve a problem, evaluate this strategy.
11. Distinguish the objects of calculation with real-variable function and their properties and utilities.
12. Evaluate the advantages and disadvantages of using calculation and abstraction.
13. Identify the essential ideas in the demonstration of ceratin basic theorems and know how to adapt these to obtain other results.
14. In an orderly and accurately manner, draft brief mathematical texts (exercises, resolution of theoretical questions, etc.).
15. Make effective use of bibliographical resources and electronic resources to obtain information.
16. Read and understand a mathematical text at the current level of the course.
17. Relate the concepts of real-variable calculation with methods and objects from other fields.
18. Solve problems by approaching them with integrals (lengths, areas, volumes, etc.).
19. 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.
20. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.

21. 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.
22. Understand and work intuitively, geometrically and formally with the notions of limit, derivative and integral.
23. Using criteria of quality, critically evaluate the work carried out.
24. Work cooperatively in a multidisciplinary context, taking on and respecting the role of the distinct members in the team.

Content

1. Sequences of real numbers.

Limit of a sequence and algebraic properties.
Monotone sequences.
Accumulation points. Subsequences.
Bolzano-Weierstrass theorem.
Cauchy sequences.
Computation of limits.

2. Real functions.
Domain of a function.
Elementary functions.
Limit of a function at a point. One-sided limits. Properties of the limits. As
Continuity of a function.
Bolzano's theorem.
Mean value theorem and Weierstrass theorem.

3.Derivatives.

Derivatives of a function at a point.
Calculation of some derivatives.
Tangent line equation.
Chain rule. Inverse functions and differentiation. Logarithmic differentiatic
Absolute and relative extreme values of a function.
Rolle's theorem. Mean value theorem.
Hôpital Rule.
Newton's method for finding numerical solutions of functions.

4. Approximation by Taylor polynomials.
Order of contact between functions.
Taylor polynomial. Properties
Taylor's formula. Taylor's residue.
Approximate calculations. Application to the computation of limits.
Local study of functions.

5. Integration
Primitives of a function.
Immediate integrals. Integrals by change of variable. Integrals by parts.
Integration of rational functions. Integration of irrational functions.
The fundamental theorem of calculus.
Applications of integration: flat areas, length of a curve, areas and volur
Improper integrals Convergence criteria. Absolute convergence

6. Numerical series and power series.
Numerical series. Necessary condition of convergence.
Criteria of: comparison, quotient, root, integral.
Alternate series. Absolute convergence
Power series.Radius of Convergence.
Derivation and integration of power series.

Methodology

The theory sessions, problem sessions and practice sessions are undistinguishable, so we will alternate them according to the needs of the course and the students.

In principle, the theory teacher will give the main ideas on the various subjects. The student must solve the proposed problems.

The professors of problems and of practices will solve the doubts that appear in the sessions and will propose methods for solving them.

Throughout the semester the student must solve and deliver problems. These deliveries will be part of the continuous evaluation 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			
Problem and practice sessions	23	0.92	2, 5, 4, 6, 22, 9, 11, 1, 16, 21, 20, 14, 15
Theory sessions	30	1.2	2, 5, 4, 6, 22, 8, 9, 1, 21, 20, 19
Type: Supervised			
Doubt clearing sessions student-professor	16	0.64	3, 23, 1, 16, 14, 18, 24, 15
Type: Autonomous			
At home work	60	2.4	2, 5, 4, 9, 1, 16, 20, 14
Exam preparation	15	0.6	9, 1, 21, 20

Assessment

During the course, there will be two deliveries of exercises.

These can be doneindividually or in pairs.

The grades of these exercises will represent 20% of the final grade.
There will be an exam (Partial 1) before half semester in which the know

of the first part of the course will be evaluated.

This exam will contribute 30% to the final grade. All students who do
This exam can no longer be rated as NON EVALUABLE.

Students who have taken this exam with a grade lower than 3.5,

must take a second-chance exam once the classes have ended, in
the date and time established by the Coordination of the Degree.

The student who has not taken this exam
will be considered NON EVALUABLE for academic purposes and will not

the right to take the second-chance exam (except for cause
duly justified in which the second-chance examination will be allowed).

To be able to passthe subject, the grade of this exam

(or its second-chance version) can not be less than 3.5 and will represent 30%
of the final grade.
At the end of the semester there will be a second exam (Partial 2)

in which remaining part of the course will be evaluated.

The mark of this exam will provide another 30% of the final grade.

Students who have done
this exam with a grade lower than 3.5,

must do the second-chance exam once the classes are finished,

on the date and time established by the Coordination of the Degree.

The student who has not done
this examination will not have the right to do the second-chance version

(except for a justified cause in which it will be allowed to do

the second-chance exam). To be able to pass the subject, the grade of tl

(or its second-chance version) can not be less than 3.5 and will represent 30% of the final grade.
Therefore, in order to pass the subject, it is essential to obtain a grade f r
two partial exams or their second-chance versions.

There will be a practical exam with computer that will represent a 20% of the final grade.
The dates of delivery of exercises and partial exams will be published in
they may be subject to possible programming changes due to possible ir
The CV will always contain all the information about

these changes since it is understood that the CV is the usual exchange mechanism
of information between teacher and students.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First delivery	20%	1	0.04	1, 16, 21, 20
First partial exam	30%	2	0.08	2, 5, 4, 6, 7, 22, 9, 11, 1, 13, 16, 20, 17
Second partial exam	30%	2	0.08	3, 23, 12, 8, 10, 1, 16, 20, 14, 18, 24, 15
delivery	20%	1	0.04	1, 16, 19, 14

Bibliography

1.S.L. Salas, E. Hille. *'Calculus'* Vol. 1, Ed. Reverté, 2002.

2.Bartle, R.G., Shebert, D.R. (1996) *Introducci on al An alisis Matem atico de una variable.* 2a ed. Limusa. ISBN: 978-968-18-5191-0.

3.Ortega Aramburu, J.M. (2002). *Introducci o a l'An`alisi Matem`atica.* 2a ed. Manuals de la Universitat Aut`onoma de Barcelona.

Software

SageMath