Degrees in Mathematics

Extract from the Bulletin (*Notiziario) 2013-2014* (*)

COURSES PROGRAMME

Academic Year 2013/2014

I Semester:
Monday 30, September 2013 - Monday 13, January 2014

II Semester:
Monday 3, March 2014 - Friday 6, June 2014

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

♥♦♣♠ *byAliceinWonderland*♥♦♣♠

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).

All lectures are held in **Italian language** (*).

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

(*) An **Italian Language course**, **free of charge**, will be offered by the Università degli Studi di Perugia to Erasmus Students who will be attending courses at our University during the academic year 2013/2014.....*continue to the address:* http://cla.unipg.it/erasmus/53-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/it/didattica

AA 2013-2014
Courses at the first level (*Bachelor*): Mathematics

NAME	CFU ECTS	Year / Semester	Sector	LECTURER
1. ALGEBRA I (Algebra I)	6	1 -I	MAT/02	BURATTI Marco
2. ALGEBRA II (Algebra II)	9	1 -II	MAT/02	LORENZINI Anna
3. ANALISI MATEMATICA I (Mathematical Analysis II)	9	1 - I	MAT/05	PUCCI Patrizia
4. ANALISI MATEMATICA II (Mathematical Analysis III)	9	2 - I	MAT/05	CARDINALI Tiziana
5. ANALISI MATEMATICA III (Mathematical Analysis III)	9	2 – II	MAT/05	FILIPPUCCI Roberta
6. ANALISI MATEMATICA IV (Mathematical Analysis IV)	9	3 – I	MAT/05	PUCCI Patrizia
7. ANALISI NUMERICA (Numerical Analysis)	9	3 - II	MAT/08	GERACE Ivan
8. CALCOLO DELLE PROBABILITA' (Probability)	4 + 2 (*)	Free -II	MAT/06	REGOLI Giuliana
9. FISICA I (Physics I)	9	1 – II	FIS/01	BIASINI Maurizio
10. FISICA II (Physics II)	9	2 - II	FIS/01	CECCHI Claudia
11. FISICA MATEMATICA 1 (Mathematical Physics 1)	6	3 - II	MAT/07	SALVATORI Maria Cesarina
12. GEOMETRIA I (Geometry I)	9	1 - I	MAT/03	VINCENTI Rita
13. GEOMETRIA II (Geometry II)	9	1 - II	MAT/03	CATERINO Alessandro
14. GEOMETRIA III (Geometry III)	9	2 - I	MAT/03	GUERRA Lucio
15. GEOMETRIA IV (Geometry IV)	9	3 - I	MAT/03	FATABBI Giuliana
16. INFORMATICA I (Computer Science I)	6	1 - I	INF/01	BAIOLETTI Marco Borrowed from degree in Physics

17. INFORMATICA II (Computer Science II)	9	2 - I	ING-INF/05	BICOCCHI Rosanna
18. MECCANICA RAZIONALE I (Rational Mechanics I)	9	3– I	MAT/07	NUCCI Maria Clara
19. METODI MATEMATICI PER L'ECONOMIA (Mathematical Methods for Economics)	6	Free - I	MAT/05	BENEDETTI Irene
20. PROBABILITA' E STATISTICA I	6	2 -II	MAT/06	REGOLI Giuliana
(Probability and Statistics) Module 1 and Module 2	"	"	"	CAPOTORTI Andrea
21. STORIA DELLE MATEMATICHE I (History of Mathematics)	6	Free - II	MAT/04	NUCCI Maria Clara
22. TOPOLOGIA I (Topology I)	6	Free- I	MAT/03	CATERINO Alessandro

(*) Each credit (resp., 2) is equivalent to 12 hours laboratory .

For the English and Italian language courses cf. page 20.

