



Manifesto del Corso di Laurea Magistrale in Matematica

Approvato nel Consiglio di Dipartimento del 9 marzo 2016

1. Definitions of terms used in this document

- Laurea Magistrale in Matematica = Master of Science in Mathematics = M.Sc. in Maths
This is what this document is about.
- Laurea = Laurea Triennale
This is an Italian Bachelor's Degree, lasting three years.
- 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 credits are required for a M.Sc.
- Course type = credit type = tipo
Nation-wide Italian rules require students studying for a M.Sc. to collect a certain number of credits in various categories. Some of these categories have self-explanatory names. For instance free-choice credits (*crediti liberi*) can be taken basically arbitrarily, subject to loose rules explained below. The two more arcane categories are probably *caratterizzante* (pl. *caratterizzanti*) and *affine* (pl. *affini*). These are best defined below through explicit lists.
- Settore = Settore scientifico-disciplinare = SSD
This is a nation-wide classification of University courses, sorted out in various categories. The categories for Maths are the following:

SSD	Italiano	English
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

- *Curriculum* (pl. *curricula*)
Within the general framework of the M.Sc. 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 for Life Sciences or in Cryptography and Coding Theory. Each *curricula* will have different rules in the choice of courses: see below.

- *Piano degli studi* = *piano di studio* = *piano di studi* = study plan
Each student of the Laurea Magistrale has to spell out the choices she or he is taking among the various course on offer in a document with this name. (The plural of *piano* is *piani*).
- *Orientamento* = 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.
- *Semestre* (pl. *semestri*) = semester = sem
Teaching is arranged in two periods, conventionally called semesters = six months, although they last only about 14 weeks each. The first *semestre* starts in mid-September and ends about a week before the end of December. The second *semestre* lasts from mid-February to the end of May/beginning of June.
- MUT = *Mutuato* = Corso mutuato
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 = *Non attivato*
A course that has been active in previous years, and may well be active again in the future, but is not currently offered.

2. “Istituzione e attivazione”

The Department of Mathematics promotes the *Corso di Laurea Magistrale in Matematica* (Master of Science in Mathematics), belonging to the class “LM-40 - Matematica”. The degree is activated starting from the Academic Year 2009/10 through the insertion in the *Database of the Offerta Formativa*.

3. Instruction language

All courses of the Laurea Magistrale in Mathematics are taught in English.

4. Goals

The Master of Science in Mathematics (“Laurea Magistrale in Matematica”) is aimed at providing an in-depth knowledge and understanding of several areas of advanced Mathematics, and of its relations to other Sciences.

5. Admission requirements

To apply to the Laurea Magistrale in Matematica, 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 <http://web.unitn.it/dmath/25152/requisiti-e-domanda-di-ammissione>:

- a detailed study plan of the Bachelor's degree, including titles and syllabi of all the courses taken;
- a document issued from the University that issued the Bachelor's degree reporting, in Italian or English, the list of courses, the score obtained in each of them and the final score associated to 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 Corso di Laurea Magistrale in Matematica, and what he/she 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 at least the basic concepts of linear algebra and mathematical analysis. A certificate for a B1 level of English is also required.

In particular, formal requirements are automatically satisfied by students who possess:

- *Laurea in Matematica (classe "L-35 – Scienze matematiche")*.
- *Lauree affini*, for instance a Bachelor's Degree (Laurea) in Physics, Computer Science, Engineering or Economics, with a suitable number of credits in the *settori MAT/**.

The personal qualification is evaluated by a *Commissione*, designated by the Council of the Mathematical Department.

The *Commissione* can require a personal interview (possibly on-line) with the applicants, to better evaluate their curriculum. The interview can include questions on the main topics studied in the Bachelor's Degree; this will occur in particular if the mark obtained in the Bachelor's degree is below a given threshold. For the Academic Year 2016-17 the threshold for those that have obtained a *Laurea in Matematica (classe "L-35 – Scienze matematiche")* is set to 85/110, increased by 2 points for each year beyond the third that was needed to obtain the degree.

The student is admitted to the chosen curriculum or to a different one as defined by the commission. Some students might be required to follow a particular *piano degli studi* (study plan).

6. Piano degli studi

Students have to submit a *piano degli studi* (study plan), which satisfies the requisites for one of the four *curricula* spelled out below. Such a *piano* is subject to approval by the *Commissione Didattica di Dipartimento*. Students are not allowed to repeat activities already taken in their earlier career.

