UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Calculus

2425-1-E3401Q001

Aims

The main objective of this course is to obtain greater confidence with the mathematical tools necessary for the geology studies.

The idea is not to provide a mere list of calculation procedures, but to understand the mathematics behind those procedures so that you can use them when needed. For this purpose, an indication will be given on the practical use in the geological field for most of the topics covered.

Contents

The macro topics of the course are the following:

- differential and integral calculus in one and two variables,
- differential equations,
- linear algebra.

Detailed program

The topics will be explained in more detail below:

- **Numbers**: natural, integer, rational and real, scientific notation.
- **Functions**: domain, image and counter-image. Composite and inverse functions. Cartesian plane. Continuous functions. Fees. Graphs, symmetries and periodicity. Elementary functions: powers, exponentials, logarithms, sine, cosine, tangent (graphs and properties). 2d/3d polar coordinates. The zero

theorem and the approximate calculation of the zeros of a function.

- **Limits**: definition and geometric meaning of the limit, calculation of limits, forms of indecision.
- **Derivatives**: definition and geometric meaning of first and second derivatives, tangent line to a curve, concavity and convexity. Derivation rules and derivatives of elementary functions. Fermat, Rolle, Lagrange, De l'Hopital. Maxima and minima of functions.
- **Integrals**: Definition and geometric meaning. Properties of the integral. Mean theorem. Fundamental theorem of integral calculus, primitives and indefinite integrals. Integration methods: decomposition, parts, replacement.
- **Two-variable functions**: Two-variable differential calculus. Partial and directional derivatives. Differentiability and linear approximation, plane tangent to a surface. Gradient and direction of maximum slope. Free maximums and minimums. Application for calculating the least squares line.
- **Ordinary differential equations**: definition and geometric meaning Physical examples (wave equation, motion of a body) and geometric meaning. First order equations with separable and linear variables. Linear second order equations with constant coefficients.
- **Linear algebra**: definition and examples of vector spaces. Dimension and basis of a vector space. Vectors, matrices (pixels), linear transformations. Systems of linear equations.

Prerequisites

The algebra, analytical geometry, and trigonometry of the high school curriculum are basic prerequisites. In particular, you need to know what equations and inequalities are, the equation of the straight line, the resolution of second degree equations, the definitions and properties of powers, exponentials, logarithms, sines, cosines and tangents.

As you can see from the extended program these concepts will be covered in class but **very quickly**.

Teaching form

Theoretical lessons in the classroom and exercises on the topics covered in the theoretical lessons:
-> 32 lessons of 2 hours in presence, Interactive Teaching;
-> 24 2-hour in-person practice activities, Interactive Teaching.
The course is supported by tutoring activities, with methods decided independently by the tutor and the participants.
The lectures will be yielded in Italian language.

Textbook and teaching resource

There are two possible texts for the course

- "Mathematics, infinitesimal calculus and linear algebra" by Bramanti, Pagani and Salsa. A rigorous theoretical text of a purely mathematical nature.
- "Mathematical methods for applied sciences" by Bisi and Fioresi. A more practical text than the previous one.

Both texts have a series of exercises at the end of each chapter.

Furthermore, they contain **much more topics** than those covered in the course, for example descriptive statistics. These topics will **not** be examined.

Handouts on the theoretical part of the course written by the course holder will also be available, as well as notes on the exercise part.

Semester

First Semester

Assessment method

The exam is practical and oral: the practical exam includes five exercises on the five macro topics of the course. An oral test will also be mandatory in which the candidate's knowledge will be examined starting from the written test.

The grade is out of thirty and the exam is considered passed if the final grade is at least 18/30.

Office hours

Before or after lessons or by appointment.

To make this appointment, contact the teacher by email at *franco.dassi@unimib.it*

Sustainable Development Goals