AA 2013-2014
Courses at the second level (*Master*): Mathematics

NAME	CFU ECTS	Year / Semester	Sector	LECTURER
1. ALGEBRA III (Algebra III)	6	1 - I	MAT/02	LORENZINI Anna
2. ANALISI DI METODI NUMERICI (Analysis of numerical Methods)	6	1- I	MAT/08	GERACE Ivan
3. ANALISI MATEMATICA V (Mathematical Analysis V)	9	1– II	MAT/05	PUCCI Patrizia
4. ANALISI MATEMATICA VI (Mathematical Analysis V)	9	2 – I	MAT/05	VITILLARO Enzo
5. ANALISI SUPERIORE (Higher Analysis)	6	2- I	MAT/05	MUGNAI Dimitri
6. CODICI E CRITTOGRAFIA (Codes and Cryptography)	6	1 -I	MAT/03	GIULIETTI Massimo
7. EQUAZIONI DIFFERENZIALI (Differential Equations)	6	Free - II	MAT/05	CARDINALI Tiziana
8. ESPERIMENTI DI FISICA (Physics experiment)	6	1– I	FIS/01	MADAMI Marco
9. FISICA MATEMATICA II (Mathematical Physics II)	5 + 1*	1– I	MAT/07	DE LILLO Silvana
10. FISICA MATEMATICA III (Mathematical Physics III)	4 + 2*	2 – I	MAT/07	NUCCI Maria Clara
11. FISICA MODERNA (Modern Physics)	6	2 – I	FIS/03	SACCHETTI Francesco
12. FONDAMENTI DI GEOMETRIA (Fundamentals of Geometry)	6	1– II	MAT/03	ZAPPA Paolo
13. GEOMETRIA COMBINATORIA II (Combinatorics II)	6	1 - II	MAT/03	VINCENTI Rita
14. GEOMETRIA V (Geometry V)	9	1 – II	MAT/03	TANCREDI Alessandro
15. GEOMETRIA VI (Geometry VI)	9	2– I	MAT/03	TANCREDI Alessandro
16. MATEMATICHE COMPLEMENTARI (Additional Mathematics)	6	Free - II	Mat/04	FAINA Giorgio

17. METODI GEOMETRICI IN TEORIA DELLA RELATIVITA' (Geometric Methods in the Theory of Relativity)	6	1– I	MAT/03	MAMONE CAPRIA Marco
18. METODI MATEMATICI PER PROCESSI STOCASTICI (Mathematics Methods for Stochastic Processes)	6	1 - I	MAT/05	CANDELORO Domenico
19. MODELLI GEOMETRICI (Geometric Models)	6	1 – I	MAT/03	UGHI Emanuela
20. MODELLI MATEMATICI PER LA FINANZA (Mathematical models for Finance)	6	1 – II	MAT/06	CRETAROLA Alessandra
21. TEORIA DELLE DECISIONI (Decision Theory)	6	1 – I	MAT/06	COLETTI Giulianella

(*) Each credit (resp., 1 and 2) is equivalent to 12 hours laboratory .

Notes for each course

1 - the *title* is maintained in the Italian alphabetic order

2 - the *subtitle* describes the content in brief

3 - the *year* suggests the year of the *bachelor degree* or of the *master degree*

4 - the *semester* states in which of the two semesters of the year the course is held

5 - the *sector* indicates the code of the scientific area of the content

6 - the *prerequisites* suggest pre-course requirements.

7 - the *hours* are the total number of hours of lessons in the semester *in lecture-hall*, inclusive of practice, *laboratory*

8 - 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

List of the Courses

(in alphabetic order)

ALGEBRA I - 6 CFU

ALGEBRA I

Subtitle: *Set theory, combinatorial calculus and rings of integers.*
Year: I Bachelor
Semester: I
Sector: MAT/02
Prerequisites: None
Hours of lessons: 63

Lecturer: Marco Buratti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5006, E-mail:buratti@dmi.unipg.it

Content

Common number sets: natural numbers; the integers; rational numbers; real numbers; complex numbers. Prime numbers. Proofs by induction. Proofs by contradiction. Finite and infinite sets: properties and operations. Relations. Mappings. Permutations. Cardinality. Numerability. Combinatorial calculus. The ring of residues modulo *n*. The Chinese Remainder Theorem.

Textbooks

D.Dikranjan, M.S. Lucido, *Aritmetica e Algebra*, Liguori (2007).