To write a proper *piano*, a total of 120 credits have to be chosen in the following categories: *caratterizzanti*, *affini* and *liberi* (see below for a short description and the following pages for a list of possible courses for each kind).

Any change of curriculum is subjected to a verification of the *Commissione* in charge for admission.

7. Crediti caratterizzanti

Depending on the *curriculum*, whose rules are spelled out below, the students have to select a certain number of *crediti caratterizzanti*, which correspond to certain core Mathematics courses in two groups of *settori*. A list of such courses is given for each *curriculum* below.

8. Crediti affini

Depending on the *curriculum*, whose rules are spelled out below, the students have to select a certain number of *crediti affini*. A list of *settori* whose credits are considered *affini* is given below. Note that all Mathematics courses are *affini*. Note also that students can take Mathematics courses at the *Laurea Magistrale in Matematica* of the *Università di Verona* as *affini* courses. Also, once the proper number of *crediti caratterizzanti* has been chosen, the student can select more *caratterizzanti* courses under the *affini* label.

9. Crediti liberi/free-choice credits

In the *piano degli studi* students can select any course offered at the University of Trento for their free-choice credits (*crediti liberi*), subject to approval by the *Commissione*

Didattica di Dipartimento. Students are required to give a detailed motivation for these choices in the *piano di studi*.

Note that further *caratterizzanti* and *affini* courses can be taken under this label. Note also that students can take Mathematics courses at the *Laurea Magistrale in Matematica* of the *Università di Verona* as *liberi* courses.

10. Language Skills

Students are required to get a B2 (or higher) certificate of English for 3 credits of *Language Skills*. Students who have already used such a certification earlier in their career may alternatively get these 3 credits by getting a course in Technical English Language (level B2 advanced) at CLA.

11. Stage/Internship and Thesis/*tesi*

Several internships at companies and institutions are available. An internship has a default credit value of 12. In this case, the thesis has a credit value of 18.

Students can otherwise choose to write a thesis for 30 credits.

Detailed information and further regulation are provided in the description of each *curriculum*.

12. “Curriculum”

The course is organized into four *curricula*:

- **Advanced Mathematics;**
- **Teaching and Scientific Communication;**
- **Mathematics for Life Sciences;**
- **Coding Theory and Criptography.**

Every students is required to formally choose one of the *curricula* and to follow the corresponding rules as stated in the Regolamento Didattico della Laurea Magistrale (<http://www.unitn.it/dmath/25156/norme-e-regolamenti>)

Within each curriculum, we propose particular study plans (called *orientamenti*) which are suggested to the students; such *orientamenti* are automatically approved. Students have the opportunity to write a personal study plan within each curriculum: such plan is subject to approval by the *Commissione Didattica*.

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);

general and algebraic topology;

geometry (topological and differentiable manifolds, basic projective geometry);

complex analysis (in one variable);

measure theory (Lebesgue measure and integration theory);

ordinary differential equations and basic examples of partial differential 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 *orientamenti* in italian:

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

“Orientamento” General Advanced Mathematics

A consistent study plan in this curriculum will adhere to the following rules:

Caratterizzanti courses:

a. at least 24 credits in the *settori* MAT/01-05 among which at least 15 credits shall be taken in the first table:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Analysis	145129	9	63	MAT/05	1	Francesco Serra Cassano
Advanced Geometry	145130	9	63	MAT/03	1	Roberto Pignatelli
Computational Algebra	145135	6	42	MAT/02	1	Willem de Graaf

other courses that can be taken as *caratterizzanti* in the *settori* MAT/01-05 are:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Mathematical Logic	145146	6	42	MAT/01	1	Stefano Baratella
Algebraic Geometry I	145131	6	42	MAT/03	1	Gianluca Occhetta
Coding Theory and Applications	145394	6	42	MAT/02	1	Massimiliano Sala
Partial Differential Equations	145393	9	63	MAT/05	2	Augusto Visintin

b. at least 15 credits in *caratterizzanti* courses of the *settori* MAT/06-09

Course	Code	CFU	Hours	SSD	Semester	Teacher
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro
Mathematical Physics	145147	9	63	MAT/07	2	Enrico Pagani
Numerical Methods for PDE	145152	6	48	MAT/08	2	Ana Maria Alonso Rodriguez

Affini courses:

At least 36 credits shall be taken from in *affini* courses, including at least 24 credits in *settori* MAT/* or FIS/* offered by the Master's Degree in Mathematics of the University of Trento or by the Master's Degree in Mathematics of the University of Verona (as set by Art. 5 of the *Regolamento*). In particular, the following courses can be taken as *affini* courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Algebraic Geometry II	145132	6	42	MAT/03	2	Luis Sola Conde
Geometric measure theory	145258	6	42	MAT/05	2	Francesco Serra Cassano
Algebraic Topology	145506	6	42	MAT/03	-	N.A.
Geometric Analysis	145563	6	42	MAT/05	1	Lorenzo Mazzieri
Model Theory	145407	6	42	MAT/01	-	N.A.
Set Theory	145156	6	42	MAT/01	2	Stefano Baratella
Type Theory	145568	6	42	INF/01	2	Roberto Zunino
Cryptography	145321	6	42	MAT/02	1	Mut. (mutuated as a part of Algebraic Cryptography – modulo Cryptography (Cod. 145441)
Topics in Mathematical Physics of Quantum Theories	145567	6	42	MAT/06	1	Romeo Brunetti
Advanced Topics in analysis	145507	6	42	MAT/05		N.A.

Further, every course offered by a Master's Degree of the University of Trento or by the Master's Degree in Mathematics of the University of Verona (as set by Art. 5 of the *Regolamento*) in the following or *settori affini* list in Tab 1 can be taken:

Tab. 1: list of settori affini	
BIO/*	Biologia
FIS/*	Fisica
ICAR/01	Idraulica
ICAR/02	Costruzioni idrauliche e marittime e idrologia
ICAR/07	Geotecnica
INF/01	Informatica
ING-IND/*	Ingegneria Industriale
ING-INF/*	Ingegneria Informatica
MAT/*	Matematica
MED/01	Statistica medica
SECS-P/*	Economia
SECS-S/*	Statistica

Corsi liberi (free courses):

Students shall choose courses for 12 credits, among all the courses offered by the University of Trento or by the Master's Degree in Mathematics of the University of Verona as stated in Art. 5 of the *Regolamento*. Such courses shall be consistent with the selected curriculum and shall not repeat contents already provided by other courses or in the Bachelor's degree.

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master Thesis. The process leading to write the thesis can be divided into one of the following ways:

- a. an original thesis, carried out with the guidance of a supervisor, which provides 30 credits;
- b. an internship / placement, which assigns 12 CFU, followed by an original thesis, carried out under the guidance of a supervisor, who provides 18 credits.

Approximately the length of the Master's Thesis (including the possible internship) is equivalent to one semester of full-time work (25 hours x 30 credits).

“Orientamento” in Advanced Algebra and Geometry

Students interested in studying topics in algebraic - geometric area can follow the following plan of studies (“orientamento” in Advanced Algebra and Geometry).

This orientamento 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.

The students of this orientamento 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, and on 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 orientamento is well suited for pursuing PHD studies in Italy or abroad, as well as for applying to international fellowships in Pure and Applied Mathematics.

Caratterizzanti courses (42 credits):

Course	Code	CFU	Hours	SSD	Semester.	Teacher
Computational Algebra	145135	6	42	MAT/02	1	Willem De Graaf
Advanced Geometry	145130	9	63	MAT/03	1	Roberto Pignatelli
Advanced Analysis	145129	9	63	MAT/05	1	Francesco Serra Cassano
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro
Mathematical Physics	145147	9	63	MAT/07	2	Enrico Pagani

Affini courses (36 credits)

Taking the following course:

Course	Code	CFU	Hours	SSD	Year/Sem.	Teacher
Advanced Commutative Algebra	145558	6	42	MAT/02	1/2	Alessandra Bernardi
Algebraic Geometry 1	145131	6	42	MAT/03	2/1	Gianluca Occhetta

Taking 4 courses from the following table:

Course	Code	CFU	Hours	SSD	Year/Sem.	Teacher
Algebraic Geometry II	145132	6	42	MAT/03	2/2	Luis Sola Conde
Homological Algebra	145565	6	42	MAT/03	2/-	N.A.
Discrete Fourier Analysis	145212	6	42	MAT/02	2/2	Giancarlo Rinaldo
Advanced Group Theory	145560	6	42	MAT/02	1/2	N.A.
Finite Fields and symmetric cryptography	145141	6	42	MAT/02	1/2	Mutuated from Algebraic Cryptography – mod. 2 - Finite Fields and Symmetric Cryptography – cod. 145441
Hodge Theory	145564	6	42	MAT/03	1/2	Claudio Fontanari
Algebraic Topology	145506	6	42	MAT/03	2/-	N.A.
Real Algebraic Geometry	145566	6	42	MAT/03	1/2	Riccardo Ghiloni
Set Theory	145156	6	42	MAT/01	1/2	Stefano Baratella
Model Theory	145407	6	42	MAT/01	2/-	N.A.
Geometric Analysis	145563	6	42	MAT/05	1	Lorenzo Mazzieri
Advanced Topics in analysis	145507	6	42	MAT/05		N.A.

Corsi liberi (free courses, up to 12 credits):

To complement the preparation in this *orientamento*, students are highly recommended to choose the free courses among the courses in settori MAT/02-03 (also from the Bachelor's degree) and, especially, Algebra Commutativa (MAT/03 – 6 CFU), Geometria Differenziale (MAT/03–6 CFU), Teoria algebrica dei numeri (MAT/02 – 6 CFU) and Teoria di Galois (MAT/02 – 6 CFU) are particularly suggested.

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master's Thesis. The process leading to write the thesis can be divided into one of the following ways:

- a. an original thesis, carried out with the guidance of a supervisor, which provides 30 credits (this is the preferred option for this study plan);
- b. an internship/placement, under the guidance of a tutor, which assigns 12 CFU, followed by an original thesis carried out under the guidance of a supervisor, which assigns 18 credits. Approximately the length of the Master's Thesis (including the possible internship) is equivalent to one semester of full-time work (25 hours x 30 credits).

“Orientamento” Calculus of Variations, Partial Differential Equations and Dynamical Systems

Students interested in studying theoretical aspects of Mathematical Analysis and some of its applications, can follow the following plan of studies (“*orientamento*” in *Calculus of Variations, Partial Differential Equations and Dynamical Systems*).

This orientamento 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 *orientamento* will have the possibility to develop a research thesis on Calculus of Variations, Analysis in abstract metric spaces, Dynamical Systems, geometrical aspects of Partial Differential Equations, nonlinear Partial Differential Equations, Optimal Control Problems, theoretical Aspects of Numerical Analysis of Partial Differential Equations.

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 *orientamento* is well suited for pursuing PHD studies in Italy or abroad, as well as for applying to international fellowships in Pure and Applied Mathematics.

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Analysis	145129	9	63	MAT/05	1	Francesco Serra Cassano
Advanced Geometry	145130	9	63	MAT/03	1	Roberto Pignatelli
Partial Differential Equations	145393	9	63	MAT/05	2	Augusto Visintin
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro
Numerical Methods for PDE	145152	6	48	MAT/08	2	Ana Maria Alonso Rodriguez

Affini courses for the orientamento: 36 CFU

Take one of the following courses

Course	Code	CFU	Hours	SSD	Semester	Teacher
Geometric Analysis	145563	6	42	MAT/05	1	Lorenzo Mazzieri
Geometric Measure Theory	145258	6	42	MAT/05	2	Francesco Serra Cassano
Advanced Topics in Analysis	145507	6	42	MAT/05		N.A.

Take 30 CFU among the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Geometric Analysis	145563	6	42	MAT/05	1	Lorenzo Mazzieri
Geometric Measure Theory	145258	6	42	MAT/05	2	Francesco Serra Cassano
Fourier Analysis	145434	6	42	MAT/05	1	Augusto Visintin
Stochastic Differential Equations	145159	6	42	MAT/06	2	Luciano Tubaro
Foundations of Analysis	145142	6	42	MAT/05	2	Fabio Bagagiolo
Hodge Theory	145564	6	42	MAT/03	2	Claudio Fontanari
Mathematical Physics	145147	9	63	MAT/07	2	Enrico Pagani
Topics in Mathematical Physics of Quantum Theories	145567	6	42	MAT/06	1	Romeo Brunetti
Advanced Topics in Analysis	145507	6	42	MAT/05		N.A.
Mathematical Control Theory	145259	6	42	MAT/05		N. A.
Advanced Functional Analysis	145559	6	42	MAT/05		N. A.
Dynamical Systems	145562	6	42	MAT/05		N. A.
Advanced Calculus of Variations	145557	6	42	MAT/05		N. A.

