DEGREES IN MATHEMATICS A.A. 2015/2016

Extract from the Bulletin (Notiziario) (*)

I Semester: 1 October 2015 - 13 January 2016
II Semester: 1 March - 6 June 2016

(*) Available to the address
http://www.dmi.unipg.it/MatematicaNotiziario

NOTES

The 3+2 degree courses give a Bachelor degree (or, a first level degree) after 3 years, and a Master degree (or, a second level degree) after a further 2 years.

1 CFU=1 ECTS is earned by attending 7 hours of lectures (12 hours in case of Laboratory).

Almost all lectures of the bachelor degree are held in Italian language with exception of some of them that may be held completely or partially in English language, in agreement with the enrolled students (recommended level of language skills: B1). Some lectures of the master degree (title in English) are completely held in English language (recommended level of language skills: B2).(**)

For several courses, examinations can be performed in English on request.

Attendance of the lectures is warmly recommended (***).

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(**) An Italian Language course, free of charge, will be offered by the Universitá degli Studi di Perugia to Erasmus Students who will be attending courses at our University during the academic year 2015/2016, in two periods, September 2015 and February 2016.......continue to the address:

http://cla.unipg.it/corsi-di-lingua/corsi-erasmus/31-erasmus-incoming.html

(***) The training offer for the Bachelor and the Master Degrees in Mathematics is also available to the address:
http://www.unipg.it/en/courses

AA 2015-2016 Courses at the first level (Bachelor): Mathematics

Name	Area of int.(SDS)	ECTS	Year/Sem.	Lecturer
ALGEBRA I (Algebra I)	MAT/02	6	1 / I	M. BURATTI
ALGEBRA II (Algebra II)	MAT/02	9	1 / II	A. LORENZINI
ANALISI MATEMATICA I (Mathematical Analysis I)	MAT/05	9	1 / I	P. BRANDI
ANALISI MATEMATICA II (Mathematical Analysis II)	MAT/05	9	2 / I	T. CARDINALI
ANALISI MATEMATICA III (Mathematical Analysis III)	MAT/05	9	2 / II	R. FILIPPUCCI
ANALISI MATEMATICA IV (Mathematical Analysis IV)	MAT/05	9	3 / I	P. PUCCI
ANALISI NUMERICA (Numerical Analysis)	MAT/08	9	3 / II	B. IANNAZZO
CALCOLO DELLE PROBABILITÀ (Probability)	MAT/06	6	Free / II	A. CAPOTORTI
FISICA I (Physics I)	FIS/01	9	1 / II	M. PLAZANET
FISICA II (Physics II)	FIS/01	9	2 / II	C. CECCHI
FISICA MATEMATICA 1 (Mathematical Physics 1)	MAT/07	6	3 / II	M.C. SALVATORI
GEOMETRIA I (Geometry I)	MAT/03	9	1 / I	R. VINCENTI
GEOMETRIA II (Geometry II)	MAT/03	9	1 / II	A. CATERINO
GEOMETRIA III (Geometry III)	MAT/03	9	2 / I	L. GUERRA
GEOMETRIA IV (Geometry IV)	MAT/03	9	3 / I	N. CICCOLI
INFORMATICA I (Computer Science I)	INF/01	6	1 / II	M. BAIOLETTI
INFORMATICA II (Computer Science II)	ING–INF/05	9	2 / I	R. SANTINI
MECCANICA RAZIONALE I (Rational Mechanics I)	MAT/07	9	3 / I	M.C. NUCCI

Name	Area of int.(SDS)	ECTS	Year/Sem.	Lecturer
METODI MATEMATICI PER L'ECONOMIA (Mathematical Methods for Economics)	MAT/05	6	Free / I	P. BRANDI
PROBABILITÀ E STATISTICA I - Modulo 1 e 2 (Probability and Statistics - part 1 and 2)	MAT/06	12(6+6)	2 / II	G. COLETTI A. CAPOTORTI
STORIA DELLE MATEMATICHE I (History of Mathematics)	MAT/04	6	Free / II	M.C. NUCCI
TOPOLOGIA I (Topology I)	MAT/03	6	Free / II	L. STRAMACCIA

AA 2015-2016 Courses[1] at the second level (Master): Mathematics

Name	Engl.	Area of int.(SDS)	ECTS	Year/Sem.	Lecturer
ADVANCED ANALYSIS	+	MAT/05	6	2 / I	D. MUGNAI
ALGEBRA III (Algebra III)		MAT/02	6	1 / I	A. LORENZINI
ANALISI DI METODI NUMERICI (Analysis of numerical Methods)		MAT/08	6	1 / I	I. GERACE
ANALISI MATEMATICA V (Mathematical Analysis V)		MAT/05	9	1 / II	P. PUCCI
ANALISI MATEMATICA VI (Mathematical Analysis VI)		MAT/05	9	2 / I	E. VITILLARO
CODES AND CRYPTOGRAPHY	+	MAT/03	6	1 / I	M. GIULIETTI
COMBINATORICS II	+	MAT/03	6	1 / II	R. VINCENTI
EQUAZIONI DIFFERENZIALI (Differential Equations)		MAT/05	6	1 / II	T. CARDINALI
FISICA MATEMATICA II (Mathematical Physics II)		MAT/07	5+1[2]	1 / I	S. DE LILLO
FONDAMENTI DI GEOMETRIA (Fundamentals of Geometry)		MAT/03	6	1 / II	P. ZAPPA

[1]Those marked with a + in the Engl.column are held in English.
[2]This credit is equivalent to 12 hours laboratory.

Name	Engl.	Area of int.(SDS)	ECTS	Year/Sem.	Lecturer
GEOMETRIA V (Geometry V)		MAT/03	9	1 / II	A. TANCREDI
GEOMETRIA VI (Geometry VI)		MAT/03	9	2 / I	A. TANCREDI
MATEMATICHE COMPLEMENTARI (Complementary Mathematics)		MAT/04	6	1 / II	G. FAINA
MATHEMATICAL METHODS FOR STOCHASTIC PROCESSES	+	MAT/05	6	Free/ I	D. CANDELORO
MATHEMATICAL MODELS FOR FINANCE	+	MAT/06	6	1 / II	A. CRETAROLA
MATHEMATICAL PHYSICS III	+	MAT/07	6	2 / I	M.C. NUCCI
METODI GEOMETRICI IN TEORIA DELLA RELATIVITÀ (Geometric Methods in the Theory of Relativity)		MAT/03	6	Free/ I	M. MAMONE CAPRIA
MODELLI GEOMETRICI (Geometric Models)		MAT/03	6	Free/ I	E. UGHI
MODERN PHYSICS	+	FIS/03	6	2 / I	M.M. BUSSO
PHYSICS EXPERIMENTS	+	FIS/01	6	Free / I	M. MADAMI
TEORIA DELLE DECISIONI (Decision Theory)		MAT/06	6	Free / I	G. PETTURITI

Bachelor Teaching Plan 2015-16

I Year – I Semester	I Year – II Semester
Algebra I – Mat/02 – 6 ECTS – 42 hours	**Algebra II** – Mat/02 – 9 ECTS – 63 hours
Mathematical Analysis I – Mat/05 – 9 ECTS – 63 hours	**Physics I** – Fis/01 – 9 ECTS – 63 hours
Geometry I – Mat/03 – 9 ECTS – 63 hours	**Geometry II** – Mat/03 – 9 ECTS – 63 hours
English - B1 Level – L-Lin/12 – 3 ECTS	**Computer Science I** – Inf/01 – 6 ECTS – 42 hours

II Year – I Semester	II Year – II Semester
Mathematical Analysis II – Mat/05 – 9 ECTS – 63 hours	**Mathematical Analysis III** – Mat/05 – 9 ECTS – 63 hours
Geometry III – Mat/03 – 9 ECTS – 63 hours	**Physics II** – Fis/01 – 9 ECTS – 63 hours
Computer Science II – Ing–Inf/05 – 9 ECTS – 63 hours	**Probability and Statistics I** – Mat/06 – 12 ECTS – 84 hours
Further Linguistic Notions – 3 ECTS English – B2 Level , **or** an other European language – B1 Level	

III Year – I Semester	III Year – II Semester
Mathematical Analysis IV – Mat/05 – 9 ECTS – 63 hours	**Numerical Analysis** – Mat/08 – 9 ECTS – 63 hours
Geometry IV – Mat/03 – 9 ECTS – 63 hours	**Mathematical Physics I** – Mat/07 – 6 ECTS – 42 hours
Rational Mechanics I – Mat/07 – 9 ECTS – 63 hours	**One course chosen by the student** – 6 ECTS
One course chosen by the student – 6 ECTS	**Bachelor Thesis** – 6 ECTS

Master Teaching Plan 2015-16

I Year – I Semester	I Year – II Semester
Algebra III – Mat/02 – 6 ECTS – 42 hours	**Mathematical Analysis V** – Mat/05 – 9 ECTS – 63 hours
Mathematical Physics II – Mat/07 – 5+1 ECTS – 47 hours	**Geometry V** – Mat/03 – 9 ECTS – 63 hours
3 courses chosen among **GROUP A:** **Advanced Analysis** – Mat/05 or **Analysis of numerical Methods** – Mat/08 or **Codes and Cryptography** – Mat/03 or **Mathematical Methods for Stochastic Processes** – Mat/05 or **Mathematical Physics III** – Mat/07 or **Geometric Methods in the Theory of Relativity**– Mat/03 or **Mathematical Methods for Economics** – Mat/05 or **Geometric Models** – Mat/03 or **Modern Physics** – Fis/03 or **Physics Experiments** – Fis/01 or **Decision Theory** – Mat/06 6 ECTS – 42 hours	1 course chosen among **GROUP B:** **Probability** – Mat/06 or **Combinatorics II** – Mat/03 or **Differential Equations** – Mat/05 or **Fundamentals of Geometry** – Mat/03 or **Complementary Mathematics** – Mat/04 or **Mathematical Models for Finance** – Mat/06 or **History of Mathematics I** – Mat/04 or **Topology I** – Mat/03 6 ECTS – 42 hours **One course chosen by the student** – 6 ECTS

II Year – I Semester	II Year – II Semester
Mathematical Analysis VI – Mat/05 – 9 ECTS – 63 hours	**Further Learning Activities** – 3 ECTS *Further notions aimed at job placement*
Geometry VI – Mat/03 – 9 ECTS – 63 hours 1 course chosen among **GROUP A** **One course chosen by the student** – 6 ECTS	**Master Thesis** – 27 ECTS

Courses details

NOTES FOR EACH COURSE LISTED BELOW

- the order is in the English title and divided per degree
- the year suggests the year of the bachelor degree or of the master degree
- the semester states in which of the two semesters of the year the course is held
- the sector indicates the code of the scientific area of the content
- the prerequisites suggest pre-course requirements
- the hours are the total number of hours of lessons in the semester in lecture-hall, inclusive of practice, laboratory
- 1 ECTS of theoretical lessons is equivalent to 1 CFU (Crediti Formativi Universitari) that consists of 7 hours in lecture-hall plus 18 hours of individual study, respectively.

Links to further information:
http://www.dmi.unipg.it/Matematica
Office hours: http://www.dmi.unipg.it/MatematicaOrarioRicevimento

BACHELOR DEGREE

ALGEBRA I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/02 **Year**: 1 **Semester**: 1

Lecturer	BURATTI Marco
Prerequisites	Nothing
Content	Classical numerical sets: N, Z, Q and R. Proofs ab absurdo and proofs by induction. The square root of a prime number is not rational. The set C of complex numbers. Sum and product of complex numbers. Conjugate complex numbers. Reciprocate of a complex number. Cartesian and trigonometric representation of a complex number. Modulus and argument of a complex number. De Moivre formula. n-th roots of unity in the complex field. Fundamental Theorem of Algebra (without proof). Every algebraic equation of odd degree with real coefficients admits at least one real solution. Elementary operations between sets. Cartesian product. The power-set of a set. The power-set of a set of size n has size 2^n. Binomail coefficients. Tartaglia-Pascal triangle. Applications. Injective, Surjective and Bijective applications. Relations. Order realtions and equivalence relations. Quotient set. Countable sets. Cantor theorem about the coutability of Q. The power-set of a set X has cardinality strictly greater than the cardinality of X. R is not countable. Prime integers. Euclidean division. Euclid algorithm for determining the greatest common divisor between two integers. Bezout identity. Euclid lemma: if a prime p divides the product of two integers, then p divdes at leat one of them. The Fundamental Theorem of Arithmetic. Euclid theorem on the existence of inifinitely many primes. Congruences. Elementary properties. Congruence equations of the first degree. Diophantine equations. Chinese Remainder Theorem. Criterions for divisibility by 3, 4, 9, 11. Little Fermat Theorem. Euler Phi function. Calculation of phi(n). Euler Theorem. Wilson Theorem. The congruence $x^2 = -1 (mod p)$ with p an odd prime has a solution if and only if p=1 (mod 4). The Diophantine equation $x^2 + y^2 = n$. Pithagorean triples. Algebraic structures. Semigroups, Monoids, Groups. Some examples of abelian and non-abelian groups. The group of nxn invertible matrices. The symmetric group S_n. The Boolean group of the power-set of a set X. Subgroups. Criterion fro establishing whether a subset S of a group G is a subgroup of G. Order o(x) of an elemet x of a group G. The subgroup generated by x. If o(x)=n, then x^h has order n/MCD(n,h). For every element x of a multiplicative group G of order n, we have $x^n = 1$. Right and left cosets of a subgroup. Lagrange Theorem. Definitions of ring and field. Examples of rings and fields.