ALGEBRA II - 9 CFU

ALGEBRA II

Subtitle: *Groups, rings, fields*
Year: I Bachelor
Semester: II
Sector: MAT/02
Prerequisites: Set theory, relations, functions; cardinality; integers, rationals, reals, residue classes.
Hours of lessons: 63

Lecturer: Anna Lorenzini, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5020, E-mail: annalor@dmi.unipg.it

Content

Algebraic structures. Permutations. Homomorphisms. Direct products. Cyclic groups. Normality and conjugation. Lagrange Theorem. Cauchy Theorem and Sylow's theory. Fundamental theorem of homomorphisms for groups and rings. Prime and maximal ideals. Euclidean, principal and factorial domains. Characteristic. Polynomial rings. Extensions of rings and fields.

Textbooks

Dikranjan-Lucido, *Aritmetica e Algebra*, Liguori (2007)
Piacentini Cattaneo, *Algebra: un approccio algoritmico*, Decibel-Zanichelli (1996).

ALGEBRA III - 6 CFU

ALGEBRA III

Subtitle: *Computer and commutative algebra*
Year: I Master
Semester: I
Sector: MAT/02
Prerequisites: Rings, ideals, fields, polynomial rings
Hours of lessons: 42

Lecturer: Anna Lorenzini, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5020, E-mail: annalor@dmi.unipg.it

Content

Polynomials in several indeterminates. Monomial ideals. Dickson's Lemma. Monomial orderings. Division algorithm. Groebner bases. Noetherian modules and rings. Hilbert basis theorem. Buchberger's criterion and algorithm. Membership algorithm. Elimination and intersection algorithm. Primary decomposition in noetherian rings.

Affine varities. Affine Hilbert Nullstellensatz and consistency algorithm. Radical membership criterion and algorithm. Homogeneous ideals and projective varieties. Projective Hilbert Nullstellensatz and consistency algorithm.
Hilbert function and polynomial, dimension of affine and projective varities.

Textbooks

Cox-Little-O'Shea, *Ideals, varieties and algorithms*, Springer (1997)
Atiyah-MacDonald, *Introduction to commutative algebra*, Addison-Wesley (1969).

ANALISI DI METODI NUMERICI - 6 CFU

ANALYSIS OF NUMERICAL METHODS

Subtitle: *Numerical treatment of partial differential equations and integral equations*
Year: I Master
Semester: I
Sector: MAT/08
Prerequisites: None
Hours of lessons: 42

Lecturer: Ivan Gerace, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5050, E-mail: gerace@dmi.unipg.it

Content

Partial differential equations. Weak formulation of the problem. Finite elements method. Methods for solving the linear system: conjugate gradient. Fredholm integral equations. III-position of the problem. Regularization.

Textbooks

A. Quarteroni, *Modellistica Numerica per Problemi Differenziali,* Springer, 2008.

ANALISI MATEMATICA I - 9 CFU

MATHEMATICAL ANALYSIS I

Subtitle: *Calculus I: Differentiation and Integration of functions of one real variable.*
Year: I Bachelor
Semester: I
Sector: MAT/05
Prerequisites: Elements of set theory. Subsets of real numbers. Pre-university mathematics.
Hours of lessons: 63

Lecturer: Patrizia Pucci, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5038, E-mail: pucci@dmi.unipg.it
http://www.dmi.unipg.it/pucci

Content

Upper and lower bounds. Complex Numbers. Sequences. Infinite and infinitesimal sequences. Continuous and uniformly continuous functions and their properties. Limits of functions, properties and important limits. Differentiable functions: local and global properties (the Fermat, the Rolle, the Lagrange, the Cauchy, the L'Hospital, etc. theorems). Higher order derivatives. Intedeterminate asymptotic forms and developments. Qualitative study of functions. The Riemann integration. Continuous functions, primitives and the Torricelli-Barrow theorem. Techniques of integration by parts, by substitution, etc. Numerical integrals and series. Convergence criteria for numerical series.

Textbooks

E. Acerbi & G. Buttazzo, *Analisi Matematica ABC,* Pitagora Ed. Bologna, 2003.
G. Buttazzo & V. Colla, *Temi d'Esame di Analisi Matematica I,* Pitagora Ed., Bologna, 2000.
G. Buttazzo, G. Gambini & E. Santi, *Esercizi di Analisi Matematica I,* Pitagora Ed., Bologna, 1991.
G. De Marco & C. Mariconda, *Esercizi di calcolo in una variabile per il nuovo ordinamento,* Decibel - Zanichelli, 2001.
C. Vinti, *Lezioni di Analisi Matematica,* Galeno Editrice Perugia.