Corsi liberi (free courses, up to 12 credits):

To complement the preparation in this orientamento, students are highly recommended to choose the free courses among the courses in settori MAT/05 (both from Master's and Bachelor's degree), and especially, if not already taken during their Bachelor degree, Equazioni Differenziali Ordinarie (MAT/05 – 6 CFU), Calcolo delle Variazioni (MAT/05 – 6 CFU), Analisi Funzionale (MAT/05 – 6CFU). The following Bachelor course is also suggested: Geometria Differenziale (MAT/03-6CFU).

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master's Thesis. The process leading to write the thesis can be divided into one of the following ways:

- a. an original thesis, carried out with the guidance of a supervisor, which provides 30 credits (this is the preferred option for this study plan);
- b. an internship/placement, under the guidance of a tutor, which assigns 12 CFU, followed by an original thesis carried out under the guidance of a supervisor, which assigns 18 credits. Approximately the length of the Master's Thesis (including the possible internship) is equivalent to one semester of full-time work (25 hours x 30 credits).

The curriculum Mathematics for Life 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);

numerical analysis;

probability (axiomatic construction).

Some basics about partial differential equations is suggested.

Students are invited to choose between the following options, which are called *orientamenti* in Italian:

- **Statistics and data science**
- **Modelling, Statistics and Analysis of Biosystems**
- **Modelling and Simulation for Biomedical Applications**

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 *Commissione Didattica* of the Department.

“Orientamento” Statistics and data science

An introduction to modern statistical methods with particular emphasis in the analysis of high dimensional and complex data sets, taking into account the applications in various areas of environmental, biology, economics.

Caratterizzanti courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Fourier Analysis	145434	6	42	MAT/05	1	Augusto Visintin
Mathematical Biology	145145	9	63	MAT/05	1	Andrea Pugliese
Scientific computing	145427	9	72	MAT/08	2	Michael Dumbser
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro
Stochastic Differential Equations	145159	6	42	MAT/06	2	Luciano Tubaro

Affini courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Data analysis and exploration	145136	6	48	INF/01	2	Contratto
Computational Algebra	145135	6	42	MAT/02	1	Willem De Graaf
Bayesian statistics	145561	6	42	SECS-S/01	2	Claudio Agostinelli, Pierluigi Novi Inverardi
Statistical models	145333	3	24	MAT/06	1	Claudio Agostinelli

Students are encouraged to choose the other *affini* exams and the *liberi* courses in the following list. Moreover, if any course of particular interest will be activated in the University of Trento, it will be highlighted to the students during the year.

Course	Code	CFU	Hours	SSD	Semester	Teacher
Genomics	145542	12	96	BIO/11 BIO/19	2	MUT 0521H (cod. 145542)
Statistics of Stochastic Processes	145256	6	42	MAT/06	1	Claudio Agostinelli
Laboratory of biological data mining	145053	6	48	ING- INF/05	1	MUT DISI (0517H Cod. 145053)
Stochastic Differential Equations	145159	6	42	MAT/06	2	Luciano Tubaro
Big data and social networks	145449	6	36	ING- INF/05	1	(MUT DISI 0517H, 145449)
Machine learning	145062	6	48	INF/01	1	MUT DISI (0517H Cod. 145062)

Liberi courses:

Students are suggested to take the free courses among those listed before. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include appropriate courses (in Italian) from Bachelor's degree (Laurea triennale) among free-choice courses.

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

“Orientamento” Modelling, Statistics and Analysis of Biosystems

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

Caratterizzanti courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Fourier Analysis	145434	6	42	MAT/05	1	Augusto Visintin
Mathematical Biology	145145	9	63	MAT/05	1	Andrea Pugliese
Statistics of Stochastic Processes	145256	6	42	MAT/06	1	Claudio Agostinelli
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro

One among:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Numerical Methods for PDE	145152	6	48	MAT/08	2	Ana Maria Alonso Rodriguez
Scientific computing	145427	9	72	MAT/08	2	Michael Dumbser

Affini courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Statistical models	145333	3	24	MAT/06	1	Claudio Agostinelli
Data analysis and exploration	145136	6	48	INF/01	2	Contratto
Modelling and simulation of biological systems	145387	9	63	INF/01	2	Ozan Kahramanogullari
Introduction to Cell Biology	145389	9	70	BIO/13	1	Mut. DISI (0517H Cod. 145389)

