UNIVERSITÀ DI TRENTO
Dipartimento di Matematica

Manifesto degli Studi del
Corso di Laurea Magistrale in Matematica
a.a. 2024-2025

Approvato dal Consiglio di Dipartimento il 13 marzo 2024

1. Activation

The Department of Mathematics promotes the Master of Science in Mathematics (*Corso di Laurea Magistrale in Matematica)*, belonging to the class "LM-40 - Matematica". The Master of Science in Mathematics is aimed at providing an in-depth knowledge and understanding of several areas of advanced Mathematics, and of its relations to other Sciences. Courses of the Master of Science in Mathematics are taught in English.

2. Curricula

The Master of Science in Mathematics is organized into four *curricula:*

- **Advanced Mathematics**
- **Cryptography**
- **Mathematics and Statistics for Life and Social Sciences**
- **Teaching and Scientific Communication**

Every student is required to formally choose one of the curricula and to follow the corresponding rules as stated in the *Regolamento Didattico della Laurea Magistrale in Matematica*. Advisors of studies are available for the various curricula. Any change of curriculum is subjected to a verification of the Teaching Committee.

3. Admission requirements

To apply to the Master of Science in Mathematics, a student shall fulfill both some formal requirements and a satisfactory personal qualification.
The following information is required and shall be provided according to the instructions given in the web site:

- to which curricula the applicant is interested in;
- a detailed study plan of the bachelor's degree, including titles and syllabi of all the courses taken;
- a document from the University that issued the bachelor's degree with reporting, in Italian or English, the list of courses, the mark obtained in each of them and the final mark associated with the degree;
- work and professional experiences;
- level of knowledge of English Language, certified by internationally recognized organizations or by the University that issued the bachelor's degree;
- a motivation statement, explaining why the student is willing to apply to the Master of Science in Mathematics, and what he expects from it.

As far as the formal requirements are concerned, a bachelor's degree lasting for three years or longer is mandatory; such a degree must provide a good basic mathematical knowledge, including at least linear algebra, mathematical analysis and some of their applications. A certificate for a B1 level of English is also required.
These formal requirements are satisfied by students who possess a bachelor's degree belonging to the class "L-35 – Scienze matematiche" or a bachelor's degree with at least 60 credits in sectors MAT/XX (credits in sectors FIS/, SECS-S/, INF/01 may also be considered, for courses with a strong mathematical content).

Knowledge and skills of the applicant are evaluated by the Admission Committee of the Department of Mathematics. The evaluation may require a written examination and/or an interview.

The details on the admission procedure can be found as an attachment to this document or on the web site.
The student is admitted to one or more chosen curricula or to a different one as decided by the Admission Committee. Some students might be required to follow a particular study plan.

4. Study plan

Students have to submit a study plan, which satisfies the requisites of the chosen curriculum as described in the Regolamento Didattico. A proper study plan must contain at least 120 credits, chosen in the following categories: **core** courses (caratterizzanti), **complementary** courses (affini), **free choice** courses (liberi), **language** courses and Stage/Thesis.

In this document we propose, for each curriculum, specific study plans (called *tracks*) which are suggested to the students; such study plans are approved by default. Students have the opportunity to write a personal study plan within each curriculum: such study plan must comply with the rules contained in the Regolamento Didattico and is subject to approval by the Teaching Committee. Students are not allowed to repeat activities already taken in their earlier career.

By the agreement with the University of Verona, students may propose a study plan in which some courses are offered by the Master Degree in Mathematics of that university. By the agreement with SMI (Scuola Matematica Interuniversitaria), students who attended a Summer School and passed the related exam can obtain the recognition of credits, subject to approval by the Teaching Committee.

5. Safety courses

The on-line courses "*Health and Safety in the workplace General Risk training*" (4 hours) and "*Health and Safety in the workplace Specific risk training (Low Risk)*" (4 hours) are mandatory for all the students attending courses held in computer and/or teaching labs. The courses are available through Didattica online. The course "*Health and Safety in the workplace Specific risk training (Low Risk)*" is replaced by the course "*Safety in the laboratory*" for students attending the courses Experimental Physics Laboratory at High School Level I and/or II. The course "*Safety in the laboratory*" must appear in the study plan (cod. 140551).

Activities provided by other Departments or Stage activities may have other requirements regarding safety courses.

6. Foreign languages

Students are required to get a B2 certificate of English (3CFU). In case the student has already used a B2 certificate of English to get 3CFU in the bachelor's degree, then he/she must obtain 3 CFU with a C1 certificate of English or a B1 certificate of French, German or Spanish or with the course Scientific Writing and Presentations in English.

The rules for certificates are the ones fixed by CLA. In particular, the score in every ability should be at least equal to 6/10.

IMPORTANT NOTICE

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/25 will be activated in the academic year 2025/26.

The *curriculum* Advanced Mathematics

Prerequisites
Students are supposed to have a basic knowledge on the following topics and a good comprehension of some of them:

- Algebra (groups and rings, ideals, quotients, isomorphism theorems);
- Geometry (general and algebraic topology, topological and differentiable manifolds, projective geometry);
- Complex Analysis (in one variable);
- Measure Theory (Lebesgue measure and integration theory);
- Ordinary Differential Equations and basic examples of Equations (Laplace, heat and wave equations); Functional Analysis (Banach and Hilbert spaces, linear operators);
- Basics of approximation techniques in Numerical Analysis;
- Classical foundations of Mathematical Physics; Probability (axiomatic construction).