ANALISI MATEMATICA II - 9 CFU

MATHEMATICAL ANALYSIS II

Subtitle: *Differential calculus for functions of several variables and Lebesgue integration in* $\boldsymbol{R^n}$
Year: II Bachelor
Semester: I
Sector: MAT/05
Prerequisites: Analisi Matematica I
Hours of lessons: 63

Lecturer: Tiziana Cardinali, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5042, E-mail: tiziana@dmi.unipg.it
http://www.dmi.unipg.it/~tiziana

Content

Vector functions and curves. Functions of several variables: continuity, partial derivability, differentiability, maximums and minimums with and without constraints. Implicit functions. Lebesgue integration in $\mathbf{R^n}$. Integrals on curves. Differential forms and their integration. Gauss and Green's theorem, divergence theorem, Stokes' theorem in $\mathbf{R^2}$.

Textbooks

M. Bramanti, C.D.Pagani, S.Salsa, *Analisi matematica 2*, Zanichelli, 2009.

Other recommended books:

M. Bramanti, *Esercitazioni di Analisi Matematica 2*, Progetto Leonardo - Ed.Esculapio Bologna, 2012.
G. Buttazzo, V. Colla, *Temi di esame di Analisi Matematica II*, Pitagora Ed., 2001
A. Bacciotti, P. Boieri, D. Farina, *Esercizi di Analisi Matematica II,* Progetto Leonardo Ed. Esculapio, Bologna 1999.
M. Amar, A. M. Bersani, *Esercizi di Analisi Matematica per i Nuovi Corsi di Laurea*, Progetto Leonardo Ed. Esculapio, Bologna, 2002.

The lecturer will supply texts about the subject " Lebesgue integration in $\boldsymbol{R^n}$*".*

ANALISI MATEMATICA III - 9 CFU

MATHEMATICAL ANALYSIS III

Subtitle: *Sequeces and series of functions. Differential equations and systems.*
Year: II Bachelor
Semester: II
Sector: MAT/05
Prerequisites: Mathematical Analysis II
Hours of lessons: 63

Lecturer: Roberta Filippucci, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5033, E-mail: filippucci@dmi.unipg.it
http://www.dmi.unipg.it/filippucci

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. Integration 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.

Textbooks

C. Pagani, S. Salsa, *Analisi Matematica 2***,** Masson, 1998.
G. Prodi, *Lezioni di Analisi Matematica 2,* Bollati Boringhieri, 2011.
G. De Marco, *Analisi 2. Teoria ed esercizi,* Zanichelli, 1999, 2a ed
S. Salsa, A. Squellati, *Esercizi di Analisi Matematica 2,* Zanichelli, 2011.

NOTES WILL BE SUPPLIED BY THE LECTURER.

ANALISI MATEMATICA IV - 9 CFU

MATHEMATICAL ANALYSIS IV

Subtitle: *Real Analysis.*
Year: III Bachelor
Semester: I
Sector: MAT/05
Prerequisites: Analisi Matematica III.

Hours of lessons: 63

Lecturer: Patrizia Pucci, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5038, E-mail: pucci@dmi.unipg.it
http://www.dmi.unipg.it/pucci

Content

Lebesgue spaces: definition, completeness, separability, uniform convexity, duality. Theorems of limits under the sign of integral. Convergences: in measure, quasi-uniform. The theorem of Vitali and comparison of the several 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.

Textbooks

H. Brezis, *Functional Analysis, Sobolev Spaces and Partial Differential Equations,* Universitext, Springer, 2011.

P. Cannarsa & T. D'Aprile, *Introduzione alla teoria della misura e all'analisi funzionale,* UNITEXT, Springer, 2008.

H. Amann & J. Escher, *Analysis. III, Translated from the 2001 German original,* Birkhäuser Verlag, Basel, *2009*.

ANALISI MATEMATICA V - 9 CFU

MATHEMATICAL ANALYSIS V

Subtitle: *Linear Functional Analysis.*

Year: I Master

Semester: II

Sector: MAT/05

Prerequisites: Basics of Mathematical Analysis of a Bachelor Degree in Mathematics.