One course to choose among:

Advanced Topics in biomathematics	145133	6	42	MAT/06	2	Da definire
Laboratory of biological data mining	145053	6	48	ING-INF/05	1	MUT DISI (0517H Cod. 145053)

One course to choose among the ones not chosen above or in the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Partial Differential Equations	145393	9	63	MAT/05	2	Augusto Visintin
Stochastic Differential Equations	145159	6	42	MAT/06	2	Luciano Tubaro
Mathematical aspects of bioelectromagnetism and imaging	145331	6	42	MAT/08	1	Ana Maria Alonso Rodriguez
Machine learning	145062	6	48	INF/01	1	Mut. DISI (0517H Cod. 145062)

Liberi courses:

Students are suggested to take the free courses among those listed before. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include appropriate courses (in Italian) from Bachelor's degree (Laurea triennale) among free-choice courses.

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

“Orientamento” Modelling and Simulation for Biomedical Applications

A study plan yielding competences in mathematics, scientific computation, physics, physiology, applicable to a range of disciplines in medicine, pharmaceutical industry, sanitary services

Caratterizzanti courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Fourier Analysis	145434	6	42	MAT/05	1	Augusto Visintin
Mathematical Biology	145145	9	63	MAT/05	1	Andrea Pugliese
Numerical Methods for PDE	145152	6	48	MAT/08	2	Ana Maria Alonso Rodriguez
Scientific computing	145427	9	72	MAT/08	2	Michael Dumbser
Mathematical aspects of bioelectromagnetism and imaging	145331	6	42	MAT/08	1	Ana Maria Alonso Rodriguez

Affini courses:

students shall take at least 36 credits from the exams in the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Statistical models	145333	3	24	MAT/06	1	Claudio Agostinelli
Theoretical biomechanics	145332	9	70	ICAR/01	1-2	Davide Bigoni Giorgio Rosatti
Physiological flow and transport in porous tissues	145392	6	42	ICAR/02	2	Alberto Bellin
Bio-Medical Imaging	145338	6	48	FIS/07	2	Mut. (0518H cod. 145338)
Computational haemodynamics	145428	9	72	MAT/08	1	Eleuterio Toro
Partial Differential Equations	145393	9	63	MAT/05	2	Augusto Visintin
Molecular and Cellular Biophysics	145235	6	48	BIO/10	1	Mut. (0518H cod. 145235)

Liberi courses:

Students are invited to take the free courses among those listed before; also, the following courses are strongly suggested:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Biomedical Applications of Mathematics	145429	3	21	MAT/08	1	Alberto Valli
Fisiologia molecolare	145377	6	57	BIO/09	1	Mut. (0516G cod. 145377)

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

The *curriculum* Coding Theory and Cryptography

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:

Coding theory and Cryptography

According to their own inclination, the students are free to choose between two options, which are called *orientamenti* in Italian:

- **stage-oriented**
- **research-oriented**

It remains possible for a student to choose a personal study plane, which is however subject to approval by the Department and which needs a strong motivation behind.

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.

As regards the stage-oriented programme, 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.

As regards the research oriented programme, more advanced algebra will be useful, such as fluency in Galois theory and number theory.

Stage-oriented

This *orientamento* 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 *orientamento* complements a solid algebraic background with both applied courses, such as *Cryptography* or *Coding Theory and Applications*, and practical Computer Science courses, such as Java programming (*Programmazione II*) or *Network Security*.

An internship is *mandatory* to graduate. The internship can be either *external* in a company or *internal* within the Laboratory of Cryptography on a project proposed by a company.

39 credits in *caratterizzanti* courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Computational Algebra	145135	6	42	MAT/02	1	Willem de Graaf
Coding Theory and Applications	145394	6	42	MAT/02	1	Massimiliano Sala
Algebraic Cryptography Modulo Cryptography (6 crediti) Modulo Finite Fields and Symmetric Cryptography(6 crediti)	145441	12	84	MAT/02	1 2	Massimiliano Sala Giancarlo Rinaldo
Stochastic Processes (I modulo)	145157	6	42	MAT/06	1	Mut. (mutuated as a part of Stochastic Processes (Cod. 145435)
Scientific computing	145427	9	72	MAT/08	2	Michael Dumbser