The graduates will meet strong demand from the business-oriented environment where problem solving and analytical skills are highly appreciated.

Students are invited to choose between the following options, which are called t*racks*:

- ***General Advanced Mathematics***
- ***Advanced Algebra and Geometry***
- ***Calculus of Variations, Partial Differential Equations and Dynamical Systems***

Advanced Algebra and Geometry

This track has a strong focus on Algebra, Geometry and their interactions, such as in algebraic geometry. In particular, a firm grasp of core algebraic and geometric notions will be required, such as groups, rings, multivariate polynomials, linear algebra, projective geometry, topological spaces, functions of one complex variable. Students will have the possibility to develop a research thesis on Commutative Algebra, Computational Algebra, Lie Theory, Group Theory, Algebraic Curves, Algebraic Surfaces, Higher Dimensional Algebraic Varieties, Real, Complex and Quaternionic Geometry.
The graduates will meet strong demand from the business-oriented environment where problem solving and analytical skills are highly appreciated. The high specialization of this track is well suited for pursuing PHD studies in Italy or abroad, as well as for applying to international fellowships in Pure and Applied Mathematics.

Calculus of Variations, Partial Differential Equations and Dynamical Systems

This track has a strong focus on subjects as: Calculus of Variations, Partial Differential Equations (mainly theoretical but also numerical), Ordinary Differential Equations and Dynamical Systems.
Beyond the general prerequisites of the Curriculum in Advanced Mathematics, eligible students should have a firm grasp of core topics in Analysis such as: standard notions of ordinary differential equations (linear systems and nonlinear Cauchy problem), basic notions of Partial Differential Equations (Laplace, heat and wave equations, classification), elements of Real Analysis (Lebesgue measure theory, Lebesgue integration theory, L^p spaces), first elements of Banach and Hilbert spaces, basic probability theory, basic differential geometry.

The students of this track will have the possibility to develop a research thesis on Calculus of Variations, Analysis in metric spaces, Dynamical Systems, geometrical aspects of Partial Differential Equations, Nonlinear Partial Differential Equations, Optimal Control, Numerical Analysis of Partial Differential Equations. The high specialization of this track is well suited for pursuing PHD studies in Italy or abroad, as well as for applying to international fellowships in Pure and Applied Mathematics.

The *curriculum* Cryptography

Prerequisites

This curriculum has a strong focus on algebra and its applications to coding theory and cryptography. In particular, a firm grasp of core algebraic notions will be required, such as the notion of groups, rings, multivariate polynomial and the arithmetic of finite fields. The ideal candidate is also expected to have some familiarity with geometry, number theory, and probability.

For the stage-oriented track, also some basic programming notions will be useful, such as conditional statements, loops, and functions, as is a willingness to learn and apply more advanced concepts in unfamiliar programming languages.

For the research-oriented track, more advanced algebra will be useful, such as fluency in Galois theory and number theory.

In this highly specialized curriculum, the students will receive an introduction to modern methods in Computational Algebra, with an emphasis on its main real-life applications:

According to their own inclination, the students are free to choose between two options:

- ***Stage-oriented***
- ***Research-oriented***

Stage-oriented

This track is especially aimed at students who wish to work in the security department of a company. Typically, security departments of banks hire our graduates, but also IT companies and security-focused firms find their study preparation of high interest. Indeed, this *track* complements a solid algebraic background with both applied courses, such as *Algebraic Cryptography, Applied Cryptography* or *Coding Theory and Applications,* and practical Computer Science courses, such as Java programming (*Laboratorio di Programmazione)* or *Introduction to Computer and Network Security.*

An internship is available for all students. The internship can be either *external* in a company or *internal* within the Laboratory of Cryptography on a project proposed by a company.

Research-oriented

This track is aimed especially at students interested in mathematics research in Applied Algebra, with focus on Cryptography and Coding Theory, and willing to pursue a PhD in Mathematics on these subjects.

The *curriculum* Mathematics and Statistics for Life and Social Sciences

Prerequisites

Students are supposed to have a basic knowledge on the following topics and a deep comprehension of some of them:

- General Topology;
- Measure Theory (Lebesgue measure and integration theory);
- Functional Analysis (Banach and Hilbert spaces, linear operators, ordinary differential equations, Fourier series);
- Ordinary and Partial Differential Equations
- Numerical Analysis;
- Probability (including its axiomatic construction);
- Mathematical Statistics.

Some basic programming notions will be useful, as is a willingness to learn and apply different programming languages..

Students are invited to choose between the following options, which are called tracks*:*

- ***Mathematics for Data Science***
- ***Modelling, Statistics and Analysis of Biosystems***
- ***Modelling and Simulation for Biomedical Applications***
- ***Modelling, Statistics and Analysis in Mathematical Finance***

It is also possible for a student to present a personal study plan that may cover applications of mathematics to different fields such as finance, economics, engineering or others. Such a study plan is subject to approval by the Teaching Committee*.*

Mathematics for Data Science

Students who take this track will have the opportunity to learn the theoretical and computational foundations of Mathematics for Data Science, including advanced tools in Probability, Mathematical Statistics, Machine Learning and Deep Learning. The track equips students with the knowledge and skills needed to tackle challenges in modelling high dimensional and complex data sets, which are frequently encountered in environmental, biological, social and economic fields.