Learning goals	The basics about the modern mathematical language: sets, applications, relations, finite and transfinite cardinal numbers etc. The development of a mathematical theory starting from the axioms. The construction of the main numerical sets. First examples of algebraic structures obtained by quotienting. The rings of residue classes modulo an integer.
Textbooks	Dikranjan-Lucido, *Aritmetica e Algebra* , Liguori (2007) I. N. Herstein, Abstract Algebra (third edition). Wiley, 1996.
Lecture type	Frontal lectures. All theoretical results will be rigorously proved and many related exercises will be proposed.
Examination description	Twenty/thirty minuets of oral examination during which some possible exercises will be proposed.
Language	Italian

ALGEBRA II

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/02 **Year**: 1 **Semester**: 2

Lecturer	LORENZINI Anna
Prerequisites	Good knowledge of the topics from Algebra I, independently of having passed that exam. In particular, it is necessary to be rather familiar with the properties of natural numbers, of integer numbers (euclidean division included) and residue classes, with the main properties of functions and their invertibility, of relations and cardinalities, both finite (including basic combintorics) and infinite.
Content	Algebraic structures. Permutations. Omomorphisms. Direct products. Normality and conjugates. Cuachy theorem and Sylow theory. Fundamental theorem of omomorphisms for groups and rings. Prime and maximal ideals. Euclidean, principal and factorial rings. Characteristic of rings and fields. Polynomial rings. Ring and field extensions.
Learning goals	Mathematical comprehension and capability to connect the various subject of the course and to solve the proposed exercizes.
Textbooks	Dikranjan-Lucido, Aritmetica e algebra, Liguori (2007) Herstein, Topics in ALgebra, Wiley (1975)
Lecture type	face to face
Examination description	Written and oral examination. It is possible to be exonerated from the written final exam by obtaining at least 15/30 in three mid term tests. In the first summer session it is possible to retrive one of the mid-term tests in case one mark was not sufficient or not satisfactory or in case of absence. All the written (including mid-term) tests last two hours and consist in solving three problems which can be small part of theory and are usefull to control the level of understanding of the topics treated and the capability to connect them. The oral examination, lasting 45-60 minutes, tends to confirm the level of understanding of the topics treated and of critic study and personal rethinking.
Language	Italian
Note	Upon request, both the written test and the oral examination are given in English

GEOMETRY I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 1

Lecturer	VINCENTI Rita
Prerequisites	Elementary Maths for higher education.
Content	Elementary affine geometry. Vector spaces over a field K. The space $\mathbb{R}^n$, the space of real functions, real matrices, polynomials. Linear systems over R. Linear applications. Geometry of the affine real plane and of the 3-dimensional real space. Affine spaces. Frames of references. Groups of affinities.
Learning goals	Sufficient at 70%. The principal target consists in giving to a student a basis to face the study of the affine geometry of the real plane and of the real space by means of linear algebra. The main knowledge a student will gain in: foundation elements of algebra (groups, rings, fields), of linear algebra (vector spaces over a field, on the real field, models, spaces of matrices, of polynomials), basic theorems (characterization, on dimension), linear systems (rank, determinant), representation via linear applications. The main skills will be to be able to solve problems on any vector space of finite dimension and in the range of affine geometry (with vector space as back up) to find solutions of incidence problems in the plane and in the space.
Textbooks	A. BASILE, Algebra lineare e geometria cartesiana, Margiacchi-Galeno Editore, Perugia, 1997. M.STOKA-V.PIPITONE, Esercizi e problemi di geometria, Vol.I, Cedam, Padova, 1995 K.W. Gruenberg and A.J. Weir, Linear Geometry. GTM, Springer-Verlag, New York, 1977. Notes will be supplied by the lecturer.
Lecture type	Lessons in classroom with notes online (http://estudium.unipg.it/matematica/), continuous relations with the students, presence of a tutor, support with further didactic activities.
Examination description	An early first writing/test is organized, then during the semester at least two writings in room at free attendance. Each writing consists of 3 problems on the topics taught till then. Normally easy computations, but a clear and a comprehensive exposition of the procedure is requested. If both positive, the two writings can be used to partially or totally exonerate the exam. The examination consists of a writing (3 problems on vector space, affine plane, affine space) and an oral test (if the writing is sufficient) to increase both the calculus and abstraction capacity, and to give everybody chance to express his own possibilities.. A student can repeat eventually the exam at each session. A positive writing holds till the oral test, in any case within the reference session. However the last positive writing is the unique to be considered. For every writing 2 hours are available. An oral test goes on for at least 20 minutes and may be opened with a theme freely chosen by the student. For the Erasmus incoming students only a writing examination with the text in English (if required) is considered.

Language	Italian
Note	To the address http://estudium.unipg.it/matematica–>Insegnamenti–>Geometria 1, under the heading Risorse per l'anno accademico 2015/2016 there are pdf files with all the writings assigned during the past academic year. Moreover there will be online all the notes in English prepared by the docent on all the topics of the programm that will be reworked for the new academic year and put again online at the right time under the heading Risorse per l'anno accademico 2015/2016. For a positive training of the course Geometry I it needs a continuous interaction between docent and students who are warmly invited to actively participate in classroom and attend to each of the scheduled activities (lessons, exercises, training, tests, tutor assistance) and extra during the time the professor will dedicate to receive students. NOTE: the lectures might be held in English in agreement with the enrolled students. The exams can be held in English on request

GEOMETRY II

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 2

Lecturer	CATERINO Alessandro
Prerequisites	In order to be able to understand and reach the objectives of the course of Geometria II, it is important that the students have successfully passed the exam of Geometria I. In particular basic topics, such as : vector spaces, linear maps and matrices, affine spaces, parametric and cartesian equations of affine subspaces, are required.
Content	Eigenvalues and eigenvectors. Diagonalization. Bilinear forms. Quadratic forms. Euclidean vector spaces. Euclidean affine spaces. Orthogonal operators, symmetric operators and the spectral theorem. Topological and metric spaces. Continuous functions. Connected and compact spaces.
Learning goals	Knowledge and ability on bilinear and quadratic forms, euclidean spaces and basic elements of Topology.
Textbooks	E. SERNESI, Geometria 1, Boringhieri, 1992 M. STOKA-V.PIPITONE, Esercizi e problemi di geometria, Vol.I, Cedam, Padova, 1995. LIPSCHUTZ, LIPSON, Linear Algebra, Schaum's Outlines, 2013.
Lecture type	The course is organized as follows: face-to-face lessons on all the topics of the course and practical training usueful to prepare the students for the written test. It is planned a tutor teaching activity.
Examination description	The exam consists of a written test (or two progress assessments) and a final oral exam. The written exam requires the solution of three problems (eigenvectors and diagonalization of matrices, reduction to canonical form of quadratic forms, Euclidean affine spaces, topology) and it has a duration of 2 hours and a half. Its objectives are to evaluate the resolutive capacity of the problems and the proper use of acquired knowledge. The oral exam consists of a talk of about 40 minutes. It is aimed at testing the degree of comprehension the students have reached, expositive skills and capacity of finding connections between the topics studied. If it is required, the exam can be taken in English.
Language	Italian

GEOMETRY III

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 2 **Semester**: 1

Lecturer	GUERRA Lucio
Prerequisites	Nothing
Content	Projective geometry, extending affine geometry. The linear projective group. The axiomatic theory of projective spaces. Quadratic polynomials, quadric curves and surfaces, affine and projective.
Learning goals	Basic knowledge of projective geometry and quadratic geometry.
Textbooks	E. Sernesi, Geometria 1, Bollati-Boringhieri, 2000.
Lecture type	lectures
Examination description	written and oral exam
Language	Italian

GEOMETRY IV

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 3 **Semester**: 1

Lecturer	CICCOLI Nicola
Prerequisites	It is unlikely that the students can profit from following this course without a solid background in multivariable calculus (comprehensive of existence and uniqueness theorems for ordinary differential equations) and linear algebra. A good background in affine geometry, elementary metric topology and some general basic algebraic concepts would be of help.
Content	Basic topology theory as needed in the course: topological spaces and continuous maps. Local theory of differentiable parametrized curves. Arclength, Frènet's frame, curvature and torsion. Reconstrcution problems. Hints on global problems. Locale theory of parametrized surfaces in $\mathbb{R}^3$. Differentiable functions, tangent space. First and second fundamental forms. Curvatures: principal, normal, mean, Gaussian. Manifolds and submanifolds. Charts, orientability. Hints on global properties.
Learning goals	Being capable of computing the main geometric invariants of curves and surfaces, and reconstrucitng parametric equations of curves and surfaces satisfying suitable conditions.
Textbooks	E. SERNESI, Geometria 2, Bollati Boringhieri, 1994. M. ABATE, F. TOVENA, Curve e superfici, Springer, 2006. M. LIPSCHULTZ, Schaum's outlines, Differential Geometry, McGraw&Hill, 1969. M. P. DO CARMO, Di erential Geometry of curves and surfaces, Pearson, 1976.
Lecture type	Face to face lectures covering all topics in the program.
Examination description	Written exam (<3h) with open answer questions. This is aimed at verifying the student ability in computing explicitely differential geometric invariants. Oral exam (approx. 45 minutes) aimed at verifying comprehension of proofs, quality of mathematical exposition, capability of making connections between different parts of the program. Progress assessments may be available.
Language	Italian
Note	The lectures might be held in English in agreement with the enrolled students. The exams can be held in English on request.

HISTORY OF MATHEMATICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/04 **Year**: 1 **Semester**: 2

Lecturer	NUCCI Maria Clara
Prerequisites	Nothing
Content	Ancient Mathematics. The Beginnings of Mathematics in Greece. Mathematical Methods in Hellenistic Times. The Final Chapters of Greek Mathematics. The Mathematics of Islam. Mathematics in Medieval Europe (brief introduction).
Learning goals	The student shall learn the importance of the history of mathematics in order to teach mathematics effectively
Textbooks	C.B. Boyer and U. C. Merzbach, A History of Mathematics, II ed., Wiley, 1991. J. Katz, A History of Mathematics, III ed., Addison Wesley, 2008. J. Fauvel, J. Gray (ed.), The History of Mathematics - A Reader, MacMillan Press, 1987. A. Demattè, Fare matematica con i documenti storici, IPRASE Trentino, 2006. The lecturer will supply copies of the original works (or their translations), papers from the American Mathematical Monthly, Archive of History of Exact Sciences, Bolletino di Storia delle Scienze Matematiche, Bullettino di Bibliografia e Storia delle Scienze Matematiche e Fisiche, Centaurus, Endeavour, Historia Mathematica, ISIS, Mathematics Teacher, Scripta Mathematica.
Lecture type	lectures
Examination description	Oral exam
Language	Italian

INFORMATICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: INF/01 **Year**: 1 **Semester**: 2

