UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Analisi Matematica II

2526-2-E4101B009

Learning objectives

The main objective of the course is to introduce the student to differential and integral calculus for functions of several real variables, with particular reference to those elements of the theory that find greater application in statistical and economic sciences.
The present course therefore contributes to consolidating knowledge and understanding in the field of mathematical analysis, in line with the Mathematics learning area of the three-year degree course in Statistical and Economic Sciences.

The student will revisit the notions of limit, continuity, differentiability, convexity/concavity, extremality and integrability, already encountered in the course of Mathematical Analysis I, comparing differences and analogies, in light of the changed and more varied vector-topological setting that characterizes the n-dimensional Euclidean space.
In particular, he will learn new concepts such as directional derivative, gradient, Jacobian matrix, Hessian matrix, level curve or surface, multipliers, change of coordinates, which will allow him to master the fundamental techniques of differential and integral calculus in several variables.
The acquisition of the above-mentioned elements will enable him to specifically address the following problems:

1. use partial derivatives (first and successive) to approximate a function of several variables (defined explicitly or implicitly) and control the error;

2. recognize the possible concavity/convexity property of a function through differential calculus tools;

3. determine unconstrained and constrained extrema (in the presence of various types of constraints) of a function of several variables;

4. calculate multiple integrals, both proper and generalized, using various computational techniques (reduction method, change of variables, symmetries).

The development of these skills, of use both in Statistics and in Economics, will be achieved through the guided resolution of exercises and problems of gradual complexity, aimed at forming an autonomous judgment on the choice of theoretical elements from mathematical analysis to be used, combined and adapted in the different case studies.

A parallel objective of the teaching is to accustom the student, both in the reading phase of a text and in the production phase, to the use of the formal language in use, in relation to the topics covered, in mathematical communication, with particular reference to:

1. definition of a mathematical concept/property and formulation of theorem statements;

2. description of the methodology for solving a problem (correct presentation of calculations and their justification, as well as logical-deductive reasoning).

The achievement of this last objective, together with the acquisition of the fundamental contents proposed in the teaching, will enable the student to independently access in-depth material on the topics (as indicated by the teacher).

Contents

Elements of differential and integral calculus for functions of several real variables.

Detailed program

I. Functions on several real variables

I.1 Topological-vector structure of R^n;
I.2 Limits and continuity;
I.3 Partial and directional derivatives, gradient;
I.4 Differentiability and tangent hyperplane;
I.5 Higher order derivatives and Hessian matrix;
I.6 Taylor's formula;
I.7 Convexity/concavity for multivariable functions;
I.8 Uncontrained extrema.

II. Functions implicitly defined

II.1 Equation systems and level curve/surfaces;
II. 2 Implicit function theorem;
II.3 Constrained extrema and Lagrangian multiplier method;
II.4 Invertibility for vector-valued functions.

III. Mutiple integration

III.1 Step functions and their integral;
III.2 Riemann integrability and integral for bounded functions over a n-dimensional interval;
III.3 Multiple integral over simple domains and reduction method;
III.4 Change of variable in multiple integration;

III.5 Polar coordinates in the plane and in the 3d space;
III.6 Multiple integral over unbounded domains.

Prerequisites

The contents of the following courses: "Mathematical Analysis I" and "Linear Algebra".

Teaching methods

All lessons are held in person in the following delivery mode:
12 lessons of 2 hours and 6 lessons of 3 hours, all delivered in person.

Assessment methods

The assessment method is based on a mandatory written test and, in case of passing the written test with a sufficient grade (>=18/30), on an optional oral test (upon request of the teacher or the student). There are no partial exam tests in progress.

The written tests are designed to ascertain the acquisition of theoretical skills, calculation techniques and use of the main tools, and the ability to solve problems similar to those discussed and commented on in the classroom during the lessons of the course. They are structured in:

4 PROBLEMS/EXERCISES;

1 OPEN QUESTION, possibly devided into several points.

The resolution of problems/exercises requires the rationalization of a mathematical question, the application of one or more principles, sometimes appropriately combined, as well as the use of the calculation tools learned, while in the open question a succinct but pertinent theoretical exposition is required (for example, the formal definition of notions, the formulation of statements and, where applicable, their justification, the comparison between notions, the production of examples and/or counterexamples relating to pre-established properties) of the topics in the program.

The oral exam, optional, is intended to verify the learning of all the theoretical elements proposed in class as well as the ability to apply them. It therefore includes a DISCUSSION INTERVIEW ON THE WRITTEN SUBJECT, followed by an INTERVIEW ON TOPICS COVERED IN CLASS.

If the written and oral tests are passed, the final grade will be determined by the average of the results of the written and oral tests.

The criteria followed by the examination board to evaluate the written tests and any oral test will take into account the ability to identify the themes that emerge when addressing a problem, the methodological rigor in solving problems, the ability to express quantitative concepts precisely and rigorously through formal language, and the completeness of treatment in the exposition of theoretical issues.

Textbooks and Reading Materials

1. M. Bramanti, C.D. Pagani, S. Salsa, "Analisi matematica 2", Zanichelli, Bologna, 2009;
2. S. Salsa, A. Squellati, "Esercizi di Analisi metematica 2", Zanichelli, Bologna, 2011.

Semester

The course is scheduled in the second half of the second semester.

Teaching language

Italian.

Sustainable Development Goals

QUALITY EDUCATION | RESPONSIBLE CONSUMPTION AND PRODUCTION