This track is ideal for students seeking a Ph.D. in Statistics, Data Science, Applied Mathematics, Machine Learning, Artificial Intelligence or related fields. Graduates from this track are also highly sought-after by data analysis departments across various industries, including IT, consulting, business, genomics, bioinformatics, medicine, and data-driven research centres.

Modelling, Statistics and Analysis of Biosystems

This *track* provides a widespread preparation at the interface between Biological sciences, Mathematics and Informatics. Students from this *track* have continued with Ph.D. studies and beyond.

An introduction to modern mathematical methods in areas of biology, ecology, epidemiology, molecular networks is provided.

Companies, in particular from the pharmaceutical sector, are interested in students with these competences in modelling and Statistics.

Modelling and Simulation for Biomedical Applications

This track provides the student with the ideal toolbox to design, implement, and apply mathematical models to problems of biomedical and clinical interest. Students will develop solid skills in mathematical modeling, continuum mechanics, differential equations, numerical analysis, machine learning, and scientific computing. Biomedical applications are manifold, including inverse problems, computational hemodynamics, and cardiac modeling. By design, the track has several interactions with clinical research in hospitals, universities, and research centers. Acquired competencies will provide students with a solid background for a Ph.D. in Applied Mathematics or Biomedical Sciences, as well as to work in the biomedical sector or companies with computational model-based R&D departments.

Modelling, Statistics and Analysis in Mathematical Finance

The program in entirely taught in English. Students are required to acquire expertise in both analytical and stochastic modeling, data analysis, machine learning, and programming. Upon completion of the program, as part of thesis preparation, students are offered internships with companies and the opportunity to collaborate on their thesis with international research institutions.

The *curriculum* Teaching and Scientific Communication

The goal of this curriculum is to cover the spectrum of knowledge and skills required to undertake mathematical teaching at secondary school's level as well as to communicate mathematics and science to a broad public.

Prerequisites
Students are supposed to have a basic knowledge on the following topics and a good comprehension of some of them:

- Algebra (groups and rings, ideals, quotients, isomorphism theorems),
- Geometry (general and algebraic topology, topological and differentiable manifolds, basic projective geometry),
- Physics (mechanics, thermodynamics, electromagnetism),
- Measure Theory (Lebesgue measure and integration theory),
- Ordinary Differential Equations,
- Classical Foundations of Mathematical Physics,
- Probability (including the axiomatic construction) and Statistics.

Curriculum Advanced Mathematics, *Track General Advanced Mathematics*

Advisor of study: Francesco Serra Cassano

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
At least 24 credits in sectors MAT/01-05, of which at least 15 in the following table						
145135	Computational Algebra	6	42	MAT/02	1	Alessandra Bernardi
145130	Advanced Geometry	9	63	MAT/03	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MAT/05	1	Francesco Serra Cassano
The remaining credits in the following table:						
145146	Mathematical Logic	6	42	MAT/01	1	Stefano Baratella
145394	Coding Theory and Applications	6	42	MAT/02	1	Nadir Murru
145393	Partial Differential Equations (I modulo) Partial Differential Equations (II modulo)	6 3	42 21	MAT/05	1 1	Alberto Valli Alessandro Carlotto
At least 15 *credits in sectors MAT/06-09 from the following table*						
145435	Stochastic Processes	9	63	MAT/06	1	Stefano Bonaccorsi
145908	Mathematical Physics – Differential Geometric Methods	9	63	MAT/07	2	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MAT/07	2	Valter Moretti
145152	Numerical Methods for PDEs	6	48	MAT/08	2	Robert Nürnberg
COMPLEMENTARY COURSES – Credits in Core and Complementary courses must be at least 75						
Complementary courses can be chosen in the following table:						
145407	Model Theory (**)	6	42	MAT/01		N.A.
145156	Set Theory (*)	6	42	MAT/01	2	Stefano Baratella
145131	Algebraic Geometry I	6	42	MAT/03	1	Edoardo Ballico Alessandro Oneto
145132	Algebraic Geometry II (*)	6	42	MAT/03	2	Luis Eduardo Solá Conde Elisa Postinghel
145506	Algebraic Topology (**)	6	42	MAT/03		N.A.
145566	Real Algebraic Geometry (*)	6	42	MAT/03	1	Riccardo Ghiloni
145557	Advanced Calculus of Variations (*)	6	42	MAT/05	2	Andrea Pinamonti
145507	Advanced Topics in Analysis (**)	6	42	MAT/05		N.A.
145434	Fourier Analysis	6	42	MAT/05	2	Gian Paolo Leonardi
145538	Geometric Analysis	9	63	MAT/05	2	Lorenzo Mazzieri
145258	Geometric Measure Theory	6	42	MAT/05	2	Andrea Marchese Paolo Bonicatto
145259	Mathematical control theory (*)	6	42	MAT/05	1	Fabio Bagagiolo
146115	Minimal surfaces	6	42	MAT/05	1	Alessandro Carlotto
145159	Stochastic Differential Equations	6	42	MAT/06	2	Michele Coghi
146211	Optimal transport	6	42	MAT/05	1	Paolo Bonicatto Andrea Marchese
146212	Toric Geometry (**)	6	42	MAT/03		N.A.
146213	Dynamical systems (**)	6	42	MAT/05		N.A.
145567	Topics in Mathematical Physics of Quantum Theories	6	42	MAT/07	1	Romeo Brunetti
FREE CHOICE COURSES						
The choice of free courses shall be consistent with the selected curriculum. Students may use 3 of these CFU to get a C1 certificate of English, a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English, or to take an internship, according to the rules of the Regolamento.						
THESIS						
The course of studies is concluded with the discussion of an original thesis providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU. Students who choose to take a 3 CFU internship among the free choice courses have to submit an original thesis worth 30 CFU						