Lecturer	BAIOLETTI Marco
Prerequisites	None
Content	Introduction to the basic concepts of computer science. Computer organization. Operating systems. Information representation. Application software for mathematics. Introduction to algorithmics and programming.Algorithms and their properties. Algorithms and programs. Programming and tools for programming. Computational cost. Python Programming language and Numpy/Scipy libraries. Variables, expressions and assignment. Function definition and parameters. Conditional and iterative instructions. Vectors and matrices. Recursion. Bidimensional graphics. Symbolic computation.
Learning goals	This course represents the first course of Computer Science and examines the basic concept of computer science The main purpose of this course is to provide to the students the tools and knowledge needed for an advanced use of computers, mainly in a scientific environment. Main knowledge acquired will be: basic elements of hardware and software architectures; computational problems and algorithms; basic elements of computer programming; some advanced aspect of computer programming (recursion, bidimensional graphics). Main competence will be: computational problem solving; being able to write small programs in Python; being able to use Python and Numpy/Scipy/Sympy libraries as a scientific toolkit.
Textbooks	class notes provided by the teacher; e-book `http://www.openbookproject.net/thinkcs/python/english2e/`
Lecture type	The course is organized as follows: Lectures on all the subjects of the course; Exercices at the class for solving programming problems in Python; Exercices at the computer lab for solving programming problems in Python.
Examination description	The exam is divided in two tests. A first practical/written test (with maximum duration of 2 hours) where it is required solve with the computer some programming exercises in Python, concerning the programming aspects indicated in the program. The purpose of this test is ascertain the capabilities of problem solving and writing Python code acquired by the student.; A second oral test (with duration of about 30 minutes) concerning all the concepts indicated in the program: more in detail, it is required to solve a programming problem in Python, then the student will be asked to describe some theoretical topics seen in the course. The purpose of this test is to ascertain the knowledge level, understanding capabilities and communication skills acquired by the student. Students who do not speak italian can do the exam in french or english.
Language	Italian

INFORMATICS II

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: ING-INF/05 **Year**: 2 **Semester**: 1

Lecturer	SANTINI Francesco
Prerequisites	Nothing
Content	An imperative language: data types and control structures, procedures and functions, recursion, pointers and dynamic variables.Algorithms: language for describing algorithms, analysis of algorithms.Abstract data types: specific, representation . lists, binary trees, hash tables, binary search trees, graphs. Divide et impera, dynamic programming, greedy.
Learning goals	management and implementation of the various data structure
Textbooks	A.Bertossi,A.Montresor:Algoritmi e strutture di dati, Citta'Studi edizioni
Lecture type	face-to-face Practical training Theoretical lessons and practical training
Examination description	written exam, oral exam
Language	Italian

MATHEMATICAL ANALYSIS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 1

Lecturer	BRANDI Primo
Prerequisites	Mathematical Analysis 1 is a challenging and intensive course (CFU 9 - 13 weeks). In order to follow the lessons in a profitable way, it is essential to have a good preparation on the basic knowledge base (see below). Basic knowledge. Order relation. Algebra of polynomials. Elements of analytic geometry. Elements of goniometry and trigonometry. Elementary functions and their inverse or partial inverse. Transformations of a function (translation and rescaling) and effect on the graph. Elementary equations and inequalities. Logic elements (conjunctions and, or, not, De Morgan's laws).
Content	Order structure in R. Maximum and minimum of a set. Dedekind's extension (upper and lower bound). Sequences. Induction principle. Topological structure of R and extended R. Concept of limit; basic properties. Indeterminate forms and fundamental limits. Infinite and infinitesimal. Continuity and uniform continuity. Conservation of compactness. Weierstrass Theorem. Conservation of connection. Intermediate value theorem. The derivative. Differentiable functions: local and global properties (Fermat, Rolle, Lagrange, Cauchy, Hospital). Higher order derivatives. Linearization methods. Polynomial approximation. Qualitative study of the graph of a function. Optimization problems. The Riemann integral. Antiderivatives. Torricelli-Barrow theorem. Darboux theorem. Integral function. Integration's techniques. Generalized integrals and numerical series. Convergence criteria for numerical series. Taylor series. Asymptotic expansions.
Learning goals	The course has the role of introducing students to the structures the demonstrative processes and the argumentative tools of the discipline. The student will have acquired basic knowledge of Mathematical Analysis for functions of one variable, a good ability to conjecture, argue and prove. He will have also acquired basic skills on elementary modeling
Textbooks	P.Brandi - A.Salvadori, Prima di iniziare, Aguaplano Officina del Libro (2015) - [reference text for basic knowledge] P. Brandi A. Salvadori, Percorsi di Analisi Matematica, Dispense online (2015) (textbook) William F. Trench, Andrew G. Cowles, Introduction to real analysis, Department of Mathematics Trinity University, San Antonio, Texas, USA, `http://ramanujan.math.trinity.edu/wtrench/texts/TRENCH_REAL_ANALYSIS.PDF` Vladimir A. Zorich, Mathematical Analysis I, Moscow State University, Universitext, Springer http://math.univ-lyon1.fr/ okra/2011-MathIV/Zorich1.pdf G.C. Barozzi G.Dore E. Obrecht, Elementi di analisi matematica, Zanichelli Ed. (2011) E. Acerbi G. Buttazzo, Analisi Matematica ABC, Pitagora Ed. Bologna (2003)

Lecture type	The exam includes a written test and an oral interview. Written test (2 hours) - Type: resolution of some open questions; It is allowed the use of textbooks, manuals, graphic-symbolic calculators (strictly off-line); - Aim: to assess the knowledge, skills and expertise in arguing, conjecturing and demonstrating. It will be particularly appreciated not only the correctness of the procedures, but also the quality of the arguments used to support the answers. Interview (30-45 minutes) Aim: to assess the communication skills of the student, and the skill in organizing the exhibition content. The exam will assess the knowledge on the course content and the skills acquired in the demonstrative and argumentative tools. The final evaluation will be based on the results of the written test and the outcome of the interview. Timing: the date of the written tests are fixed; that of the interview can be agreed with the teacher.
Examination description	The exam includes a written test and an oral interview. Written test (2 hours) - Type: resolution of some open questions; It is allowed the use of textbooks, manuals, graphic-symbolic calculators (strictly off-line); - Aim: to assess the knowledge, skills and expertise in arguing, conjecturing and demonstrating. It will be particularly appreciated not only the correctness of the procedures, but also the quality of the arguments used to support the answers. Interview (30-45 minutes) Aim: to assess the communication skills of the student, and the skill in organizing the exhibition content. The exam will assess the knowledge on the course content and the skills acquired in the demonstrative and argumentative tools. The final evaluation will be based on the results of the written test and the outcome of the interview. Timing: the date of the written tests are fixed; that of the interview can be agreed with the teacher.
Language	Italian

MATHEMATICAL ANALYSIS II

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 2 **Semester**: 1

Lecturer	CARDINALI Tiziana
Prerequisites	This course assumes that the student has a good working knowledge of Mathematical Analysis I topics including limits, continuity, derivatives, basic integration and improper integrals on the real line. These prerequisites are concepts that students meet not only in the mentioned basic course of Mathematics but also in their pre-university education.
Content	Vector functions and curves. Functions of several variables: continuity, partial derivability, directional derivability, differentiability, maximums and minimums with and without constraints. Lagrange Multipliers. Chain Rules. Implicit functions. Lebesgue integration in R^n. Polar coordinates in R^2, cylindrical coordinates spherical coordinates. Integrals on curves. Differential forms and their integration. Gauss and Green's theorem, divergence theorem, Stokes' theorem in R^2.
Learning goals	On successful completion of the course, students should be able to: - to read and understand the definitions and properties about tht differential calculus for functions of several variables and Lebesgue integration in R^n, - to own computational skills to solve various exercises, - to think critically, and express mathematical concepts precisely in writing, - to be prepared to take Mathematical Analysis III, - to provide themselves a mathematical proof of simple statements, - to apply the knowledge gained in this course to other situations and disciplines, - to be able to communicate the mathematical knowledge acquired in the course. - toapply knowledge and skills acquired in mathematical analysis to analyze and handle novel situations in a critical way.
Textbooks	The main material introduced during lectures and is contained in Text-book: M. BRAMANTI, C.D. PAGANI, S. SALSA, Analisi matematica 2, Zanichelli, 2009. The lecturer will supply texts about the subject Lebesgue integration in $\mathbb{R}^n$ (italian). Other recommended books: M. BRAMANTI, Esercitazioni di Analisi Matematica 2, Ed. Esculapio, Bologna, 2012. G. BUTTAZZO, V. COLLA, Temi di esame di Analisi Matematica II, Pitagora, 2001. A. BACCIOTTI, P. BOIERI, D. FARINA, Esercizi di Analisi Matematica II, Progetto Leonardo Ed. Esculapio, 1999 M. AMAR, A. M. BERSANI, Esercizi di Analisi Matematica per i Nuovi Corsi di Laurea, Progetto Leonardo Ed. Esculapio, 2002. V. A. ZORICH, Mathematical Analysis II,Springer-Verlag Berlin Heidelberg , 2004 . P. CANNARSA , T. D'APRILE, Introduction to Measure Theory and Functional Analysis - Highlights interaction between integration theory and functional analysis, with constant focus on applications – Springer, 2015.

Lecture type	The course is split into traditional lectures, in which several exercises are presented to the students. In the tutorial service the students will be followed individually by the teacher. Suggestions for to study the course, the book text and the exam tests (The lectures, the book text and the exam tests) 1. Read the example problems carefully, filling in any steps that are left out (ask someone for help if you can't follow the solution to a worked example). 2. Later use the worked examples to study by covering the solutions, and seeing if you can solve the problems on your own. 3. Keep in mind that sometimes an answer could be expressed in various ways that are analitically equivalent, so don't assume that your answer is wrong just because it doesn't have exactly the same form as the answer in the back.
Examination description	The final exam consist of written and oral tests: - the written exam consists of three exercises one of which divided into several questions and takes about three hours. - the oral exam consists of a discussion on three topics one of which divided into several questions and takes about 30/40 minutes. The oral exam is designed to verify the level of knowledge attained by the student on the theoretical contents and on the methodologies of the course. Moreover, the oral examination allows the teacher to assess the performance of the student and his/her ability to organize the presentation in autonomy. It is necessary that the student will need to know all definitions introduced in the course. Moreover, the student will need to understand them, how they work, and more importantly whether they can be used or not. As an example, the first topic we will look at is Integration by Parts (that the student has studied in Analysis Mathematical 1). The integration by parts formula is very easy to remember. However, just because you've got it memorized doesn't mean that you can use it. You'll need to be able to look at an integral and realize that integration by parts can be used (which isn't always obvious) and then decide which portions of the integral correspond to the parts in the formula (again, not always obvious).
Language	Italian
Note	Attendance of the lectures is warmly recommended. The lectures will be companied by exercises sessions. The teacher will distribute educational material on the argument : Lebesgue integration (in italian) useful for a better understanding of this topic. All cell phones and electronic devices that transmit wirelessly must be turned off during the written exam. Vibrate or silence modes are not allowed. Laptops, iPods, language translators, or any devices that can receive a wireless signal are not allowed. The final exam may be conducted in the English language at the request of the student.

MATHEMATICAL ANALYSIS III

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 2 **Semester**: 2

Lecturer	FILIPPUCCI Roberta
Prerequisites	To better understand the topics covered in the course the student should have passed the exams of Mathematical Analysis I and II. Therefore, the prerequisites are concepts that students meet not only in basic courses of Mathematics but, increasingly, also in their pre-university education. Furthermore the student is required to be familiar with the notions of metric spaces, eigenvalues, eigenvectors and to recognize and draw quadrics. In particular, the course aims mainly at making the student familiar with theories that play a central role in modern mathematics, such as ordinary differential equations and systems. Indeed this tool has thousand of applications in all the fields of applied science.
Content	Sequences and series of functions. Power series. Fourier series and applications. General theory of ODEs and systems of differential equations in the nonlinear and linear cases, with fundamental examples. Integrals on manifolds. Special functions. Differential operators, the divergence theorem and applications. For a detailed program and useful training aids and tools see teacher's web page.
Learning goals	The student should acquire a basic knowledge of seuqnces and series of functions, theory of ordinary differential equations e integration on manifold. The course matter is part of the contents of a standard reformed first level course for Italian three-year degrees in Mathematics. Even the setting is reformed, and the textbooks used are rich of examples and counterexamples, and therefore seem to be optimal to achieve a good understanding of the topics starting from exercises, that is from applications. Main knowledge acquired will be: - To know the main topics of ordinaly differential equations and how to apply them to the natural and technological sciences, - To know several tools and computationa techniques to solve elementary and basilar exercises,, - To obtain a good comprehension of the definitions and of the statement of the theorems, Main competence (i.e. ability to apply the main knowledge acquired) will be: - To apply the theory to the resolution of exercises or problems based on models developed during lessons - To read and understand texts of Mathematical Analysis, - To solve some easy mathematical problems in the field of applied mathematics, indipendently, - To communicate in Italian the mathematical knowledge acquired in the course, as well as related issues - To work in teams, but also in autonomy The skills listed above are set out in the framework of the professions related to both a traditional mathematician, and a mathematician oriented to technical and/or industrial activities.

