UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Analisi Matematica II

2627-2-E4104B009

Learning objectives

Knowledge and understanding.
This is a service course, meaning it provides the foundational knowledge required for subsequent, more specialized, courses in the Statistics and Information Management degree program. Specifically, Mathematical Analysis II is the direct continuation of Mathematical Analysis I, and therefore shares its core objectives. The substantial difference lies in the types of functions considered and studied, which depend on two or more variables rather than a single one.

Applying knowledge and understanding
Data often present themselves as a series of numbers associated with each observation of an experiment. Studying them collectively, rather than individually, requires mathematical objects called multivariate functions. Since these functions form the core of Mathematical Analysis II, the ability to determine when and how to best utilize these tools is fundamental to understanding the subjects covered in the core courses of the Degree Program.

Contents

1. Multivariable Calculus
2. Functions Study
3. Multivariable Integral Calculus
4. Few examples of vector spaced endowed by inner product
5. Basics of Fourier Series and Complex Numbers

Detailed program

Complex Numbers.
Definition of complex numbers: algebraic form. Trigonometric and exponential forms. Geometric interpretation of algebraic operations (addition, product, quotient).

Fourier Series.

1. Review: Vector spaces equipped with an inner product. Orthogonality and the generalized Pythagorean Theorem. Orthonormal vectors and the Gram-Schmidt orthonormalization process.
2. Trigonometric polynomials in real and complex forms.
3. Fourier series associated with a periodic function.
4. Bessel's inequality and Parseval's identity.
5. The Riemann-Lebesgue Theorem on Fourier coefficients.

Multivariate Differential Calculus

1. Preliminaries.
2. Partial derivatives. Differentiable functions. Directional derivatives.
3. Maxima and minima in open sets.
4. Positive/negative definite and semidefinite matrices.
5. Classification of relative maxima and minima using the Hessian matrix.
6. Constrained maxima and minima.

Multivariate Integral Calculus.

1. Definition of the Riemann integral for real-valued functions of two real variables. Properties of integrals.
2. x-simple and y-simple domains in R^2.
3. Definition of the integral for functions from R^n to R.
4. Change of variables in double integrals: polar coordinates, Jacobian matrix. Cylindrical and spherical coordinates in R^3.
5. Caomputation of the volume of a sphere.
6. Improper integrals. Evaluation of Gaussian integrals.

Prerequisites

Calculus I Course.
Linear Algebra Course.

Teaching methods

The coursework amounts to 6 CFU. A part of the classes will be devoted to the applications of the theoretical results covered. Of the whole classes, some will be given remotely and asynchronously, while the rest will be given in presence in classroom. Tutoring sessions will be part of the course's offer, as well.

Assessment methods

Written exam, with an optional oral exam only upon request by either the instructor or the student. The oral exam can only be requested by a student if they have achieved a score of at least 18/30 on the written exam. There are no midterm exams.

The written exam consists of exercises related to the course program. The purpose of the written exam is to verify the student's ability to solve problems, highlighting both computational skills and the capacity for logical reasoning and the autonomous use of the tools acquired during the course.

During the oral exam, students may be assessed on their knowledge and understanding of the theorem proofs covered during the lectures, as well as their ability to present and discuss the definitions and computational techniques introduced in the course. Problem-solving may also be required, depending on the performance in the written exam.

Textbooks and Reading Materials

Marco Bramanti, Carlo Domenico Pagani, Sandro Salsa. **Analisi matematica 2**. Zanichelli.

Semester

First semester.

Teaching language

Italian.

Sustainable Development Goals

GOOD HEALTH AND WELL-BEING