Curriculum Advanced Mathematics, *Track Advanced Algebra and Geometry*

Advisors of study: Roberto Pignatelli, Willem Adriaan De Graaf

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145135	Computational Algebra	6	42	MAT/02	1	Alessandra Bernardi
145130	Advanced Geometry	9	63	MAT/03	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MAT/05	1	Francesco Serra Cassano
145435	Stochastic Processes	9	63	MAT/06	1	Stefano Bonaccorsi
One course among the following:						
145908	Mathematical Physics – Differential Geometric Methods	9	63	MAT/07	2	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MAT/07	2	Valter Moretti
COMPLEMENTARY COURSES						
At least 33 credits chosen in the following table:						
145407	Model Theory (**)	6	42	MAT/01		N.A.
145156	Set Theory (*)	6	42	MAT/01	2	Stefano Baratella
145560	Advanced Group Theory (**)	6	42	MAT/02		N.A.
145953	Advanced Number Theory (*)	6	42	MAT/02	2	Nadir Murru Federico Pintore
145131	Algebraic Geometry I	6	42	MAT/03	1	Edoardo Ballico Alessandro Oneto
145132	Algebraic Geometry II (*)	6	42	MAT/03	2	Luis Eduardo Solá Conde Elisa Postinghel
145506	Algebraic Topology (**)	6	42	MAT/03		N.A.
145566	Real Algebraic Geometry (*)	6	42	MAT/03	1	Riccardo Ghiloni
145538	Geometric Analysis	9	63	MAT/05	2	Lorenzo Mazzieri
146212	Toric Geometry (**)	6	42	MAT/03	2	N.A.
FREE CHOICE COURSES						
Students in this track are highly recommended to choose the free courses among the courses in settori MAT/02-03. The courses can also be taken from the Bachelor's degree, among the following: *Algebra Commutativa*, *Geometria Differenziale*, *Teoria algebrica dei numeri, Introduzione alla Geometria Algebrica* and *Teoria di Galois,* if the student has not taken a similar course in the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English, or to take an internship, according to the rules of the Regolamento.						
THESIS						
The course of studies is concluded with the discussion of an original thesis providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU. Students who choose to take a 3 CFU internship among the free choice courses have to submit an original thesis worth 30 CFU						

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/2026.

Curriculum Advanced Mathematics,
Track Calculus of Variations, Partial Differential Equations and Dynamical Systems

Advisors of study: Gian Paolo Leonardi, Francesco Serra Cassano

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145130	Advanced Geometry	9	63	MAT/03	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MAT/05	1	Francesco Serra Cassano
145393	Partial Differential Equations (I modulo) Partial Differential Equations (II modulo)	6 3	42 21	MAT/05	1 1	Alberto Valli Alessandro Carlotto
145435	Stochastic Processes	9	63	MAT/06	1	Stefano Bonaccorsi
145152	Numerical Methods for PDEs	6	48	MAT/08	2	Robert Nürnberg
COMPLEMENTARY COURSES – 36 credits chosen in the following table:						
145557	Advanced Calculus of Variations (*)	6	42	MAT/05	2	Andrea Pinamonti
145507	Advanced Topics in Analysis (**)	6	42	MAT/05		N.A.
145142	Foundations of Analysis (**)	6	42	MAT/05		N.A.
145434	Fourier Analysis	6	42	MAT/05	2	Gian Paolo Leonardi
145538	Geometric Analysis	9	63	MAT/05	2	Lorenzo Mazzieri
145258	Geometric Measure Theory	6	42	MAT/05	2	Andrea Marchese Paolo Bonicatto
145259	Mathematical control theory (*)	6	42	MAT/05	1	Fabio Bagagiolo
146115	Minimal surfaces	6	42	MAT/05	1	Alessandro Carlotto
145159	Stochastic Differential Equations	6	42	MAT/06	2	Michele Coghi
145908	Mathematical Physics – Differential Geometry Methods	9	63	MAT/07	2	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MAT/07	2	Valter Moretti
146211	Optimal transport	6	42	MAT/05	1	Paolo Bonicatto Andrea Marchese
146213	Dynamical systems (**)	6	42	MAT/05		N.A.
FREE CHOICE COURSES						
Students, in this track are highly recommended to choose the free courses among the courses in sector MAT/05. The courses can also be taken from the Bachelor's degree, among the following: Equazioni Differenziali Ordinarie, Calcolo delle Variazioni, Analisi Funzionale, Geometria Differenziale, if the student has not taken a similar course in the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English, or to take an internship, according to the rules of the Regolamento.						
THESIS						
The course of studies is concluded with the discussion of an original thesis providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU. Students who choose to take a 3 CFU internship among the free choice courses have to submit an original thesis worth 30 CFU						

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/26.

