

Minor Mathematics

- Semester 1 - Linear Algebra - Edoardo Provenzi
- Semester 2 - Euclidian Spaces - Philippe Jaming
- Semester 3 - Probability and Statistics - Edoardo Provenzi
- Semester 4 - Integration & Differential Equations - Bernhard Haak

Linear Algebra

- **Course Goals**

- Introduce the core concepts of linear algebra
- Highlight their importance through real-world applications

- **Course Structure**

1. Abstract Vector Spaces: Generalize familiar geometric ideas (collinearity, decomposition on axes) to n -dimensional spaces
2. Linear Maps: Study the most natural transformations between vector spaces
3. Systems of Linear Equations: Learn general computational methods to solve them

- **Applications**

- Examples drawn from physics, chemistry, biology, and visual perception

- **Pedagogical Approach: Flipped Classroom**

- Complete lecture notes and videos available on Moodle
- You are expected to watch videos before class and post questions on Moodle
- In-class sessions will focus on your remarks, doubts, and active discussion

Euclidean Spaces

- **Course Goals**

- Representing linear maps in different basis
- Exploring angles, orthogonality, and projections

- **Course Structure**

1. Matrices as representations of linear maps
2. Scalar products and “angles” between vectors. Orthogonal projections.
3. Gram-Schmidt algorithm and its consequences
4. “good” and “numerically robust” representations of linear maps: diagonalization of symmetric matrices

- **Applications**

- Examples from Physics, Chemistry, and numerical schemes.

- **Pedagogical Approach**

- “traditional & flipped classroom”. Homework
- Coding in python

Probability and Statistics

- **Course Goals**

- Introduce the mathematical foundations of probability as the study of chance in random phenomena using a bottom-up teaching style: motivational examples first, general principles afterwards
- Emphasize its role as the basis for modern statistics and data interpretation
- Show how probability helps quantify confidence in hypotheses and predict future behavior

- **Course Structure**

1. Introduction to Probability: History, motivation, and basic concepts
2. Random Variables and Distributions: Laws, cumulative distribution functions, expectation, variance
3. Fundamental Theorems: Law of large numbers, central limit theorem, and their implications

- **Applications**

- Examples and case studies from gambling, data analysis, natural sciences, and everyday decision-making

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Integration and Ordinary Diff. Equations (ODE)

- **Course Goals**

- Understanding and programming numerical tools to solve problems
- Developing an intuition how a solution “should look like” : do not trust blindly any algorithm !

- **Course Structure**

1. Approximations of “the area under a curve” by numerical schemes.
2. Study of simple ODE's that we can solve in closed form
3. “qualitative analysis” – what can be done “on paper” if we cannot solve an ODE in closed form?
4. Numerical methods: – what can be done “by computer” if we cannot solve an ODE in closed form?

- **Applications**

- A “project phase”: you re-code in python some claims made in scientific publications and verify their findings.

- **Pedagogical Approach**

- “traditional classroom” focusing on intuition, homeworks & coding in python in small groups”.