36 credits in *affini* courses:

the following course:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Programming of Cryptographic Methods	145508	6	48	INF/01	1	Andrea Visconti

and 30 credits from the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Coding Theory and Cryptography Modulo Advanced Coding Theory Modulo Advanced Cryptography	145395	12	84	MAT/02 MAT/03	1-2	Massimiliano Sala Edoardo Ballico
Formal Technique for Cryptographic Protocol Analysis	145396	6	42	INF/01	2	Roberto Zunino
Discrete Fourier Analysis	145212	6	42	MAT/02	2	Giancarlo Rinaldo
Statistics of Stochastic Processes	145256	6	42	MAT/06	1	Claudio Agostinelli
Network Security	145065	6	48	ING- INF/05	2	Mut. DISI (0517H – cod. 145065)
Computability and computational complexity	145451	6	48	MAT/01	1	Mut. DISI (0517H – cod.145451)
Security Engineering	145298	6	48	ING- INF/05	1	Mut. DISI (0517H cod. 145622)
Digital Signal Processing	145190	6	48	ING- INF/03	1	Mut. DISI (0339H cod. 145624)
Data Hiding	145192	6	48	ING- INF/03	1	Mut. DISI (0335H – cod. 140122)
Formal methods	145056	12	96	ING- NF/05	2	Mut. DISI (0517H – cod. 145056)
Advanced Natural Language Processing and Information Retrieval	145296	6	48	ING- NF/05	2	Mut. DISI (0517h – cod. 145296)

Corsi liberi (free courses):

To complement the preparation in this *orientamento*, students who have not attended courses focused on Java programming in the Bachelor's degree are highly recommended to take the course

Course	Code	CFU	Hours	SSD	Semester	Teacher
Programmazione 2	145019	6	48	INF/01	2	Mut. (DISI 0514G – Linguaggi di programmazione mod. 1 cod. 145413)

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master Thesis. The process leading to write the thesis consists of an internship / placement, which assigns 12 CFU, followed by an original thesis, carried out under the guidance of a supervisor, who provides 18 credits.

Approximately the length of the Master's Thesis (including the internship) is equivalent to one semester of full-time work (25 hours x 30 credits).

Research-oriented

This *orientamento* 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.

No internship is possible in this *orientamento*, since its students are expected to defend a research thesis presenting some original results.

39 credits in *caratterizzanti* courses:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Computational Algebra	145135	6	42	MAT/02	1	Willem de Graaf
Coding Theory and Applications	145394	6	42	MAT/02	1	Massimiliano Sala
Algebraic Cryptography Modulo Cryptography (6 credits) Modulo Finite Fields and Symmetric Cryptography(6 credits)	145441	12	84	MAT/02	1 2	Massimiliano Sala Giancarlo Rinaldo
Stochastic Processes	145435	9	63	MAT/06	1	Luciano Tubaro
Statistics of Stochastic Processes	145256	6	42	MAT/06	1	Claudio Agostinelli

36 credits in *affini* courses, taking all the courses in the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Coding Theory and Cryptography Modulo Advanced Coding Theory Modulo Advanced Cryptography	145395	12	84	MAT/02 MAT/03	1-2	Massimiliano Sala Edoardo Ballico
Discrete Fourier Analysis	145212	6	42	MAT/02	2	Giancarlo Rinaldo
Algebraic Geometry I	145131	6	42	MAT/03	1	Gianluca Occhetta
Formal Techniques for Cryptographic Protocol Analysis	145396	6	42	INF/01	2	Roberto Zunino

The remaining credits can be taken from courses in *settori* MAT/* offered by the Department of Mathematics of the University of Trento.

Corsi liberi (free courses):

To complement the preparation in this *orientamento*, students are **highly recommended** to choose the free courses among the courses in *settori* MAT/02-03 (also from the Bachelor's degree) and, especially, Algebra Commutativa (MAT/03 – 6 CFU), Teoria algebrica dei numeri (MAT/02 – 6 CFU) and Teoria di Galois (MAT/02 – 6 CFU) are particularly suggested.

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master Thesis. The process leading to write the thesis consists of an internship / placement, which assigns 12 CFU, followed by an original thesis, carried out under the guidance of a supervisor, who provides 18 credits.

Approximately the length of the Master's Thesis (including the internship) is equivalent to one semester of full-time work (25 hours x 30 credits).