Textbooks	C. Pagani e S. Salsa, *Analisi Matematica 2 ,* Zanichelli, ISBN: 978-8808-0-1875 -5 A. Ambrosetti e S. Ahmad , A textbook on Ordinary Differential Equations, Springer, 2014 G. Buttazzo e V. Colla, Temi d'esame di *Analisi Matematica 2 ,* Pitagora
Lecture type	The course is split in theoretical lessons and practical lessons, in these latter several exercises are carried out in class. The course is composed by 63 divided into 43 hours of theory, together with different examples and counterexamples, and 20 hours of practical exercises. A overhead projector is used to project lessons. In the tutorial service the students will be followed individually by the teacher.
Examination description	The exam includes both a written exam with open answer questions and oral exam. The written part consists of solving 3 or 4 exercises on topics which cover all the programme in about 3 hours. The written exam is designed to assessthe ability of solving concrete or teoric problems. The written test is positively concluded if the grade is greater or equal to 18. Eventually the written test can be replaced by progress assessments. The oral exam consists of a discussion on three topics one of which divided into several questions and takes about 30 minutes. The oral test is designed to assess the level of knowledge attained by the student on the theoretical contents and on and counterexamples). Finally, the oral examination allows the teacher to verify the performance of the student and his/her ability to organize the presentation in autonomy.
Language	Italian
Note	The teacher makes available educational materials useful for a better understanding of the course, in order to help and to let the students pass easily the exam, visit the web page `http://www.dmi.unipg.it/filippucci/materiale_didattico_AnalisiMatematicaIII.htm` Furthermore all the previous written test can be found at the web page http://www.dmi.unipg.it/filippucci/AnMat3esami.htm, in this latter web page you can find also the results of the written test and the date of the relative oral exam. As an experiment, the course could be done wholly or partly in English, with the agreement of the students attending it. In any case, the oral exam may be conducted in the English language at the request of the student.

MATHEMATICAL ANALYSIS IV

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 3 **Semester**: 1

Lecturer	PUCCI Patrizia
Prerequisites	To better understand the topics covered in the course the student should have passed the exams of Mathematical Analysis I, II and III. In particular, the course aims at making the student familiar with the theories that play a central role in modern mathematics, such as integration and functional analysis in Hilbert spaces. Therefore, the prerequisites are concepts that students meet not only in basic courses of Mathematics but, increasingly, also in their pre-university education.
Content	Lebesgue spaces: definition, completeness, separability, duality. Theorems of limits under the sign of integrals. Convergences: in measure, quasi-uniform. The theorem of Vitali and comparison of variuos notions of convergence. Functions of bounded variation and absolutely continuous functions: differentiability and integrability properties. Hilbert spaces: Euclidean spaces, parallelogram identity, projection theorem, duality, orthonormal systems, trigonometric series. Strong convergence theorms in $L^p(X)$. Dense subsets of $L^p(X)$.
Learning goals	The student should acquire a basic knowledge in real analysis as well as in Lebesgue and Hilbert spaces theory. The course matter is part of the contents of a standard reformed second level course for Italian three-year degrees in mathematics. Even the setting is reformed, and the textbooks used are rich of examples and counterexamples, and therefore seem to be optimal to achieve a good understanding of definitions and statements of theorems. The course aims at analyzing the basic arguments of real analysis and of functional analysis in Hilbert spaces, treating so widespread and comprehensive discipline as taught for years at national and international levels. In this sense, the purpose of the course is to make the students able - To know the main topics of real analysis and integration theory and how to apply them to the natural sciences, - To own computational skills to solve various exercises, - To read and understand texts of Real Analysis and Functional Analysis, - To provide themselves a mathematical proof of simple statements, - To communicate in Italian the mathematical knowledge acquired in the course, as well as related issues, - To work in teams, but also in autonomy. The skills listed above are set out in the framework of the professions related to both a traditional mathematician, and a mathematician oriented to technical and/or industrial activities.

Textbooks	P. Cannarsa & T. D'Aprile , *Introduzione alla teoria della misura e all'analisi funzionale* , UNITEXT, Springer, 2008, xii+268 pp. R.G. Bartle , *The elements of integration and Lebesgue measure* , Wiley Classics Library, Wiley-Interscience Publ., New York, 1995, xii+179 pp. P.J. Nahin , *Inside interesting integrals (with an introduction to contour integration)* , Undergraduate Lecture Notes in Physics, Springer, New York, 2015, xiv+412 pp. J. Yeh , *Real analysis. Theory of measure and integration,* Third edition, World Scientific Publishing Co. Pte. Ltd., Hackensack, NJ, 2014, xxiv+815 pp. N. Lerner , *A course on integration theory. Including more than 150 exercises with detailed answers,* Birkhäuser/Springer, Basel, 2014, xviii+492 pp. M.A. Pons , *Real analysis for the undergraduate. With an invitation to functional analysis,* Springer, New York, 2014, xviii+409 pp.
Lecture type	The course is split into traditional lectures, in which several exercises are carried out in class. The essential arguments are summarized in handouts provided by the teacher. The course is divided into 63 hours of theory, together with different examples and counterexamples (almost 20 hours are dedicated to practical exercises). In the tutorial service the students will be followed individually by the teacher. To better understand the topics covered in the course the student should have passed the exams of Mathematical Analysis I, II and III. In particular, the course aims at making the student familiar with the theories that play a central role in modern mathematics, such as integration and functional analysis in Hilbert spaces. Therefore, the prerequisites are concepts that students meet not only in basic courses of Mathematics but, increasingly, also in their pre-university education.
Examination description	The exam includes a single oral test with the performance of some exercises. The oral exam consists of a discussion on three topics one of which divided into several questions and takes about 30 minutes. The oral test is designed to assess the level of knowledge attained by the student on the theoretical contents and on the methodologies of the course (fundamental theorems, definitions, examples and counterexamples). Finally, the oral examination allows the teacher to verify the performance of the student and his/her ability to organize the presentation in autonomy.
Language	Italian
Note	The teacher will distribute educational materials useful for a better understanding of the course, in order to help and to let the students pass easily the exam. As an experiment, the course could be done wholly or partly in English, with the agreement of the students attending it. In any case, the oral exam may be conducted in the English language at the request of the student.

MATHEMATICAL METHODS FOR ECONOMICS

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 1

Lecturer	BRANDI Primo
Prerequisites	Mathematical Methods for Economics is an intensive course (6 credits - 11 weeks) to start modeling. In order to follow the lessons in a profitable way it is essential to have reached a good level in the knowledge and skills in Mathematical Analysis. *Basic knowledge* . Differentiation of functions of several variables. Maxima and minima free and under constraints
Content	Free and constrained optimization, linear and non-linear optimization, in continuous and discrete case. Geodesic in space and time. Optimal allocation of resources. Problems of choice. Shortest paths. Positioning and Navigation (GPS system) A CAS (Computer Algebra System) and spreadsheet will be used to develop applications.
Learning goals	The exam consists of an interview lasting 30-45 minutes Aim: to assess the level of skills acquired with respect to the expected learning results. Timing: usually the date are fixed (established by the Consiglio di Corso di Studio). For special requirements the date can be agreed with the teacher.
Textbooks	P. Brandi, Percorsi di Metodi Matematici, Dispense on-line (2015) [textbook] Hamdy A. Taha, An introduction to Operations Research `http://www.math.epn.edu.ec/~sandra/TDE2015_A/libros/taha2007.pdf` M. Pappalardo, M.Passacantando, Ricerca Operativa, Pisa University Press (2006) G. Bigi, A. Frangioni, G. Gallo, S. Pallottino, M. G. Scutellà, Appunti di Ricerca Operativa (2012-2013), CdL Informatica, Università di Pisa, `http://www.di.unipi.it/optimize/Courses/ROM/1314/Appunti/Appunti1314.pdf`
Lecture type	The course consists of lectures and exercises in progress. It will also stimulated the production and presentation in class of learning objects, implemented in a group or individually by the students.
Examination description	The exam consists of an interview lasting 30-45 minutes Aim: to assess the level of skills acquired with respect to the expected learning results. Timing: usually the date are fixed (established by the Consiglio di Corso di Studio). For special requirements the date can be agreed with the teacher.
Language	Italian

MATHEMATICAL PHYSICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/07 **Year**: 3 **Semester**: 2

Lecturer	SALVATORI Maria Cesarina
Prerequisites	A mandatory prerequisite for students, planning to attend the course with profit, is the knowledge and resolution of matrices, eigenvalues ??and eigenvectors; multiple integrals, surface integrals ; divergence and transport theorems; ordinary differential equations, Cauchy problems; Fourier series and their respective convergence theorems; fundamental law of the dynamics, energy of a material system.
Content	Partial differential equations. Mathematical models. First order equations: characteristics. Second order linear equations and their classification. Initial and boundary value problems. Equations of hyperbolic, parabolic and elliptic type. Methods of solution and applications.
Learning goals	The goals of this course are . provide students with the mathematical tools that are essential to the formation of an undergraduate student to tackle problems related to mathematical models implemented by problems for partial differential equations, . motivating the study of these instruments, indicating the issues that led to their development also showing applications. . to be able to study and analyze simple mathematical models concerning partial differential equations and to study the classical solutions. These objectives involve the discussion of problems of classical mathematical physics such as: first order linear equations and their applications, second order linear equations: elliptic, parabolic and hyperbolic types. These describe the main mathematical models regarding population dynamics, potential , heat distribution, diffusion and reaction of interacting elements, vibrating string.
Textbooks	H. F. Weinberger, A first Course in Partial Differential Equations with Complex Variables and Transform Methods, Blaisdell Publishing Company. Tyn-Mynt,U. and L. Debnath, Partial Differential Equations for Scientist and Engineer, North Holland. W. E. Boyce and R. C. Diprima, Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons. Salsa, Equazioni a derivate parziali, Springer Verlag. Radu Precup, LINEAR AND SEMILINEAR PARTIAL DIFFERENTIAL EQUATIONS an introduction, De Gruyter.
Lecture type	The course is organized as follows: Lectures on all subjects of the course and respective exercices 42 hours.
Examination description	The oral examination consist on an interview about 2/3 arguments treated during the course. This allows to verify the ability of knowledge and understanding, the ability to apply the acquired skills, the ability to display and learn. Operating time up to 45/60 minutes.
Language	Italian

Note	The teacher will distribute educational material in order to facilitate the preparation of the exam. The students should also, for a better understanding of the course, have passed the examinations of Mathematics I, II, III and Rational Mechanics. In agreement with the students, the lectures and the exams could be held in english.

NUMERICAL ANALYSIS

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/08 **Year**: 3 **Semester**: 2

Lecturer	IANNAZZO Bruno
Prerequisites	Good knowledge of Real Analysis (differential calculus, uniform convergence). Basic knowledge of Fourier series, Hilber spaces and ordinary differential equations. Good knowledge of Linear Algebra. Basic knowledge of astract algebra (groups, rings).
Content	Introduction to Numerical Linear Algebra and Approximation Theory: computation of zeros of nonlinear functions; numerical solution of linear systems; polynomial, spline and trigonometric interpolation; fast Fourier transform; Hilbert space and uniform approximation; numerical quadrature; introduction to the numerical solution of ordinary differential equations. Analysis and implementation of the treated algorithms and study of some applications: search engines, vector graphics, data fitting, signal processing.
Learning goals	Understand concepts and methodology of Numerical Analysis.
Textbooks	D. Bini, M. Capovani, O. Menchi, Metodi Numerici per l'Algebra Lineare, Zanichelli, Bologna, 1988. J. Stoer, R. Burlisch. Introduction to Numerical Analysis, Third Edition, Springer, Berlin, 2002. R. Bevilacqua, D. Bini, M. Capovani, O. Menchi, Metodi Numerici, Zanichelli, Bologna, 1992. P. H. Davis, Interpolation and approximation, Dover, New York, 1975. L. N. Trefethen, Approximation Theory and Approximation Practice, SIAM, Philadelphia, 2013. Materia provided by the teacher.
Lecture type	Face-to-face
Examination description	Written test and oral
Language	Italian
Note	The lectures might be held in English in agreement with the students. The exams can be held in English on request.

PHYSICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: FIS/01 **Year**: 1 **Semester**: 2

Lecturer	PLAZANET Marie Geneviéve
Prerequisites	The course will start from the most basic concepts. Only basics knowledge of matematics (analisi matematica) is required.
Content	Introduction to physics method. Physics quantities. Measurement. Units. Dimensional equation.Kinematics. Vecctor calculus. Position, velocity, acceleration. Motion in a plane. Principles of dynamics. Relative motion. Newton's laws. Reference systems. Inerzial and gravitational mass. Work and energy. Momentum. Angular momentum an. Kinetic energy. Conservative forces. Potential energy. Conservation of mechanical energy. Gravitation. Elastic forces. Kepler laws. Oscillators. Dinamics of systems. Center of mass. Collisions. Rigid body. Equilibrium. Harmonic oscillator. Elastic properties. Mechanics of fluids. Statics. Pressure. Stevino law. Bernouilli theorem. Waves. Longitudinal and transverse waves. Stationary waves. Propagation of acoustic waves. Heat and temperatures. Thermodinamic systems. Heat. Work. Perfect gas. Kinetic theory. Carnot cycle. Entropy and disorder.
Learning goals	This is the first part of classical physics: solid mechanics, fluids, waves, thermodynamics. The aim is to assimilate the fonademental laws pf physics that enable to describe and predict the trajectory of behaviour of solids and fluids. We will introduce for this purpose concepts of inertia, forces, momentum, and moments of these quatities to describe the translational or rotational motion of particles and solids, as well as concersavtio laws of energy and momentum. We will also discuss oscillatory motions, as well as waves with the example of acoustic waves. Eventually, with thermodynamics we will have the opportunity to discuss the various states of matter, and see another approch for the description of a very large number of particles like in a gas. Besides the knowledge of classicle physics, the course will provide a methods of analysis and solving of problems: analyse the system, the forces that apply on it or relevant thermodynamical variables, evaluate the effetc that can be negligeable or not and predict the evolution of the system. This methods can be considered as much more general for the resolution of problems than only physics.
Textbooks	Mazzoldi, Nigro, Voci: Fisica, Volume I, Meccanica e Termodinamica, EdiSES. D. Halliday, R. Resnick, J. Walker: Fondamentals of Physics.
Lecture type	All arguments will be discussed during the lessons. After the presentation of the formalism, exercises will be treated and discussed with the student to have readely an example of application. Importance will be given to numbers in order to be able to discriminate between what can be neglected in which situation.

Examination description	The written exam is mandatory and consists in solving 3 or 4 problems chosen amoung the various arguments treated during the lessons. The duration is between 2 hours and 2:30 hours. The exam will mainly tests the reasoning capacities and methods of the student. If the written test is successfully passed, an oral exam can be optionally given. The oral is a discussion of about 30 minutes based on solving a problem, and questions about the arguments treated during the whole course.
Language	Italian

PHYSICS II

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: FIS/01 **Year**: 2 **Semester**: 2

Lecturer	CECCHI Claudia
Prerequisites	Vectorial calculation. First order differential equations and integrals. Physics I
Content	Electric charge. Isolant material and conductors. Electric force: Coulomb law. Electric field. Field generated by discrete charge distribution. Electric dipole. Gauss theoreme and applications: field generated by continuous charge distribution. Electric potential. Electric potential generated by a point charge, by discrete and continuous charge systems. Potential of a dipole. Calculation of the potential starting from the field and viceversa. Potential electrostatic energy. Capacity and capacitors. Electric current and density of current. Resistance, resistivity, conductivity. Ohm law. Joule effect. Electromotrice force. Circuits. Magnetic field. Lorentz force. Force on paths traversed by current. Ampere law. First law of Laplace. Solenoid. Inductance. Faraday law. Lenz law. Maxwell equations. Electromagnetic waves.
Learning goals	Confidence with electricity, Coulomb law, Gauss law. Circuits. Confidence with magnetism, Lorentz law, Ampere law.
Textbooks	Halliday Fondamenti di Fisica (it exist also in English) Ferrari-Luci Fisica 2 elettromagnetismo e ottica
Lecture type	Lectures
Examination description	Examen: written + oral
Language	Italian

PROBABILITY

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/06 **Year**: 1 **Semester**: 2

Lecturer	CAPOTORTI Andrea
Prerequisites	Notions of the courses “Probabilità e Statistica”, “Analisi Matematica I” and “Analisi Matematica II”
Content	Moment generating function. Characteristic function. Multivariate random variables: joint and conditional distributions. Conditional expected value. Coherent conditional probability assessments. Relations among random variables; transforms of multivarate random variables; independence, conditional independence. Weak convergence. Convergence in probability. Almost sure convergence. Limit Theorems: Law of Large Numbers; Central Limit Theorems.
Learning goals	Deep knowledge of multivariate distributions and asymptotical behavior of random variables. Students will be able to face and solve theoretical problems about multivariate distributions, transformations of random variables and asymptotic results. They will be also able to consciously express the learned notions.
Textbooks	Baldi P.: Calcolo delle Probabilità . McGraw-Hill ed., 2011. G. Casella, R.L. Berger, Statistical Inference, second edition, Thomson Learning, 2002. G. Coletti, R. Scozzafava, Probabilistic Logic in a Coherent Setting, Kluwer Academic Pub., 2002.
Lecture type	Lectures ; practical exercizes given as students seminars
Examination description	Written test and oral examination: - in the written part (2h) students are required to solve 3 exercises on different subjects of the program. It is intended to test practical skill; - at the oral examination (30 min) are accepted those who pas the written part with at least 18/30 or those who actively partecipate to the practical lectures during the term. It is intended to test the skill of presenting theoretical arguments and the understanding level of the subjects in the program. On request, exams can be done in English.
Language	Italian

PROBABILITY AND STATISTICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/06 **Year**: 2 **Semester**: 2

Lecturer	COLETTI Giulianella & CAPOTORTI Andrea
Prerequisites	Basic calculus notions and computer ability. To fully understand the subjects are recommended the notions of the courses "Analisi Matematica I & II, "Informatica I
Content	Events and random variables (r.v.). Conditional and joint probability. Stochastic independence. Real random variables. Distribution function, probability function density function. expected value, variance, moments. Multivarate random variables: joint and marginal distributions, conditional distributions. Relations among random variables; transforms of random variables. Common probability distributions. Approximations. Basic notions of descriptive Statistics. Simple linear models. Parametric estimation. Confidence intervals. Hypothesis tests.
Learning goals	This course is the first approach to the theory of probability. The main aim of this teaching is to provide students able to use statistical and probabilistic models for solving problems involving uncertainty. Students will be able to face and solve practical and theoretical problems about descriptive statistic, linear regression and hypothesis tests. They will be also able to consciously express the learned notions.
Textbooks	R. Scozzafava: Incertezza e Probabilita' (Zanichelli) Baldi P.: Calcolo delle Probabilità . McGraw-Hill ed., 2011. Antonelli S., Regoli G.: Probabilità discreta: Esercizi con richiami di Teoria, Liguori editore,ed. 2005 Forcina A., Stanghellini E.: Elementi di statistica per economia , Morlacchi Editore 2005. Iacus S.M., Masarotto G.: Laboratorio di statistica con R. McGraw-Hill. Erto P.: Probabilità e Statistica per le scienze e l'ingegneria, Mc-Graw-Hill, ed. 2004 S. Ross, Introduction to probability and Statistics for Engineers and Scientists, Academic Press, 2009.
Lecture type	–Lectures on all the topics of the program . –Proposal and resolution of problems relating to all program arguments made in court. Theoretical lessons and practical training with R statistical package.
Examination description	Examination divided in a preliminary written and practical part, and a consequently oral examination. - Written part, of about 2h mean duration, is composed of 3 exercises and is apt to verify problem solving skill and is about all the subjects; - The practical part, of 1.5h mean duration, is about 2 practical problem to solve by the statitical software R and is apt to verify practical attitude to deal with real or simulated data and to make basic statistical descrptive and inferential analysis; - The oral examination can be done by students who will pass the scrip/practical part with an average mark of at least 18/30 or those who have passed intermediate similar tests (esoneri) during the term. It is of 30 min in the average, and is apt to verify the presentation skill and the learning level. On request, the exam can be done in English.

Language	Italian

RATIONAL MECHANICS I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2011

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/07 **Year**: 3 **Semester**: 1

Lecturer	NUCCI Maria Clara
Prerequisites	Basic knowledge of algebra, geoemtry, calculus, and fundaments of mechanics
Content	Newtonian Mechanics: cinematics and dynamics of rigid bodies. Lagrangian Mechanics: constraints and generalized coordinates, Hamilton's principle, Lagrangian equations, stability, Lie's and Noether's symmetries. Hamiltonian Mechanics: Hamiltonian equations, Poisson brackets, canonical transformations, Hamilton-Jacobi theory.
Learning goals	A basic knowlege of Analytical Mechanics
Textbooks	H. GOLDSTEIN, C.P. POOLE, J.L. SAFKO, Classical Mechanics, III ed., Addison Wesley, 2001; G. GRIOLI, Lezioni di Meccanica Razionale, Libreria Cortina; V. I. ARNOLD, Mathematical Methods of Classical Mechanics, II ed., Springer-Verlag, 1989. F. R. GANTMACHER, Lezioni di Meccanica Analitica, Editori Riuniti, 1980. M. BRAUN, Differential Equations and their Applications, IV ed., Springer-Verlag, 1993. *The lecturer will supply notes, scientific articles, and computer programs written in either REDUCE or MAPLE language* .
Lecture type	Lectures
Examination description	oral exam that includes solving exercises
Language	Italian

TOPOLOGY I

A.A. 2015/2016 – Bachelor – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 2

Lecturer	STRAMACCIA Luciano
Prerequisites	It is recommended to have attended the institutional courses of Algebra and Geometry I. Also it is assumed the knowledge of the concepts of topology of Euclidean plane and space: neighborhoods, open sets, basis and continuous functions.
Content	Categories, functors and natural trasformations. Limits and colimits in a category. Metric spaces and topological spaces. Continuous maps . Subspaces, quotients, topological products and coproducts. Separation axioms. Compactness. Connectedness. Compactly generated spaces. Function spaces. Homotopia. Fundamental group and groupoid functor.
Learning goals	Managing basic concepts of Category Theory, of General Topology and Homotopy Theory.
Textbooks	S.Willard, General Topology, Addison-Wesley 1970 R.Brown, Topology and Groupoids, `https://store.kagi.com/cgi-bin/store.cgi?storeID=6FEPD_LIVE/` Niotes provided by theatcher
Lecture type	*face-to-face*
Examination description	Oral exam lasting about one hour.
Language	Italiano

(MASTER)

ADVANCED ANALYSIS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 1

Lecturer	MUGNAI Dimitri
Prerequisites	In order to be able to understand and apply the majority of the techniques described within the Course, students must have succesfully passed the Analisi Matematica V exam. Topics and techniques developed therein are indeed a mandatory prerequisite for students planning to follow this course with profit.
Content	Introduction to the theory of distributions. Elements of Calculus of Variations. Nemitskii operators. Deformation Lemma. Saddle, Mountain Pass and Linking Theorems. Applications to partial differential equations. Schroedinger equations.
Learning goals	The course is the natural completion of all the courses in Mathematical Analysis of the Degree in Mathematics, since all topics treated in those previous courses find here further applications and motivations. In particular, the main purpose is to provide students with the bases to recognize the nature of a variational problem in the applied sciences and to solve the easiest ones. Main acquired knowledge: basic topics in the theory of distributions; properties of Nemitzskii operators in L^p spaces; minimum theorems and applications; fundamental minimax theorems and applications: saddle, mountain pass and linking theorem. Main competence: identification of te variational nature of a problem; determine the geometrical properties of the associated functional and choose the minimax theorem to apply; prove the existence of solutions for differential problems by a critical point theorem.
Textbooks	A. Ambrosetti & A. Malchiodi, Nonlinear Analysis and Semilinear Elliptic Problems, Cambridge Studies in Advanced Mathematics 104 (2007). M. Willem, Minimax Theorems, Progress in Nonlinear Differential Equations and Their Applications 24 (1996). Struwe, Michael Variational methods. Applications to nonlinear partial differential equations and Hamiltonian systems, Springer-Verlag, Berlin (2008). Teacher's notes.
Lecture type	Lectures on all subject of the course, with related applications and examples.
Examination description	The exam consists of an oral interview of about 1 hour, aiming at verifying the knowledge level and the understanding ability acquired by the student on the theoretical and ,ethodological contents as indicated in the program. Moreover, the oral exam will test the student communication skills, her/his correct use of language and autonomy in the organization and exposure of the considered topics. Upon request, students can take the exam in Italian.
Language	English

