Universitat Autònoma de Barcelona

2023/2024

One-Variable Calculus

Code: 104382
ECTS Credits: 6

Degree	Type	Year	Semester
2503740 Computational Mathematics and Data Analytics	FB	1	1

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

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	22	0.88	2, 5, 4, 6, 22, 9, 11, 1, 16, 21, 20, 14, 15
Theory sessions	27	1.08	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	64	2.56	2, 5, 4, 9, 1, 16, 20, 14
Exam preparation	15	0.6	9, 1, 21, 20

Assessment

Traducció del català efectuada per "Google Translate"

There will be an evaluable test / delivery of the practical part of the course, with computer, which will be worth 20% of the final grade. This part of the note will not be recoverable.

The delivery of solved exercises, as the teacher indicates, complements (10%) the course evaluation. This part will not be recoverable either.

There will be an exam (First Partial = P_1) in the middle of the semester in which the work done up to that point will be evaluated. The mark of this exam will provide 35% of the final grade. All students who take this exam can no longer be graded as NON-EVALUABLE. A student who has not taken this exam will be listed as NON-EVALUABLE for academic purposes and will not have the right to retake it (except for a duly justified reason, in which case the retake exam will be allowed).

At the end of the semester there will be a second partial exam (called P_2) in which the knowledge of the subjects that have not been evaluated in the first partial will be evaluated. The mark of this exam will provide another 35% of the final grade. A student who has not taken this exam will not be entitled to retake it (except for a duly justified reason, in which case the resit exam will be allowed).

If the average of the marks (out of 10) of the two partial ones (P_1 + P_2) / 2 is inferior to 3,5 the student must go to the examination of recovery, that is an global examination of all the asignatura . If the mean M = (P_1 + P_2) / 2 is greater than or equal to 3.5, then the final grade is NF = 0.7 M + 0.2 P + 0.1 LI, where P is the practical part of the course (out of 10) and LI is the grade for deliveries (out of 10). If NF is higher than 5 the student has passed and has NF as a final grade. If not, the student must go to the recovery exam and in this case the final gradewill be 0.7 R + 0.2 S + 0.1 LI, where R is the grade of the exam recovery (about 10).

5% of the students will be able to obtain the qualification of Honorary Enrollment. They will necessarily have to have a grade equal to or higher than 9. The final decision on the MH grade will be made by the teacher.

In the partial exams and in the one of recovery it will not be allowed to use calculator.

For each evaluation activity, a place, date and time of review will be indicated in which the student will be able to review the activity with the teaching staff. In this context, claims may be made on the grade of the activity, which will be evaluated by the teacher responsible for the subject. If the student does not appear for this review, this activity will not be reviewed later. Dates of problem deliveries and midterm exams will be posted on the Virtual Campus (CV) and may be subject to possible scheduling changes for reasons of adaptation to possible incidents; these changes will always be reported to the CV as the CV is understood to be the usual mechanism for exchanging information between teacher and students.

Without prejudice to other disciplinary measures deemed appropriate and in accordance with current academic regulations, irregularities committed by a student that may lead to a variation in the grade will be graded with a zero (0). For example, plagiarizing, copying, copying, having communication devices (such as cell phones, smart watches, etc.) in an evaluation activity will involve suspending that evaluation activity with a zero (0). Assessment activities qualified in this way and by this procedure will not be recoverable. If it is necessary to pass any of these assessment activities to pass the course, this course will be suspended directly, without the opportunity to retake it in the same course. The numerical mark of the transcript will be the lower value

between 3.0 and the weighted average of the marks in case the student has committed irregularities in an act of evaluation (and therefore it will not be possible to pass it by compensation).

Unique assessment. Students who have accepted the single assessment modality will have to take a final test which will consist of an exam where there may be theory questions, problem solving and short practical questions. This test will be held on the same day, time and place as the second partial test. Anyone who does not appear for said test without justifiable reason, will be graded as NOT ASSESSABLE. If a grade of less than 5 is obtained, it can be retaken on the same day, time and place as the rest of the students in the course are retaken.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First delivery	20%	1	0.04	1, 16, 21, 20
First partial exam	35%	2	0.08	2, 5, 4, 6, 7, 22, 9, 11, 1, 13, 16, 20, 17
Second partial exam	35%	2	0.08	3, 23, 12, 8, 10, 1, 16, 20, 14, 18, 24, 15
delivery	10%	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