Curriculum Cryptography, *Track Stage-Oriented*						
Advisor of study: Marco Calderini						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145441	Algebraic Cryptography Cryptography Finite Fields and Symmetric Cryptography	 6 6	 42 42	MAT/02	I. 1 2	Massimiliano Sala
145394	Coding Theory and Applications	6	42	MAT/02	I.1	Nadir Murru
145135	Computational Algebra	6	42	MAT/02	I.1	Alessandra Bernardi
145157	Stochastic Processes (I modulo)	6	42	MAT/06	1	Sonia Mazzucchi
145427	Scientific Computing	9	72	MAT/08	2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following four courses:						
145508	Advanced Programming of Cryptographic Methods	6	48	INF/01	II.1	Silvio Ranise
145937	Introduction to computer and network security	6	48	ING-INF/05	I.1	Mut DISI (0517H – cod. 145937)
145777	Applied Cryptography	6	42	MAT/02	I.1	Marco Calderini
146266	Cryptographic Protocols for Secure Networks and Applications	6	42	NG-INF/05	I.2	Silvio Ranise
At least 12 credits in the following table:						
145451	Computability and computational complexity	6	48	MAT/01	1	Mut DISI (0517H – cod. 145451)
146117	Advanced Coding Theory	6	42	MAT/02	2	Marco Calderini
146116	Advanced Cryptography	6	42	MAT/02	II.1	Edoardo Ballico
145953	Advanced number theory (*)	6	42	MAT/02	2	Nadir Murru Federico Pintore
145212	Discrete Fourier Analysis	6	42	MAT/02	2	Irene Villa
145256	Statistics of Stochastic Processes	6	48	MAT/06	1	Claudio Agostinelli
145396	Formal Techniques for Cryptographic Protocol Analysis (*)	6	42	INF/01	2	Roberto Zunino
145614	Multimedia Data Security	6	48	ING-INF/03	1	Mut DISI (0346H – 145614)
145190	Digital Signal Processing	6	48	ING-INF/03	1	Mut DISI (0346H – cod. 146224 mod. 1)
146318	Automated Reasoning and Formal Verification	12	96	ING-INF/05	2	Mut DISI (0517H – cod. 146318)
146157	Blockchain	6	48	INF/01	2	Mut DISI (0517H - cod. 146157)
FREE CHOICE COURSES						
To complement the preparation in this *track*, students who have not attended courses focused on Java programming in the Bachelor's degree are highly recommended to take the course *Laboratorio di Programmazione.* Other recommended courses from the bachelor degree program are: *Teoria Algebrica dei Numeri and Teoria di Galois* Students are recommended to use 3 of these CFU to get a C1 certificate of English.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/2026.

Curriculum Cryptography, *Track Research-Oriented*

Advisor of study: Marco Calderini

Code	Course	CFU	Hours	SSD	Year – Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145441	Algebraic Cryptography Cryptography Finite Fields and Symmetric Cryptography	 6 6	 42 42	MAT/02	II. 1 2	Massimiliano Sala
145394	Coding Theory and Applications	6	42	MAT/02	I.1	Nadir Murru
145135	Computational Algebra	6	42	MAT/02	I.1	Alessandra Bernardi
Students can choose between the pair						
145256	Statistics of Stochastic Processes	6	48	MAT/06	1	Claudio Agostinelli
145435	Stochastic Processes	9	63	MAT/06	1	Stefano Bonaccorsi
or						
145157	Stochastic Processes (I modulo)	6	42	MAT/06	1	Sonia Mazzucchi
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MAT/07	2	Valter Moretti
COMPLEMENTARY COURSES						
The following three courses:						
146116	Advanced Cryptography	6	42	MAT/02	II.1	Edoardo Ballico
146117	Advanced Coding Theory	6	42	MAT/02	2	Marco Calderini
145396	Formal Techniques for Cryptographic Protocol Analysis (*)	6	42	INF/01	2	Roberto Zunino
At least 18 credits in the following table:						
145560	Advanced Group Theory (**)	6	42	MAT/02		N.A.
145953	Advanced Number Theory (*)	6	42	MAT/02	2	Nadir Murru Federico Pintore
145131	Algebraic Geometry I	6	42	MAT/03	1	Edoardo Ballico Alessandro Oneto
145777	Applied Cryptography	6	42	MAT/02	1	Marco Calderini
145212	Discrete Fourier Analysis	6	42	MAT/02	2	Irene Villa
FREE CHOICE COURSES						
Students of this *track* are **highly recommended** to choose the free courses among the courses in the sectors MAT/02-03. The courses can also be taken from the bachelor's degree; *Algebra Commutativa*, *Teoria algebrica dei numeri* and *Teoria di Galois* are particularly suggested. Students are recommended to use 3 of these CFU to get a C1 certificate of English.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/2026.