Hours of lessons: 63

Lecturer: Patrizia Pucci, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5038, E-mail: pucci@dmi.unipg.it
http://www.dmi.unipg.it/pucci

Content

Lp spaces: convergences in measure, approximation, compactness, convolution. Hilbert spaces: geometry, liner operators, projections, duality, complete orthogonal systems. Normed and Banach spaces: the Hahn-Banach Theorem and applications, reflexive spaces, the uniform boundedness theorem and applications; the open mapping and closed graph theorems, with applications. Reflexive Banach spaces: weak and weak star topologies: the Banach-Alaoglu and the Krein-Milman theorems. Uniform convex spaces.

Textbooks

H. Brezis, *Functional Analysis, Sobolev Spaces and Partial Differential Equations*, Universitext, Springer, 2011.

P. Cannarsa & T. D'Aprile, *Introduzione alla teoria della misura e all'analisi funzionale*, UNITEXT, Springer, 2008.

F. Albiac & N.J. Kalton, *Topics in Banach space theory,* Graduate Texts in Math. 233, Springer, New York, 2006.

E. Di Benedetto, *Real analysis*, Birkhäuser Advanced Texts: Basler Lehrbücher, Birkhäuser Boston, MA, 2002.

ANALISI MATEMATICA VI - 9 CFU

MATHEMATICAL ANALYSIS VI

Subtitle: *The application of Linear Functional Analysis to linear P.D.E.'s.*

Year: II Master

Semester: I

Sector: MAT/05

Prerequisites: Analisi Matematica 5

Hours of lessons: 63

Lecturer: Enzo Vitillaro , Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5015, E-mail: enzo@dmi.unipg.it

Content

Sobolev spaces: main properties and embedding theorems. 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. Applications to heat and wave equations.

Textbooks

H. Brezis, *Functional Analysis, Sobolev Spaces and Partial Differential Equation*s, Universitext, Springer, 2010.

L.Evans, *Partial Differential Equations,* Graduate Studies in Mathematics,19, American Mathematical Society 2010.

G. Eskin, *Lectures on Partial Differential Equations. Graduate Studies in Mathematics 123*, American Mathematical Society, 2011.

Notes will be supplied by the lecturer.

ANALISI NUMERICA - 9 CFU

NUMERICAL ANALYSIS

Subtitle: *Basic concepts of numerical approximation of continuous problems.*
Year: III Bachelor
Semester: II
Sector: MAT/08
Prerequisites: None
Hours of lessons: 63

Lecturer: Ivan Gerace, Dipartimento di Matematica e Informatica
Tel. 075 585 5050, E-mail: mailto:gerace@dmi.unipg.it

Content

Polynomial interpolation. Polynomial approximation. Numerical integration. Iterative methods for linear linear system. Iterative methods for non-linear equations. Numerical methods for solving ordinary differential equations.

Textbooks

Bevilacqua, Bini, Capovani, Menchi, *Metodi numerici*, Zanichelli, 1992.

Bini, Capovani, Menchi, *Metodi numerici per l'algebra lineare,* Zanichelli, 1988.

ANALISI SUPERIORE - 6 CFU

HIGHER ANALYSIS

Subtitle: *Nonlinear analysis and partial differential equations*
Year: II Master
Semester: I
Sector: MAT/05
Prerequisites: Mathematical Analysis V
Hours of lessons: 42

Lecturer: Dimitri Mugnai, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5043, E-mail: mugnai@dmi.unipg.it
http://www.dmi.unipg.it/mugnai

Content

Some basic theorems on Sobolev Spaves. Elements of Calculus of Variations. Nemitskij operators. Deformation Lemma. Mountain Pass. Saddle. Linking. Applications to partial differential equations. Schroedinger equations. Systems of Quantum Mechanics.

Textbooks

A. Ambrosetti & A. Malchiodi, *Nonlinear Analysis and Semilinear Elliptic Problems,* Cambridge Studies in Advanced Mathematics 104 (2007).