ALGEBRA III

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/02 **Year**: 1 **Semester**: 1

Lecturer	LORENZINI Anna
Prerequisites	Basic concepts of rings and ideals, in particular rings of polynomials in one indeterminate over a field.
Content	Polynomials in several indeterminates. Monomial ideals. Dickson's lemma. Monomial orderings. Division algorithm. Groebner bases. Noetherian rings. Hilbert basis theorem. Buchberger's criterion and algorithm. Membership algorithm. Radical memebrship criterion and algorithm.Elimination and intersection algorithm. Primary decomposition in noetherian rings. Affine varieties. (Affine) Hilbert zeroes theorems and consistency algorithm. Homogeneous ideals and projective varieties. (Projective) Hilbert zeroes theorems. Varieties of monomial ideals and their dimension. Hilbert function and polinomial. Dimension of affine and projective varieties
Learning goals	Knowledge of concepts and algorithms proposed. Capability of the usage of the symbolic programme CoCoA
Textbooks	Cox-Little-O'Shea, Ideals, varities and algorithms, springer (1992) Atiyah-MacDonald, Introduction to commutative algebra, Addison-Wesley (1969)
Lecture type	face to face lessons and computer work
Examination description	Oral examination, lasting 45-60 minutes, which tends to evaluate the level of understanding of the topics treated and of critic study and personal rethinking. The topic of the first question is chosen by the student.
Language	Italian

ANALYSIS OF NUMERICAL METHODS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/08 **Year**: 1 **Semester**: 1

Lecturer	GERACE Ivan
Prerequisites	Basic elements of functional analysis (important) .
Content	Partial differential equations. Weak formulation of the problem. Finite element method. Methods for solving the linear system: conjugate gradient. Fredholm integral equations. Ill-position of the problem. Regularization.
Learning goals	The student will be able to describe, analyze, develop and apply numerical methods for: partial differential equations of elliptical type; Fredholm integral equations of the first kind.
Textbooks	A. QUARTERONI, Modellistica Numerica per Problemi Differenziali, Springer, 2008. A. QUARTERONI, A. VALLI, Numerical Approximation of Partial Differential Equations, Springer, 1997.
Lecture type	face-to-face
Examination description	There are two tests to have to overcome in order to pass the exam. The first is a written test. The purpose of this test is to entice the student in the study of solutions to problems through the application of the techniques studied in the theoretical subjects. This stage is essential in order to understand all the potentiality and purposes of the theory. The test is carried out in the classroom and independently by the student. Some exercises are offered to the student with the relevant score. The test is of unlimited duration and the student is free to consulatere books and notes and use the computer. The test is evaluated by checking the proper performance of the year. The test is passed if you get a rating greater than or equal to 16. Passing this test allows admission to the second examination. The second test is oral. The purpose of this test is to verify the theoretical competence and mastery of the subject by the student. The test can be sustained at any time after the passing of the first examination and lasts about half an hour. The result of this test will determine the final grade exam. Both tests can be given in English if the student requests it.
Language	Italian

CODES AND CRYPTOGRAPHY

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 1

Lecturer	GIULIETTI Massimo
Prerequisites	In order to understand and know how to apply most of the techniques described in the course, the student must have successfully passed the exams of Algebra I-II and Geometry I-III of the first degree
Content	Finite fields. The primitive element theorem. Group action on a set. Cyclotomic polynomials. Linear codes and projective codes. Basic inequalities and bounds: Singleton bound, Hamming bound, Plotkin bound, Gilbert-Varshamov bound, Griesmer bound. Algebraic curves over finite fields. Fields of rational functions, divisors, Riemann-Roch spaces.. Rational maps between algebraic curves. Algebraic Geometric codes as a generalization of the Reed-Solomon codes and the BCH codes. One point Goppa codes. Hermitian codes. Outline on elliptic curve cryptography.
Learning goals	Codes and Cryptography is an optional course of the degree in Mathematics addressed in a special way for students interested in the applications of algebra and geometry. The main goal of the course is to provide students with advanced elements of algebra and geometry useful for dealing with concrete problems related to network communications. The main knowledge gained will be: -Familiarity with finite fields -Familiarity with the concepts of encoding and decoding of information. -Familiarity with the theory of algebraic curves flat and with coding systems associated with them. The main skills will be: - Evaluating the performance of a linear code - Building linear codes appropriate to specific instances - Building and evaluating codes defined from algebraic curves
Textbooks	S. Ling e C. Xing, Coding Theory - A First Course, Cambridge University Press, 2004 M.A. Tsfasman and S.G. Vladut, Algebraic-Geometric Codes, Kluwer, 1991
Lecture type	The course consists of classroom lectures on all topics of the course. In each lesson about half of the time will be devoted to solving problems and exercises
Examination description	The exam consists of an oral interview. Three questions relating to three separate parts of the program will be submitted to the student. The interviews lasts about 30-40 minutes and is designed to ensure the level of knowledge and ability of understanding reached by the student on the theoretical and methodological implications listed in the program (finite fields, linear codes, plane algebraic curves, Goppa codes), The oral test will also allow to verify communication skills, appropriateness of language and autonomous organization of the exposure.
Language	English
Note	Lectures will be held in English.

COMBINATORICS II

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 2

Lecturer	VINCENTI Rita
Prerequisites	Groups, rings, fields. Affine real plane and the 3-dimensional affine real space. Projective plane and projective 3-dimensional space. Projective conics, quadrics in the 3-dimensional space: projective classification.
Content	Galois fields: basis, algebraic extensions, norms and traces, equations. The finite geometries $PG(r, q)$, $r \geq 1$: projective incidence properties, duality. The projective plane: ternary ring, translation planes, semi-fields, quasi-fields. Partitions and translation planes. Linear groups: Sylow-subgroups, trasvections, the representation of $GL(n, q)$. Projective varieties: quadrics in $PG(r, q)$, $r \geq 2$, rational normal curves. Grassmannians. Veronese surface. From projective systems to linear codes. Applications.
Learning goals	Normally very good.
Textbooks	A. Beutelspacher, U. Rosenbaum, *Projective Geometry: from foundations to applications* , Cambridge University Press, 1998. J. W. P. Hirschfeld, *Finite Projective Spaces of Three Dimensions* , Clarendon Press, Oxford, 1985. J.W.P. Hirschfeld, J.A. Thas, *General Galois Geometry* , Oxford University Press, Oxford 1991. G. Tallini, *Geometria di Galois e Teoria dei Codici* , CISU, Roma, 1995.
Lecture type	The lessons will be supported by exercises, examples and open research problems. Some foreigner colleagues in Erasmus staff mobility will be guests and they will further contribute to new research problems. On request, some notes will be delivered and probably other support text will be suggested specially in occasion of the organization of seminars. All the students may be followed in a personalized method, on request.
Examination description	A student may choose to prepare a seminar on topics chosen with the docent, as individual work or with other students. It must be written in TeX and presented to the other students at the end of the semester. In that moment the docent might ask questions on the programm mainly concerning the seminar. Alternatively the student may have a normal examination on the relavant topics treated in classroom. All the students must attend the lessons of the official docent, of the guest professors in Erasmus staff mobility and the seminars of the colleagues.
Language	English
Note	The 8 students attending the course during the academic year 2015/2016 prepared a seminar supported by a written paper. It was delivered to the other students after a supervision of the docent and told in the classroom. The pdf files are out online in the page e-studium. Lectures will be held in English according the new guideline of the Departement. The exams can be held in English on request.

COMPLEMENTARY MATHEMATICS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/04 **Year**: 1 **Semester**: 2

Lecturer	FAINA Giorgio
Prerequisites	Know the basics of Algebra, Analysis, Geometry.
Content	Introduction to Maple. Some Maple Linear Algebra Commands. Preliminary Mathematics. Finite Fields with Maple. Hadamard Matrices with Maple. Difference Sets with Maple. Reed-Muller Codes with Maple. BCH Codes with Maple. Reed-Solomon Codes with Maple. Algebraic Cryptography with Maple. Elliptic Curve Cryptography with Maple. Polya Theory with Maple. Graphs Theory.
Learning goals	Basic knowledge about primality tests and factorization algorythms. Basic knowledge about public and private key cryptosystems.
Textbooks	Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with* MAPLE, CRC Press, 1999.
Lecture type	face-to-face
Examination description	The assessment method consists of an oral exam, by mark expressed on a scale from a minimum of 18 (the threshold to pass the exam) to the maximum of 30 (cum laude). Marks below 18 will be equivalent to insufficient assessment of learning. The test has a duration of no more than 30 minutes and is designed to evaluate the ability to correctly apply the theoretical knowledge and the understanding of the issues proposed.
Language	Italian

DECISION THEORY

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/06 **Year**: 1 **Semester**: 1

Lecturer	PETTURITI Davide
Prerequisites	All the concepts necessary for the complete understanding of the issues of the course are contained in the syllabus of a degree in Mathematics from any University.
Content	Foundation of theory of measurements: the qualitative assumptions, the representations theorems, the unicity theorems. Ordinal and cardinal utility. Non additive measures of uncertainty. Comparative degree of belief and relevant representability by different uncertainty measures. The expected utility theory (Morgenstern-von Neumann's and Savage's theories). The rationality principle. Some paradoxes. Non expected utility models (some examples). The main concepts of the social choice.
Learning goals	The main objective of teaching is to achieve knowledge of the main models for dealing with uncertainty and to decide rationally. The main skills are: - Analyze the context and identify the decision-making model (or forecast) to be adopted taking into contodegli objectives to be achieved - Be able to make connections between the concepts covered in the course - Know how to deal with demonstrations along the lines of those explained in class.
Textbooks	The library materials related to major topics will be made available by the teacher during the course. As more text is suggested: P.Wakker: Additive Representations of Preferences: A New Foundation of Decision Analysis (Theory and Decision Library C)
Lecture type	The course is organized as follows: theoretical lectures on the subjects of the course.
Examination description	The exam includes only a single oral test, consisting on a discussion of about 40 minutes on the topics presented in the course. The test will be devoted to ensure the understanding of the basic concepts, their formalization and the links between them. It will also be tested the ability to perform proofs of theorems showed during the course. On demand of the student the test can be taken in English.
Language	Italian

DIFFERENTIAL EQUATIONS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 2

Lecturer	CARDINALI Tiziana
Prerequisites	This course assumes that the student has a good working knowledge of Mathematical Analysis topics of a Bachelor Degree in Mathematics.
Content	Fixed point theory. Existence theorems for problems involving differential equations or differential inclusions. Selections theorems for multifunctions. Applications to the existence of equilibrium points for deterministic or random abstract economies.
Learning goals	On successful completion of the course, students should be able to: - to have a critical study about esistence of solutions local or global for problems involving differential equations or differential inclusions - to organize the presentation in autonomy; - to think critically and express mathematical concepts precisely in writing; - to apply the knowledge gained in this course to other situations and disciplines; - to communicate the mathematical knowledge acquired in the course; - to read and understand texts of Differential Equations, - to provide themselves a mathematical proof of simple statements. - to apply knowledge and skills acquired in Differential Equations to analyze and handle novel situations in a critical way.
Textbooks	I will use pieces of : 1) S. SINGH, B. WATSON, P. SRIVASTAVA, Fixed Point Theory and Best Approximation. The KKM-map Principle, Kluwer Academic Publisher, 1997. 2) J.M. A. TOLEDANO, T. D. BENAVIDES, G. L. ACEDO, Measures of Noncompactness in Metric Fixed Point Theory, Birkhauser, 1997. 3) M. KISIELEWICZ, Differential Inclusions and Optimal Control, Kluwer Acad. Publishers, 1991. 4) L. C. PICCININI, G. STAMPACCHIA,G. VIDOSSICH, Equazioni differenziali ordinarie in Rn, Ed. Liguori, 1978. Some texts (in Italian language) will be supplied by the lecturer.
Lecture type	Lectures - exercise sessions - office hours. The course consists into 42 hours of theory, together with different examples and counterexamples. The perspective of the course is very analytic: this is my own personal perspective. The aim of course is - to invite students to a critical approach to the study of existence of solutions of differential equation (by using examples and counterexamples in order to compare definitions and theorems) - to show methods in order to obtain a solution for problems involving differential equations. - to show methods in order to obtain the existence of a fixed point for a map.