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Mathematics for Data Science*						
Advisor of study: Veronica Vinciotti						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145905	Geometry and Topology for Data Analysis	6	42	MAT/03	I.2	Alessandro Oneto
145435	Stochastic Processes	9	63	MAT/06	I.1	Stefano Bonaccorsi
145427	Scientific Computing	9	72	MAT/08	I.2	Robert Nürnberg
145256	Statistics of stochastic processes	6	48	MAT/06	II.1	Claudio Agostinelli
One course among the following:						
145145	Mathematical Biology	9	72	MAT/05	I.1	Simone Pezzuto Cinzia Soresina
145538	Geometric Analysis	9	63	MAT/05	2	Lorenzo Mazzieri
COMPLEMENTARY COURSES						
145909	Tensor Decomposition for Big Data Analysis	6	42	MAT/02	I.1	Alessandra Bernardi
145434	Fourier Analysis	6	42	MAT/05	II.2	Gian Paolo Leonardi
145902	Advanced Statistical Methods	6	42	MAT/06	I.2	Claudio Agostinelli
145561	Bayesian Statistics	6	42	MAT/06	I.2	Pier Luigi Novi Inverardi Sara Kathryn Wade
145914	Statistical Models	6	42	MAT/06	I.1	Veronica Vinciotti
146049	Graphical Models and Network Science	6	42	MAT/06	II.1	Veronica Vinciotti
FREE CHOICE COURSES						
Students are suggested to take the free courses among those listed below. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English						
145159	Stochastic Differential Equations	6	42	MAT/06	2	Michele Coghi
145152	Numerical Methods for PDEs	6	48	MAT/08	2	Robert Nürnberg
146213	Dynamical systems (**)	6	42	MAT/05		N.A.
146214	Markov Decision Processes and Reinforcement Learning	6	48	MAT/06	1	Francesco Giuseppe Cordoni
146211	Optimal transport	6	42	MAT/05	1	Paolo Bonicatto Andrea Marchese
145903	Deep Learning	6	48	INF/01	2	Mut DISI (0342H – cod.145857 Machine Learning (mod. II))
145062	Machine Learning	6	48	INF/01	1	Mut DISI (0517H – cod. 145062)
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Modelling, Statistics and Analysis of Biosystems*

Advisor of study: Andrea Pugliese

Code	Course	CFU	Hours	SSD	Year – Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
The following five courses						
145145	Mathematical Biology	9	72	MAT/05	I.1	Simone Pezzuto Cinzia Soresina
145139	Partial Differential Equations	6	42	MAT/05	1	(condivide 6 CFU con l'a.d. 145393 I mod) Alberto Valli
145256	Statistics of Stochastic Processes	6	48	MAT/06	II.1	Claudio Agostinelli
145435	Stochastic Processes	9	63	MAT/06	I.1	Stefano Bonaccorsi
145427	Scientific Computing	9	72	MAT/08	I.2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following five courses						
145133	Advanced Topics in Biomathematics	6	48	MAT/05	I.2	Cinzia Soresina
145914	Statistical Models	6	42	MAT/06	I.1	Veronica Vinciotti
145588	Molecular Biology of the Cell	6	48	BIO/10	I.1	N.A.
145136	Data Analysis and Exploration	6	48	INF/01	I.2	Mario Lauria
145910	Network Modeling and Simulation	6	48	INF/01	I.1	Mut QCB (0521H – mod. Network Modeling and Simulation – cod. 146089)
At least one of the following:						
145434	Fourier Analysis	6	42	MAT/05	I.2	Gian Paolo Leonardi
145902	Advanced Statistical Methods	6	42	MAT/06	I.2	Claudio Agostinelli
145561	Bayesian Statistics	6	42	MAT/06	I.2	Pierluigi Novi Inverardi Sara Kathryn Wade
145159	Stochastic Differential Equations	6	42	MAT/06	I.2	Michele Coghi
145429	Biomedical Applications of Mathematics	3	21	MAT/08	I.2	Lucas Omar Müller
145331	Mathematical Aspects of Bioelectromagnetism and Imaging	6	42	MAT/08	II.1	Ana María Alonso Rodríguez
145152	Numerical Methods for PDEs	6	48	MAT/08	I.2	Robert Nürnberg
146213	Dynamical systems (**)	6	42	MAT/05	1	N.A.
145259	Mathematical control theory (*)	6	42	MAT/05	1	Fabio Bagagiolo
146214	Markov Decision Processes and Reinforcement Learning	6	48	MAT/06	1	Francesco Giuseppe Cordoni
146049	Graphical Models and Network Science	6	42	MAT/06	II.1	Veronica Vinciotti
145903	Deep Learning	6	48	INF/01	2	Mut. DISI (0342H – cod.145857 Machine Learning (mod. II))
145062	Machine Learning	6	48	INF/01	1	Mut. DISI (0517H – cod. 145062)
145053	Laboratory of Biological Data Mining	6	48	ING-INF/05	1	Mut. QCB (0521H – cod. 145547 Mod. Laboratory of Biological Data Mining)
146200	Digital Epidemiology	6	48	ING-INF/05	2	Mut. DISI (0346H – cod. 146200)
FREE CHOICE COURSES						
Free courses are suggested to be chosen from the list above. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Modelling and Simulation for Biomedical Applications*