P. Drábek & J. Milota, *Methods of Nonlinear Analysis*, Birkhauser Advanced Texts (2007).

M. Willem, *Minimax Theorems*, Progress in Nonlinear Differential Equations and Their Applications 24 (1996).

M. Schechter, An Introduction to Nonlinear Analysis, Cambridge Studies in Advanced Mathematics 95 (2005).

D.G. Costa, *An Invitation to Variational Methods in Differential Equations*, Birkhäuser Boston (2007).

Further notes will be supplied by the lecturer.

CALCOLO DELLE PROBABILITÀ - (4+2) CFU

PROBABILITY THEORY

Subtitle: *Intermediate course on probability theory*
Year: Free, Bachelor
Semester: II
Sector: MAT/06
Prerequisites: main contents from the courses Analisi Matematica 1, Analisi Matematica 2, Analisi Matematica 3, Geometria 1, Algebra 1, Probabilità e statistica.
Hours of lessons: 52

Lecturer: Giuliana Regoli, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5022, E-mail: regoli@dmi.unipg.it

Content

Moment generating function. Characteristic function.
Multivariate random variables: joint and conditional distributions. Conditional expected value. 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.

Textbooks

Baldi P.: *Calcolo delle Probabilità* . McGraw-Hill ed., 2011.
Dall'Aglio, G.: *Calcolo delle probabilità*, Ed. Zanichelli, 2001.

Summarizing notes will be supplied by the lecturer.

CODICI E CRITTOGRAFIA - 6 CFU

CODES AND CRUPTOGRAPHY

Subtitle: *Coding Theory and Cryptography*
Year: I Master
Semester: I
Sector: MAT/03
Prerequisites: Linear Algebra
Hours of lessons: 42

Lecturer: Massimo Giulietti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5021, E-mail: giuliet@dmi.unipg.it
http://www.dmi.unipg.it/giuliet

Content: Error detection, correction, and decoding. Finite fields. Linear codes. Basic inequalities and bounds. Constructions. Algebraic curves over finite fields. Algebraic Geometric codes. One point Goppa codes. Hermitian codes. Elliptic curve cryptography. Isogenies. Weil pairing and MOV attack to the elliptic curve cryptography**.**

Textbooks

S. Ling and C. Xing, *Coding Theory - A First course*, Cambridge University Press, 2004
M.A. Tsfasman and S.G. Vladut, *Algebraic-Geometric Codes,* Kluwer**,** 1991
I.F. Blake, G. Seroussi and N.P. Smart, *Elliptic curves in cryptography***,** Cambridge University Press, 1999.

Notes will be supplied by the lecturer.

EQUAZIONI DIFFERENZIALI - 6 CFU

DIFFERENTIAL EQUATIONS

Subtitle: *Differential equations*
Year: I or II Master
Semester: II
Sector: MAT/05

Prerequisites: None
Hours of lessons: 42

Lecturer: Tiziana Cardinali, Dipartimento di Matematica e Informatica, Tel. +39 075 585 5042,

E-mail: tiziana@dmi.unipg.it, http://www.dmi.unipg.it/~tiziana

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.

Textbooks

S. SINGH, B. WATSON, P. SRIVASTAVA, *Fixed Point Theory and Best Approximation. The KKM-map Principle*, Kluwer Academic Publisher, 1997.

J.M. A. TOLEDANO, T. D. BENAVIDES, G. L. ACEDO, *Measures of Noncompactness in Metric Fixed Point Theory*, Birkhauser, 1997.

M. KISIELEWICZ, *Differential Inclusions and Optimal Control*, Kluwer Acad. Publishers, 1991.

L. C. PICCININI, G. STAMPACCHIA,G. VIDOSSICH, *Equazioni differenziali ordinarie in* $\boldsymbol{R^n}$, Ed. Liguori, 1978.

Some texts will be supplied by the lecturer.

ESPERIMENTI DI FISICA - 6 CFU

PHYSICS EXPERIMENTS

Subtitle: *Experimental tools in Physics Teaching*
Year: I Master
Semester: I
Sector: FIS/01
Prerequisites: Fisica I, Fisica II
Hours of lessons: 42

Lecturer: Marco Madami, Dipartimento di Fisica, Tel. +39 075 585 2714,

E-mail: marco.madami@fisica.unipg.it

Content

The course is a laboratory of physics consisting of two modules: an introductory module focused on the basic tools of measuring physical quantities and an experimental module in which the students will carry out laboratory experiments such as: measure of *g*, laser diffraction, Rutherford experiment, Franck-Hertz experment, measure of Planck constant *h*.