Examination description	Examination with oral tests with the performance of some exercises. It consists of a discussion on three topics one of which divided into several questions and takes about 30 minutes. The final exam is the student's opportunity to demonstrate everything he/she have learned in our time together. In the final exam it is necessary that the student will need to know all definitions, theorems, proofs, examples and counterexamples introduced in the course. Moreover, the student will need to understand them, how they work, and more importantly whether they can be used or not. Finally, the oral examination allows the teacher to verify the performance of the student and his/her ability to organize the presentation in autonomy.
Language	Italian
Note	Attendance of the lectures is warmly recommended. The teacher will distribute educational materials (in Italian) useful for a better understanding of the course, in order to help and to let the students pass easily the exam.

FOUNDATIONS OF GEOMETRY

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 2

Lecturer	ZAPPA Paolo
Prerequisites	Basic knowledge of affine, metric and projective geometry. It is useful have a good memory of the Euclidean geometry studied at high school
Content	Euclid and Hilbert axioms for the geometry; the first chapter of the Elements; the elementary mesaure theory; foundations of projective geometry; cross-ratios, Möbius transformations, inversions; the absolute geometry, the elliptic geometry, the hiperbolic geometry; the models of Klein and Poincar`.
Learning goals	Knowledge of the foundations of geometry, in relationship with the foundations of mathematics. Ability to study the mathematics in critical way (choice of the axioms and definitions).
Textbooks	Euclide, *Element* i D. Hilbert, *Fondamenti della Geometria* , Feltrinelli, (in German Grundlagen der geometrie.) Federigo Enriques, *Questioni riguardanti le matematiche elementari,* parte prima, *Critica dei principi* , Zanichelli Modesto Dedò, *Matematiche Elementari* Vol II, Liguori Editore N.V. Efimov, *Higher Geometry* , MIR (in spanish *Geometria superior*) Gareth A. Jones, David Singerman, *Complex functions (An algebraic and geometric viewpoint)* , Cambridge University Press
Lecture type	Face to face. Use of the sofware Geogebra to show some complex geometric construction.
Examination description	Oral examination to check the reached level
Language	Italian
Note	all lessons are in Italian

GEOMETRIC METHODS IN THETHEORY OF RELATIVITY

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 1

Lecturer	MAMONE CAPRIA Marco
Prerequisites	Basic concepts of linear algebra and multivariate calculus. Elements of classical physics.
Content	The principle of relativity in classical physics. Newtonian space-time. The origins of special relativity. Derivations of the Lorentz transformations. Affine pseudo-Euclidean geometry. The Poincar` group and its subgroups. Minkowski space-time. Proper time. Relativistic dynamics. Collisions. Mass-energy equivalence. Relativistic electromagnetism. Some notions of general relativity and cosmology.
Learning goals	The main objectives of the course are: 1) a rigorous understanding of spatial relativity, as compared to classical physics and to some aspects of quantum mechanics and general relativity; 2) getting acquainted with the notion of space-time, including a working knowledge of space-time diagrams, both for their importance in physics and as a valuable example of applied 4-dimensional geometry; 3) an introduction to the historical issues concerning such momentous changes in the foundations of physics as that occurred with the relativity revolution.
Textbooks	R. D'Inverno, Introducing Einstein's Relativity, Cambridge University Press, 1992 M. Mamone Capria (ed.), Physics Before and After Einstein, IOS, 2005. A. Sudbery, Quantum Mechanics and the Particles of Nature: An Outline for Mathematicians, Cambridge University Press, 1986.
Lecture type	Face-to-face lectures
Examination description	Oral exam with some written exercise; both may be held in Italian, English or other language accepted by the teacher.
Language	Italian

GEOMETRIC MODELS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 1

Lecturer	UGHI Emanuela
Prerequisites	Nothing
Content	Formal and informal didactics: examples of puzzles, exhibition, shows having mathematical aspects. Difficulties in mathematics: teaching tools, proposals for help children having problems and/or handicaps. New technologies in teaching mathematics: in particular, Geogebra and its features.
Learning goals	The course will offer a theoretical introduction the the mathematical Laboratory approach, and also the knowledge of a collection of examples of innovative teaching proposals , all belonging to a common laboratorial methodology. The student will get the skill to apply this methodology to use concrete and/or visual tools in planning innovative teaching activities about mathematical subjects. The student will be also able to use informatics tools for teaching.
Textbooks	References will be given during the course.
Lecture type	The course will be organized as follows: activity in the classroom, in which there wil be theory lessons, and also Mathematical Laboratory lessons, as descibed in the document Matematica2003 of the Unione Matematica Italiana. They will work with mathematicals tools and exhibits, and they will be guided to explore their meaning and teaching possibilities. Acitivity in the Laboratorio di Informatica, to laern to use new technologies to teaching mathematics (in particular Geogebra).
Examination description	The exam will evaluate how the student is able to use the Laboratory method for teaching mathematics. So the student will choose a subject (with the teacher) and then will develop a didactic proposal over this subject. The exam will consist in explaining and discussing this proposal. The exam can be discussed also in English, if the student prefers so.
Language	Italian

GEOMETRY V

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 1 **Semester**: 2

Lecturer	TANCREDI Alessandro
Prerequisites	It is supposed that the student is well acquainted with linear algebra, set topology and real multivariable calculus (see e.g. J. M. Lee, *Introduction to smooth manifolds* . Springer 2003, appendix, pp 540-553, 559-579, 581-587).
Content	Complex and real differentiability. Power series. Analytic functions. Smooth and analytic manifolds. Manifolds with boundary. Smooth partition of unity. Tangent and cotangent spaces of a manifold. Immersions, submersions, embeddings. Smooth and analytic submanifolds. Transversality. Analytic subsets.
Learning goals	First the course introduces the students to the theory of analytic functions o several variables, real and complex, and after to the theory of smooth and analytic manifolds. Its goal is to familiarize students with the tools they will need in order to use manifolds in many other fields of mathematics.
Textbooks	J. M. Lee, *Introduction to smooth manifolds* . Springer 2003 R. Narasimhan, *Analysis on real and complex manifolds* . North-Holland 1985 Further notes and references will be supplied by the lecturer
Lecture type	face-to-face
Examination description	The final exam consists in a oral discussion of about an hour on the subjects developed during the course. A detailed list of the subjects is provided at the the end of the lectures. The aim of the exam is to evaluate the level and the quality of the knowledge the students have acquired and to check their ability in the exposition.
Language	Italian

GEOMETRY VI

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/03 **Year**: 2 **Semester**: 1

Lecturer	TANCREDI Alessandro
Prerequisites	The student should be familiar with the notions and subjects of the courses of Algebra III and Geometria V.
Content	Real and complex affine algebraic sets. Singular points. Analytic structure of real and complex affine algebraic sets. Smooth, analytic and algebraic vector bundles. Tubular neighborhoods. Isotopy. Analytic and algebraic approximation of smooth manifolds. Existence of algebraic structures on some analytic subset. Nash sets.
Learning goals	The goal of the course is to introduce the students to the current research problems about the existence of algebraic models of more general structures.
Textbooks	J. Bochnak, M. Coste, M. F. Roy, *Real algebraic geometry* . Springer 1998 T. Bröcker, K. Jänich, *Introduction to differential topology* , Cambridge Univ. Press 1982 J. M. Lee, *Introduction to smooth manifolds* . Springer 2003 Further notes and references will be supplied by the lecturer
Lecture type	face-to-face
Examination description	Oral exam
Language	Italian

MATHEMATICAL ANALYSIS V

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 2

Lecturer	PUCCI Patrizia
Prerequisites	To better understand the topics covered in the course the student should know the basic topics of Mathematical Analysis acquired in any Bachelor Degree in Mathematics, Physics and/or Engineering. In particular, the course aims at making the student familiar with the theories that play a central role in modern mathematics, such as functional analysis in Banach spaces and weak topologies, with their use in applications.
Content	L^p spaces: compactness, convolution, approximation. Hilbert spaces: generalities and duality. Normed and Banach spaces: the Hahn-Banach Theorem and applications, reflexive spaces, the uniform boundedness theorem and applications; Theorem of Banach-Steinhaus and applications; Strong and weak convergence and applications; the open mapping and closed graph theorems, with applications. Reflexive Banach spaces. Weak topologies: locally convex topological spaces, duality and weak topologies. Weak and weak star topologies: the Banach-Alaoglu and the Krein-Milman theorems, linear bounded ioperators and weak topologies. Uniform convex spaces and their geometry.
Learning goals	The student should acquire a basic knowledge in functional analysis as well as in Banach spaces theory. The course matter is part of the contents of a standard reformed second level course for Italian master degrees in mathematics. Even the setting is reformed, and the textbooks used are rich of examples and counterexamples, and therefore seem to be optimal to achieve a good understanding of definitions and statements of theorems. The course aims at analyzing the basic arguments of functional analysis in Banach spaces, treating so widespread and comprehensive discipline as taught for years at national and international levels. In this sense, the purpose of the course is to make the students able - To know the main topics of functional analysis and how to apply them to the natural sciences, - To own computational skills to solve various exercises, - To read and understand texts of Functional Analysis, - To provide themselves a mathematical proof of simple statements, with strong reasoning skills, - To communicate in Italian the mathematical knowledge acquired in the course, as well as related issues, - To work in teams, but also in autonomy. The skills listed above are set out in the framework of the professions related to both a traditional mathematician, and a mathematician oriented to technical and/or industrial activities.

Textbooks	H. Brezis , *Functional Analysis, Sobolev Spaces and Partial Differential Equations* , Universitext, Springer, 2011. A. Bowers & N.J Kalton , *An introductory course in functional analysis* . With a foreword by Gilles Godefroy. Universitext.Springer, New York,2014. A. Bressan , *Lecture notes on functional analysis. With applications to linear partial differential equations* , Graduate Studies in Mathematics 143 , American Mathematical Society, Providence, RI, 2013. P.G. Ciarlet , *Linear and nonlinear functional analysis with applications* , Society for Industrial and Applied Mathematics, Philadelphia, PA, 2013.
Lecture type	The course is split into traditional lectures, in which several exercises are carried out in class to facilitate the understanding of the course. The essential arguments are summarized in handouts provided by the teacher. The course is divided into 63 hours of theory, together with different examples and counterexamples (almost 20 hours are dedicated to practical exercises). In the tutorial service the students will be followed individually by the teacher. To better understand the topics covered in the course the student should know the basic topics of Mathematical Analysis acquired in any Bachelor Degree in Mathematics, Physics and/or Engineering. In particular, the course aims at making the student familiar with the theories that play a central role in modern mathematics, such as functional analysis in Banach spaces and weak topologies, with their use in applications.
Examination description	The exam includes a single oral test with the performance of some critical exercises. The oral exam consists of a discussion on three topics one of which divided into several questions and takes about 30 minutes. The oral test is designed to assess the level of knowledge attained by the student on the theoretical contents and on the methodologies of the course (fundamental theorems, definitions, examples and counterexamples). Finally, the oral examination allows the teacher to verify the performance of the student and his/her ability to organize the presentation in autonomy.
Language	Italian
Note	The teacher will distribute educational materials useful for a better understanding of the course, in order to help and to let the students pass easily the exam. As an experiment, the course could be done wholly or partly in English, with the agreement of the students attending it. In any case, the oral exam may be conducted in the English language at the request of the student.