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),
general and algebraic topology,
geometry (topological and differentiable manifolds, basic projective geometry),
physics (mechanics, thermodynamics, electromagnetism),
measure theory (Lebesgue measure and integration theory),
ordinary differential equations,
informatics,
classical foundations of mathematical physics,
probability (including the axiomatic construction) and statistics.

A consistent study plan in this curriculum will adhere to the following rules:

Caratterizzanti courses:

30 credits in the *settori* MAT/01-05, among which at least 18 credits in the following list

Course	Code	CFU	Hours	SSD	Semester	Teacher
Foundations of Analysis	145142	6	42	MAT/05	2	Fabio Bagagiolo
Foundations of Geometry	145253	6	42	MAT/03	2	Gianluca Occhetta
Elementary Mathematics from a higher Viewpoint I	145149	6	42	MAT/04	1	Claudio Fontanari
Elementary Mathematics from a higher Viewpoint II	145150	6	42	MAT/04		N.A.
Laboratory of Didactics of Mathematic	145144	6	42	MAT/04	2	Silvano Delladio
Experimental Mathematics Laboratory at School Level	145154	6	42	MAT/04		N.A.

The remaining credits shall be taken from the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Advanced Analysis	145129	9	63	MAT/05	1	Francesco Serra Cassano
Advanced Geometry	145130	9	63	MAT/03	1	Roberto Pignatelli
Algebraic Geometry I	145131	6	42	MAT/03	1	Gianluca Occhetta
Computational Algebra	145135	6	42	MAT/02	1	Willem de Graaf
Mathematical Logic	145146	6	42	MAT/01	1	Stefano Baratella
Mathematical Biology	145145	9	63	MAT/05	1	Andrea Pugliese

The following course is mandatory:

Course	Code	CFU	Hours	SSD	Semester.	Teacher
Mathematical models for the Physical, Natural and Social Sciences	145151	6	42	MAT/06	1	Stefano Bonaccorsi

36 credits in *affini* courses:

The following course is mandatory:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Modern Physics	145155	12	84	FIS/08	1	Stefano Oss

at least 12 credits from the following list:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Experimental Physics Laboratory at High School Level I	145153	6	56	FIS/08	1	Pasquale Onorato
Experimental Physics Laboratory at High School Level II	145215	6	56	FIS/08	2	Mut. (Fisica 0518H cod. 145537)
Didactics of Computer Science	145211	6	42	INF/01	1	Luisa Mich

The remaining credits can be taken from courses in *settori* MAT/* or FIS/* offered by the University of Trento or by the Master's Degree in Mathematics of the University of Verona (as set by Art. 5 of the *Regolamento*) or in *settori affini* listed in Tab. 2 above or in the following additional areas:

Tab. 2: list of further settori affini for the curriculum Teaching and scientific communication	
M-FIL/02	Logica e filosofia della scienza
M-FIL/05	Filosofia e teoria dei linguaggi
M-PED/01	Pedagogia generale e sociale
M-PED/02	Storia della pedagogia
M-PED/03	Didattica e pedagogia speciale
M-PED/04	Pedagogia sperimentale
M-PSI/01	Psicologia generale
M-PSI/02	Psicobiologia e psicologia fisiologica
M-PSI/03	Psicometria
M-PSI/04	Psicologia dello sviluppo e psicologia dell'educazione

Corsi liberi (free courses):

Students shall choose courses for 15 credits, among all the courses offered by the University of Trento or by the Master's Degree in Mathematics of the University of Verona as stated in Art. 5 of the *Regolamento*. Such courses shall be consistent with the selected curriculum and shall not repeat contents already provided by other courses or in the Bachelor's degree.

The following course is particularly suggested:

Course	Code	CFU	Hours	SSD	Semester	Teacher
Storia della filosofia I	130023	12	60	M-FIL/06	2	Mut. (Lett. e Fil. 0416G – cod. 130023)

Language skills:

3 credits, as ruled out by the *Regolamento* and specified above.

Thesis and stage:

The course of studies is concluded with the discussion of a Master Thesis. The process leading to write the thesis can be divided into one of the following ways:

- a. an original thesis, carried out with the guidance of a supervisor, which provides 30 credits;
- b. an internship / placement, which assigns 12 CFU, followed by an original thesis, carried out under the guidance of a supervisor, who provides 18 credits.

Approximately the length of the Master's Thesis (including the possible internship) is equivalent to one semester of full-time work (25 hours x 30 credits).