Textbooks

Contact the lecturer.

FISICA I - 9 CFU

PHYSICS I

Subtitle: *Mechanics and thermodinamics*
Year: I Bachelor
Semester: II
Sector: FIS/01
Prerequisites: Vectors, operations with vectors. Derivatives and integrals of one variable functions.
Hours of lessons: 63

Lecturer: Maurizio Biasini, Dipartimento di Fisica, Tel. +39 075 585 2774,

E-mail: maurizio.biasini@pg.infn.it

Content

Experimental method. Kinematics. Principles of dynamics. Energy and Work. Forces in nature. Dynamics of systems. Rigid body. Armonic oscillator. Elastic properties of solids. Mechanics of fluid. Heat and temperature. Principles of thermodynamics. Kinetic theory. Waves.

Textbooks

Mazzoldi, Nigro, Voci, *Fisica, Volume I, Meccanica – Termodinamica*, EdiSES.

D.Halliday, R.Resnick, J.Walker, *Fondamenti di Fisica (IV Edizione), Meccanica Termologia*, Casa Editrice Ambrosiana.

FISICA II - 9 CFU

PHYSICS II

Subtitle: *Electricity and magnetism*
Year: II Bachelor
Semester: II
Sector: FIS/01
Prerequisites: Fisica I
Hours of lessons: 63

Lecturer: Claudia Cecchi, Dipartimento di Fisica,
Tel. +39 075 585 2702, E-mail: claudia.cecchi@pg.infn.it

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.

Textbooks

D. Halliday R. Resnik, J. Walker, *Fondamenti di Fisica, CEA,* 2006
V. Ferrari, C. Luci, C, Mariani, A. Pelissetto, *Fisica 2 elettromagnetismo e ottica*, Idelson, Gnocchi srl, 2009.

FISICA MATEMATICA I - 6 CFU

MATHEMATICAL PHYSICS I

Subtitle: *Mathematics methods and models for applications*
Year: III Bachelor
Semester: II
Sector: MAT/07
Prerequisites: Analisi Matematica 3, Rational Mechanics.
Hours of lessons: 42

Lecturer: Maria Cesarina Salvatori, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5064, E-mail: salva@dmi.unipg.it

Content

Partial differential equations. Linear and quasi-linear equations. First and second order equations. Initial and boundary value problems. Hyperbolic, parabolic and elliptic equations. Classical exact and approximate solutions. Initial and boundary value problems. Solution methods and applications.

Textbooks

U. Tyn-Mynt, L. Debnath, *Partial Differential Equations for Scientist and Engineer*, North Holland, 1987.

Notes will be supplied by the lecturer

FISICA MATEMATICA II - (5+1) CFU

MATHEMATICAL PHYSICS II

Subtitle: *Nonlinear partial differential equations*
Year: I Master
Semester: I
Sector: MAT/07
Prerequisites: Analisi Matematica 4, Geometria 2
Hours of lessons: 47

Lecturer: Silvana de Lillo, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5056, E-mail: silvana.delillo@pg.infn.it

Content

Introduction to the theory and applications of partial differential equations. Introduction to the theory of nonlinear partial differential equations.

Textbooks

U. Tyn-Mynt, L. Debnath, *Partial Differential Equations for Scientists and Engineers,* North Holland, 1987.

FISICA MATEMATICA III - (4+2) CFU

MATHEMATICAL PHYSICS III

Subtitle: *Lie symmetries of differential equations*
Year: II Master
Semester: I
Sector: MAT/07
Prerequisites: Basic knowledge of differential equations and their applications in Physics
Hours of lessons: 52

Lecturer: Maria Clara Nucci, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5016, E-mail: nucci@dmi.unipg.it
http://www.dmi.unipg.it/nucci

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, both for ordinary and partial differential equations, and also generalized symmetries . Since searching for symmetries requires lengthy algebraic manipulations computer REDUCE programs developed by the lecturer will be used.