Advisor of study: Lucas Omar Müller

Code	Course	CFU	Hours	SSD	Year – Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 5						
CORE COURSES						
145145	Mathematical Biology	9	72	MAT/05	I.1	Simone Pezzuto Cinzia Soresina
145139	Partial Differential Equations	6	42	MAT/05	1	(condivide 6 CFU con l'a.d. 145393 I mod) Alberto Valli
145331	Mathematical Aspects of Bioelectromagnetism and Imaging	6	42	MAT/08	II.1	Ana María Alonso Rodríguez
145152	Numerical Methods for PDEs	6	48	MAT/08	I.2	Robert Nürnberg
145427	Scientific Computing	9	72	MAT/08	I.2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following five courses						
145434	Fourier Analysis	6	42	MAT/05	I.2	Gian Paolo Leonardi
145428	Computational Haemodynamics	9	72	MAT/08	II.1	Lucas Omar Müller
145332	Theoretical biomechanics (I modulo) Theoretical biomechanics (II modulo)	6 3	46 26	ICAR/01	I. 1 I. 2	Davide Bigoni Luigi Fraccarollo
145392	Physiological flow and transport in porous tissues	6	42	ICAR/02	II.1	Alberto Bellin
146248	Cardiac Modelling	6	48	MAT/08	I.2	Simone Pezzuto
At least 6 CFU among the following courses:						
145914	Statistical Models	6	42	MAT/06	I.1	Veronica Vinciotti
145429	Biomedical Applications of Mathematics	3	21	MAT/08	I.2	Lucas Omar Müller
145133	Advanced Topics in Biomathematics	6	48	MAT/05	I.2	Cinzia Soresina
145159	Stochastic Differential Equations	6	42	MAT/06	I.2	Michele Coghi
145338	Bio-Medical Imaging	6	48	FIS/07	I.2	Mut. FIS (0518H – cod. 145338)
FREE CHOICE COURSES						
Students are suggested to take the free courses among the ones not chosen in the above list and those listed below. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English						
145259	Mathematical Control Theory (*)	6	42	MAT/05	1	Fabio Bagagiolo
145561	Bayesian Statistics	6	42	MAT/06	I.2	Pierluigi Novi Inverardi Sara Kathryn Wade
146049	Graphical Models and Network Science	6	42	MAT/06	II.1	Veronica Vinciotti
146213	Dynamical systems (**)	6	42	MAT/05		N.A.
146214	Markov Decision Processes and Reinforcement Learning	6	48	MAT/06	1	Francesco Giuseppe Cordoni
145062	Machine Learning	6	48	INF/01	1	Mut DISI (0517H - cod. 145062)
145235	Molecular and Cellular Biophysics	6	48	BIO/10	I.1	Mut.FIS (0518H - cod. 145235)
145909	Tensor Decomposition for Big Data Analysis	6	42	MAT/02	I.1	Alessandra Bernardi
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Modelling, Statistics and Analysis in Mathematical Finance*						
Advisor of study: Stefano Bonaccorsi						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145139	Partial Differential Equations	6	42	MAT/05	1	(condivide 6 CFU con l'a.d. 145393 I mod)) Alberto Valli
145145	Mathematical Biology	9	72	MAT/05	I.1	Simone Pezzuto Cinzia Soresina
145256	Statistics of Stochastic Processes	6	48	MAT/06	II.1	Claudio Agostinelli
145435	Stochastic Processes	9	63	MAT/06	I.1	Stefano Bonaccorsi
At least one of the following						
145152	Numerical Methods for PDEs	6	48	MAT/08	I.2	Robert Nürnberg
145427	Scientific Computing	9	72	MAT/08	I.2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following two courses						
145914	Statistical Models	6	42	MAT/06	I.1	Veronica Vinciotti
145159	Stochastic Differential Equations	6	42	MAT/06	I.2	Michele Coghi
The remaining CFU among the following						
145905	Geometry and Topology for Data Analysis	6	42	MAT/03	I.2	Alessandro Oneto
145902	Advanced Statistical Methods	6	42	MAT/06	I.2	Claudio Agostinelli
145561	Bayesian Statistics	6	42	MAT/06	I.2	Pier Luigi Novi Inverardi Sara Kathryn Wade
146213	Dynamical systems (**)	6	42	MAT/05		N.A.
146214	Markov Decision Processes and Reinforcement Learning	6	48	MAT/06	1	Fancesco Giuseppe Cordoni
145912	Scientific Programming	6	48	INF/01	1	Mut QCB (0521H Scientific programming – mod. Programming – cod. 145540)
121395	Financial markets and economic activity	6	36	SECS-P/01	1	Mut DEM (0119H – cod. 121395)
121469	Mercati e Intermediari Finanziari Progredito	10	60	SECS-P/11	2	Mut DEM (0122H – cod. 121469)
121470	Strumenti di Investimento e Derivati	10	60	SECS-P/11	1	Mut DEM (0122H – cod. 121470)
121414	Workshop on Financial simulation	6	36	SECS-S/03	1	Mut DEM (0122H – cod. 121414)
145855	Actuarial Mathematics for Life Insurance (**)	6	42	MAT/06		N.A.
145991	Applied Stochastic Processes	6	42	MAT/06	2	Michele Coghi Paolo Pigato
FREE CHOICE COURSES						
Students are suggested to take the free courses among those listed above and not already chosen. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree. Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

The courses marked with (*) will be offered in the academic year 2024/2025 but not in the academic year 2025/2026. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/2026.

