UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

## Calculus II

**2526-1-E3004Q001-E3004Q00102**

### Aims

The main aim of this course is to provide the second part of a Calculus course. The program covers necessary tools to successfully attend courses in Physical Sciences. In addition to understanding the theory, students should be able to illustrate it through meaningful examples and to solve suitable exercises.
Specifically:

1. Knowledge and understanding
   By the end of the course, the student will have acquired a solid understanding of differential and integral calculus in two or more variables. They will understand the geometric and physical meaning of concepts such as gradients, differentials, Hessian matrix, line and surface integrals, and the theorems of Gauss (Divergence) and Stokes, within the context of vector fields.
2. Applying knowledge and understanding
   The student will be able to compute partial derivatives, gradients, divergences, and curls of functions and fields in two or three dimensions. They will know how to find extrema of functions of more than one variable, and determine their nature. They will know how to evaluate multiple integrals, both in Cartesian and other coordinate systems, and apply the fundamental theorems of vector calculus to solve problems relevant to physics and engineering (e.g., fluxes, circulation, work).
3. Making judgements
   The student will develop the ability to recognize which mathematical tools are appropriate for solving specific problems in multivariable calculus, and to assess the validity of assumptions and approximations involved in their application.
4. Communication skills
   The student will be able to express mathematical reasoning with clarity and precision, both in written form and orally. They will be capable of explaining the logical steps behind a calculation or proof, and of interpreting mathematical results in physical terms.
5. Learning skills
   The student will develop the ability to learn new mathematical concepts independently and to apply them in different scientific contexts. The course will provide the foundations necessary for subsequent more advanced study in physics and mathematics.

## Contents

a) Linear algebra: a reminder
b) Differential calculus for functions of several variables
c) Integral calculus for functions of several variables
d) Vector analysis: Stokes and Gauss theorems in the 2- plane and the 3-space.

## Detailed program

a) Reminder of Linear Algebra. Vectors and geometry in the Euclidean space. Lines and planes. Matrices. Determinants. Quadratic forms.
b) Differential calculus for functions of several variables. Limits and continuity. Partial derivatives. Differentiability, tangent planes, and linear approximations. Directional derivatives and gradient. Regular curves. The chain rule. Surfaces and level curves. Taylor's formula. Maxima, minima, and saddle points. Constraints and Lagrange multipliers. The implicit function theorem.
c) Integral calculus for functions of several variables. Multiple integrals. Iterated integrals. Change of variables in multiple integrals.
d) Vector Analysis. Length of a curve and integrals on a line. Vector fields and path integrals. Surface area and surface integrals. Flux integrals. Conservative vector fields. Curl and divergence of a vector field. Solenoidal vector fields. Stokes and Gauss theorems.

## Prerequisites

The notions of the Course in Linear Algebra. The notions of the Course Calculus - part I.

## Teaching form

- Lectures (4 CFU) via expository teaching, fully given in remote asynchronous mode. Students will be provided with recordings of lectures where the instructor will present theoretical material and discuss problem-solving techniques. Whenever possible, mathematical concepts will be introduced via examples coming from Physics and/or other natural disciplines.
- Classes (2 CFU) via mixed expository and interactive teaching, partly given in presence and partly in remote synchronous mode. In expository sessions, students will attend expository-type classes where the instructor will apply the theoretical apparatus exposed in the lectures to solve problems. The course will also incorporate interactive teaching methods. This will involve group activities, discussions, and hands-on problem-solving sessions to enhance understanding and foster active participation.
  Video recordings of lectures and classes will be available online.

## Textbook and teaching resource

Suggested book (also available in e-book format through the university library):
C. Canuto and A. Tabacco, Mathematical Analysis 2, Springer Unitext, 2023.

Pat of the program willbe also covered by notes of the lecturer, to be posted on the e-learning page of the Course.

## Semester

Second Semester

## Assessment method

The exam consists of a written part (mandatory) and of an oral one (optional).
The written test is a closed books test. In this test, students will solve some exercises on the topics of the course and answer some questions of theoretical character on the program of the course. Both the correctness of the answers to exercises and questions and their justification will concur to the assessment and thus the final mark.
The optional oral part will mainly concern the theoretical aspects of the course.
The final mark of the Calculus exam will be obtained as a weighted average of the grades obtained in the exams of Calculus I and Calculus II.

## Office hours

Meetings with individual students or small groups thereof are to be agreed via e-mail or the e-learning page. The meetings can be held either remotely or in presence.

## Sustainable Development Goals

QUALITY EDUCATION