MATHEMATICAL ANALYSIS VI

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 9 CFU **Lecture hours**: 63 – **Areas of interest (SDS)**: MAT/05 **Year**: 2 **Semester**: 1

Lecturer	VITILLARO Enzo
Prerequisites	In order to be able to understand and apply the majority of the techniques described in the course the content of the courses: ANALISI MATEMATICA I,II,III,IV and V are mandatoty, as a basic knowledge of Linear Algebra. Some elementary knowledge of partial differential equations, usually learned in basic courses in Mathematical Physics, is also important.
Content	Sobolev Spaces. Lax-Milgram Theorem. Compact operators: definition, properties, adjoint operator, Fredholm alternative, spectrum and spectral decomposition. Elliptic linear problems, existence, uniqueness, multiplicity and regularity. Maximum principles. Eigenfunctions and eigenvalues. Function spaces for Banach-valued functions. The energy method for heat and wave equations.
Learning goals	The main aim of the COurse is to understand the application of Linear Functional Analysis to linear P.D.E.'s. The knowledge acquired will be the one listed in the program. The main ability acquired will be the ability to build a satisfactory theory on existence, uniqueness and continous dependence on the data for a linear PDE.
Textbooks	1. H. Brezis, Functional Analysis, Sobolev Spaces and Partial Differential Equations, Universitext, Springer, 2010. 2. L.Evans Partial Differential Equations. Graduate Studies in Mathematics,19, American Mathematical Society 1998 3. Lecture Notes by the teacher.
Lecture type	Face to face.
Examination description	Oral exam, takin in average 30 minutes, on all the arguements treated, to show up: how much the student understood the theory and how deeply. Moreover the ogranzing, tehnical and expository skills of the student will be investigated. Depending on the student's preferences, the language used during the exam will be Italian or English.
Language	Italian

MATHEMATICAL METHODS FOR STOCHASTIC PROCESSES

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/05 **Year**: 1 **Semester**: 1

Lecturer	CANDELORO Domenico
Prerequisites	Some basic notions of Elementary Probability and Measure Theory should be already known to the students.
Content	A partial survey of Calculus of Probability. Generating functions and their utility. Random walks: distributions, first return time, reflecting properties and applications. Markov chains: transition matrix, recurrent and transient states, classification of states. Stationary distributions and their links with mean recurrence times. Applications to random walks. Stationary processes, ergodic theorems and application. Generation of random sequences. Martingales: general properties, convergence theorems, characterization in L_2. Optional theorem and Wald Formula. Gaussian processes: general theory, examples, Wiener process and its properties. Brownian Motion: existence and approximation, properties if its trajectories, scale invariance, Iterated Logarithm Theorem and the Arcsin Law. Stochastic Integration: Stieltjes and Ito integrals. Ito formulas and stochastic differentials. Stochastic differential equations: existence and uniqueness theorem, methods of solution in the linear case.
Learning goals	Generally, after passing the exam, the student has a deep knowledge of the general properties of the main stochastic processes, and skillness in the methods of studying and connecting them, together with some ability in stochastic calculus. The students particularly motivated could be invited to face also some first-level research problems.
Textbooks	Grimmett-Stirzaker: Probability and Random Processes; Clarendon Press, Oxford (1982). Mikosch: Elementary Stochastic Calculus; World Scientific Publ. Co. Singapore (1998).
Lecture type	Lectures in classroom, and some pc-aided simulations
Examination description	Oral exam: the test usually lasts about 40 minutes, and starts with an exercise taken from a list previously distributed during the course Then a colloquium follows, aiming to evaluate if and to what extent the student is acquainted with the main topics studied, and check his/her capability in handling them, establishing connections and consequences, and possibly activating some research work.
Language	English
Note	The course will be taught in ENGLISH Further information available at http://www.dmi.unipg.it/ candelor

MATHEMATICAL MODELS FOR FINANCE

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/06 **Year**: 1 **Semester**: 2

Lecturer	CRETAROLA Alessandra
Prerequisites	In order to be able to understand and apply the majority of the techniques described within the Course, you must know the fundamental concepts of Mathematical Analysis. In particular, the knowledge of standard differential and integral calculus in one or more variables is assumed. Moreover, having learned the basic instruments of Probability Theory is considered necessary.
Content	Introduction to financial markets. Elements of probability. Market models in discrete time: arbitrage and martingale measures, fundamental theorems of asset pricing, binomial model. Continuous time stochastic processes: Brownian motion, martingales. Elements of stochastic integration theory. Ito's formula. Black & Scholes model: self-financing and Markovian strategies, Black & Scholes equation, pricing and hedging of European contingent claims. Market models in continuous time: change of probability measure, Brownian martingales representation, valuation and hedging of European contingent claims, complete markets. Some interest rate models.
Learning goals	Providing a solid introduction to the problems arising from modern Financial and to the mathematical methods to solve them. At the end of the course, the student theoretically knows the main topics related to mathematical modeling of financial markets and to pricing and hedging of the main derivatives under no arbitrage opportunities. In particular, the student is able to: use stochastic calculus instruments for a non-deterministic approach of financial markets; price the most important derivatives in markets under no arbitrage opportunities with the aware use of appropriate stochastic calculus methodologies; use the main models for the term structure of interest rates in pricing of interest rate derivatives.
Textbooks	T. Bj örk , *Arbitrage Theory in Continuous Time* , Oxford University Press, 2004. D. Filipovic , *Term-Structure Models: A Graduate Course* , Springer Finance, Springer-Verlag, Berlin, 2009. J. C. Hull , *Opzioni, Futures e altri Derivati* , Pearson Italia S.p.a., 2006. M. Musiela , M. Rutkowski , Martingale Methods in Financial Modelling, Springer (second edition), 2005. A. Pascucci , PDE and Martingale Methods in Option Pricing, Bocconi & Springer Series, 2011.
Lecture type	The course is organized as follows: Lectures on all subjects of the course (Face-to-face); Practical training exercises at the end of each subject.

Examination description	The oral exam consists in an interview of about 45 minutes long aiming to ascertain the knowledge level and the understanding capability acquired by the student on theoretical and methodological contents as indicated on the program. The oral exam will also test the student presentation skills and her/his autonomy in the organization and exposure of the thoretical topics. Oral exam. During the course, homework will be assigned to students: exercises and an active participation to such exercises will be taken into account in the final assessment. The oral exam can be also taken in Italian, according to the student's request.
Language	English

MATHEMATICAL PHYSICS II

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 5 CFU **Lecture hours**: 35 – **Areas of interest (SDS)**: MAT/07 **Year**: 1 **Semester**: 1

Lecturer	DE LILLO Silvana
Prerequisites	We require the student to be acquainted (from previous mathematical analysis courses) with the methods of solution for I and II order ordinary differential equations with constant coefficients.Moreover it is required to have familiarity with fundamental elements of the theory of partial differential equations,such as their classification and the solution of simple problems through the Fourier series approach.
Content	Laplace Transforms.Definitions,properties and transforms of fundamental functions.Applications to the solutions of ordinary differential equations.Applications to the solutions of initial and boundary value problems for partial differential equations.Elements of quantum mechanocs.Stationary Schrodinger equation.Solution of eigenvalue problems for the stationary equation with static potentials. Elements of the theory of nonlinear evolution equations.Shock solutions.Burgers equation.Solitons of the KdV and the NLS equations.
Learning goals	Following this course a student is expected to get the skills to solve some fundamental initial/boudary value problems for partial differential equations,such as the linear heat equation and the wave equation.Moreover he/she should be able to solve eigenvalue problems associated to the Schroedinger operatotor in an external potential.The student will also get acquainted with soliton solutions of nonlinear evolution equations of applicative relevance.All the above mentioned problems will be discussed in their appropriate physical or biological context,in order to clarify the important role of mathematical modeling.
Textbooks	Tyn Myint-U, L.Debnath Partial Differential Equations for Scientists and Engineers North Holland L.D.Landau, E.M Lifsits Meccanica Quantistica (non relativistica) EDITORI RIUNITI
Lecture type	Lectures. Office hours.
Examination description	Oral exam, with questions on the theoretical part of the course and discussion of some practical example.The exam will last for about 5o minutes.Its aim is to verify: i) the rigour of logic acquired by the student; ii)his ability to handle new mathematical techniques; iii) his ability to synthetise.
Language	Italian
Note	Some didactical material will be distributed to the students in order to help them to increase their understanding and knowledge.

MATHEMATICAL PHYSICS III

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: MAT/07 **Year**: 2 **Semester**: 1

Lecturer	NUCCI Maria Clara
Prerequisites	The basics of algebra, rational mechanics, analysis I and II, mathematical physics I and II
Content	Lie symmetries are an essential tool in the study of mathematical models in Physics, Engineer, Natural Sciences, Medicine, Social Sciences, etc. In fact Lie group analysis is the only systematic method that allows one to solve linear and nonlinear differential equations exactly. The program will cover the fundamentals of Lie symmetries for ordinary and partial differential equations. In the case of ordinary differential equations Noether symmetries will be also introduced, and the role of the Jacobi last multiplier and its properties will be emphasized. Since searching for symmetries requires lengthy algebraic manipulations computer REDUCE programs developed by the lecturer will be used, as well as some MAPLE worksheets.
Learning goals	Being able to apply Lie symmetries and their properties to differential equations.
Textbooks	Peter E. Hydon, Symmetry methods for differential equations: a beginner's guide, Cambridge University Press, 2000 Nail H. Ibragimov, Elementary Lie group analysis and ordinary differential equations, Wiley, 1999 Peter J. Olver , Applications of Lie groups to differential equations, Springer, 1993 Hans Stephani, Differential equations: their solution using symmetries, Cambridge University Press, 1990 Lecturer's notes, scientific articles, and computer programs written in either REDUCE or MAPLE language can be downloaded from e-studium.
Lecture type	Face-to-face Lectures and Practical training
Examination description	oral exam with the presentation of the student's report on a given assignment; the student must also be able to use two CAS (REDUCE and MAPLE) for the purpose
Language	English

MODERN PHYSICS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: FIS/03 **Year**: 2 **Semester**: 1

Lecturer	BUSSO Maurizio Maria
Prerequisites	Good knowledge of classical physics and of the common tools of calculus
Content	Remarks on the principle of the stationary action (Lagrange, Fermat) and the second Newton's law. Motion in an absolute time and space: the ether and the interaction at non-zero distance. Ernst Mach and the first doubts. Maxwell's equations and the constante velocity of light. Michelson and Morley's experiment. Electromagnetic waves from an oscillating dipole and the ultraviolet catastrophe. The solution attempted by Planck. The photoelectric effect: photons as particles (in contradiction with Maxwell). Electron diffraction: particles as waves. Double or ambiguous nature of the microscopic world. Heuristic solutions: a) Planck's law; b) Bohr's structure for the atom; c) Loretz tranfromations. Emma Noether: symmetries and conservation laws in classical physics. The stationary action as a summary of all the classical symmetries. How to build theories for a counter-intuitive physics. Links with the cultural crisis and existentialism, from Picasso to Musil. The two cultures. The solutions in physics from the symmetries in the laws of nature. Gauge invariance. The theory of special relativity. Descriptions of physics valid for any observer: General Relativity. Observational and experimental validation. Heisenberg's uncertainty principle. The quantization from DeBroglie's idea. The Schroedinger equation as a non-relativistic solution. Wave functions as probabilities. Philosophical problems of modern physics. The formulation of QM from Heisenberg. Incompatibility between quantum mechanics and general relativity. The Entanglement. A brief mention parity violation: the beta decays. CP symmetry. Elements of Quantum Electro-Dynamics and of field theories in modern physics. Electroweak interactions and nuclear interactions. The Standard Model and QCD. The Higgs fields and the form of its potential. Mass as an interaction with the Higgs field. A brief sketch of: a) Cosmology; b) Entropy and cosmic inflation. Is life a realistic outcome? c) The theory of cosmic strings.
Learning goals	The students are expected to learn about basic theories like Relativity and Quantum Mechanics and about recent progresses in Physics.
Textbooks	Main book: Modern Physics: an Introductory Text (Pfeffer & Nir: available free of charge). Then: A) Selected chapters from: 1. Susskind The theoretical minimum 2. Susskind Quantum Mechyanics: the theoretical minimum B) Various written notes in pdf and notes from the lessons (available on-line) C) Suggested general readings for optional presentations: 1. Greene The Fabric of the Cosmos 2. Zee. Fearful Symmetry. The search for Beauty in Modern Physics
Lecture type	Frontal lectures

Examination description	Oral exams; possibility of specific in-depth study of relevant parts at the student's choice
Language	English
Note	students can meet the teacher on Thursday and Friday, from 10 am to 1pm

PHYSICS EXPERIMENTS

A.A. 2015/2016 – Master – Programm details - Guidelines 2015

ECTS: 6 CFU **Lecture hours**: 42 – **Areas of interest (SDS)**: FIS/01 **Year**: 1 **Semester**: 1

Lecturer	MADAMI MARCO
Prerequisites	Nothing
Content	The course is a laboratory of physics consisting of two modules: (1) an introductory module focused on the basic tools of measuring physical quantities: precision, accuracy and sensitivity of a measuring instrument; uncertainty (error) in measurements; propagation of uncertainties (errors); rejection criteria for experimental data, Gaussian distribution for the results of a measurement. (2) an experimental module in which the students will carry out laboratory experiments such as: measure of g , study of uniformly accelerated motion, diffraction of coherent (LASER) light from gratings, spectroscopy, Franck-Hertz experiment, measure of Planck constant h .
Learning goals	to provide experimental tools in physics teaching
Textbooks	An introduction to error analysis, the study of uncertainties in physical measurements (John R. Taylor) (also available in Italian with the title: Introduzione all'analisi degli errori, lo studio delle incertezze nelle misure fisiche)
Lecture type	Lectures and experiments to be carried out in laboratory.
Examination description	Written report and oral discussion on the experiments carried out in laboratory.
Language	English