Curriculum Teaching and Scientific Communication

Advisor of study: Luigi Amedeo Bianchi

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
145151	Mathematical models for the Physical, Natural and Social Sciences (**Core course**)	6	42	MAT/06	1	Luigi Amedeo Bianchi Michele Coghi
145155	Modern Physics (**Complementary course**)	12	84	FIS/08	1+2	Giovanni Andrea Prodi
OTHER CORE COURSES – At least 30 credits						
145146	Mathematical Logic	6	42	MAT/01	1	Stefano Baratella
145135	Computational Algebra	6	42	MAT/02	1	Alessandra Bernardi
145253	Foundations of Geometry	6	42	MAT/03	2	Gianluca Occhetta
145904	Elementary Mathematics from a Higher Viewpoint	6	42	MAT/04	1	Elisa Postinghel
145144	Laboratory of Didactics of Mathematics (**)	6	42	MAT/04		N.A.
145154	Experimental Mathematics Laboratory at School Level	6	42	MAT/04	1	Silvano Delladio (P60 Laboratorio di sviluppo e approfondimento di attività per la didattica della matematica I-II)
145142	Foundations of Analysis (**)	6	42	MAT/05	2	N.A.
COMPLEMENTARY COURSES – At least one of the two courses						
145153	Experimental Physics Laboratory at High School Level I	6	56	FIS/08	1	Pasquale Onorato
145215	Experimental Physics Laboratory at High School Level II (*)	6	56	FIS/08	2	Pasquale Onorato
OTHER COMPLEMENTARY COURSES – At least 12 credits chosen in the following table or among the courses not chosen from the previous tables						
145150	Elementary Mathematics from a Higher Viewpoint 2 (**)	6	42	MAT/04		N.A.
145906	Laboratory Techniques for Mathematics Teaching	6	56	MAT/04	1	Elisabetta Ossanna (P60 Metodi e contenuti per la didattica della matematica I - II)
145913	Topics in History of Mathematics	6	42	MAT/04	2	Marco Andreatta
145914	Statistical Models	6	42	MAT/06	1	Veronica Vinciotti
145820	Laboratory of Computer Science Education (**)	6	48	INF/01		N.A.
OTHER COMPLEMENTARY COURSES – At most 6 credits						
Students can choose courses in the sectors MAT/*, FIS/*, INF/01 offered by Master's Degrees of the University of Trento or by Master's Degree in Mathematics of the University of Verona or in the sectors M-PED/, M-PSI/1-4, M-FIL/02,05 offered by University of Trento						
FREE CHOICE COURSES						
Students may use 3 of these CFU to get a C1 certificate of English or a B1 of French, German or Spanish or for the course Scientific Writing and Presentations in English, or to take an internship, according to the rules of the Regolamento.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU. Students who choose to take a 3 CFU internship among the free choice courses have to submit an original thesis worth 30 CFU.						

The courses marked with (*) will be offered in the academic year 2024/2025 but may not be offered in the academic year 2025/2026. The courses marked with (**) not activated (N.A.) in the academic year 2024/2025 will be activated in the academic year 2025/2026.

Appendix – Glossary

- Credit = Credito formativo universitario = CFU
  This is the European unit for measuring the value of activities such a course, an internship, or a thesis. One credit corresponds to about 7 hours of frontal lectures, and a total of 25 hours of work for the student. 120 CFU are required for a Master.
- Sector = Settore scientifico-disciplinare = SSD
  This is a nation-wide classification of University courses, sorted out in various categories. The categories (SSD) for Mathematics are the following:

SSD	Italiano	Inglese
MAT/01	Logica Matematica	Mathematical Logic
MAT/02	Algebra	Algebra
MAT/03	Geometria	Geometry
MAT/04	Matematiche complementari	Miscellanea
MAT/05	Analisi matematica	Mathematical Analysis
MAT/06	Probabilità e statistica matematica	Probability and Mathematical Statistics
MAT/07	Fisica matematica	Mathematical Physics
MAT/08	Analisi numerica	Numerical Analysis
MAT/09	Ricerca operativa	Operations Research

  For other sectors see http://www.miur.it/UserFiles/115.htm
- *Curriculum* (pl. curricula)
  Within the general framework of the Master of Science in Mathematics, it is possible to aim at gaining an in-depth knowledge and understanding of several areas of advanced Mathematics (curriculum Advanced Mathematics) or to aim more at acquiring knowledge useful for teaching and communicating mathematics and other sciences (curriculum Teaching and Scientific Communication) or to specialize in one of the curricula of Mathematics and Statistics for Life and Social Sciences or in Cryptography. Each curriculum will have different rules in the choice of courses.
- *Study plan (Piano di studi)*
  Each student of the Master of Science in Mathematics has to specify the choices he is taking among the various courses in a document with this name. They have to include a certain number, for each group of Sectors, of CFU in “caratterizzanti” (= Core) courses, and in “affini” (= Complementary) courses.
- *Track* = suggested study plan
  Examples of possible study plans centered on different aspects of mathematical studies.
- *Stage*: the Italian term (actually borrowed from French) for an internship.
- *Semester* (shortened in sem.)
  Teaching is arranged in two periods, conventionally called semesters = six months, although they last only about 14 weeks each. The first semester starts in mid-September and ends just before Christmas. The second semester lasts from mid-February to the end of May/beginning of June.
- Corso mutuato = *Mut*
  This is a course which is offered by a different Department or is a proxy for a course held in a different Department.
- N.A. = Not Available
  A course that has been active in previous years, and may well be active again in the future, but is not currently offered.