Textbooks

G. W. Bluman, S. C. Anco, *Symmetry and integration methods for differential equations*, Springer, 2002
P. E. Hydon, *Symmetry methods for differential equations: a beginner's guide*, Cambridge University Press, 2000
N. H. Ibragimov, *Elementary Lie group analysis and ordinary differential equations*, Wiley, 1999
P. J. Olver, *Applications of Lie groups to differential equations*, Springer, 1993
H. Stephani, *Differential equations: their solution using symmetries*, Cambridge University Press,1990.

The lecturer will supply notes, scientific articles, and computer programs written in either REDUCE or MAPLE language.

FISICA MODERNA - 6 CFU

MODERN PHYSICS

Subtitle: *Physics in the 20th century, a look to the future.*
Year: II Master
Semester: I
Sector: FIS/03
Prerequisites: Basic knowledge of linear differential operators, eigenvalue equations, definition of linear space, norm and internal product.
Hours of lessons: 42

Lecturer: Francesco Sacchetti, Dipartimento di Fisica,
Tel. +39 075 585 5022, E-mail: francesco.sacchetti@pg.infn.it

Content

Reference systems in Physics. Revised axioms of Physics. Mathematical form of the Special Relativity. Possible didactic presentations. Axioms of Quantum Mechanics. The observable in the microscopic Physics. The problem of identical particles and the consequences. The Quantum entanglement and possible connection to the real world. The Bell's inequality and the realism problem. Introduction to the idea of complexity and simple examples.

Textbooks

No textbook in the field is available. Useful references will be provided during the lectures.

FONDAMENTI DI GEOMETRIA - 6 CFU

FOUNDATIONS OF GEOMETRY

Subtitle: *Foundations of Geometry.*
Year: I Master
Semester: II
Sector: MAT/04
Prerequisites: Basic theory of groups, Euclidean and Analitic Geometry, Basic linear algebra.
Hours of lessons: 42

Lecturer: Paolo Zappa, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5016, E-mail: zappa@dmi.unipg.it

Content

According to the Erlangen Programm, an overlook of the different type of geometries: Euclidean, Hyperbolic, Elliptic, Projective.

Textbooks

David A. Brannan, Matthew F. Esplen, Jeremy J. Gray, *Geometry*, 2012, Cambridge University Press.
Modesto Dedò, *Matematiche Elementari,* Liguori Ed.
N.V. Efimov, *Higher Geometry*, MIR (also avaible in Spanish *Geometria Superior*), MIR
Papers from specialized reviews in mathematical didactic will be supplied by the lecturer.

GEOMETRIA I - 9 CFU

GEOMETRY I

Subtitle: *Basic linear algebra, affine geometry.*
Year: I Bachelor
Semester: I
Sector: MAT/03
Prerequisites: None
Hours of lessons: 63

Lecturer: Rita Vincenti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5022, E-mail: alice@unipg.it
http://www.dmi.unipg.it/~alicew/

Content

Basic algebra. Basic affine geometry of dimension 2 and 3 over the real field R. Vector spaces over a field K. Linear systems over R. Geometry of the affine plane and of the 3-dimensional affine space over R. Generalization. Linear applications. Groups of linear transformations and affinities.

Textbooks

A. Basile, *Algebra lineare e geometria cartesiana*, Margiacchi-Galeno Editore, Perugia, 2010.
M. Stoka,V.Pipitone, *Esercizi e problemi di geometria*, Vol.I, Cedam, Padova, 1995.
Notes will be supplied by the lecturer.

GEOMETRIA II - 9 CFU

GEOMETRY II

Subtitle: *Bilinear and quadratic forms, euclidean geometry and basic concepts of general topology*
Year: I Bachelor
Semester: II
Sector: MAT/03
Prerequisites: Geometria I
Hours of lessons: 63

Lecturer: Alessandro Caterino, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5013 E-mail: caterino@dmi.unipg.it
http://www.dmi.unipg.it/caterino

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.

Textbooks

E. Sernesi, *Geometria 1, Boringhieri*, 1992

M. Stoka, V. Pipitone, *Esercizi e problemi di geometria,* Vol.I, Cedam, Padova, 1995

GEOMETRIA III - 9 CFU

GEOMETRY III

Subtitle: *Projective geometry and quadratic geometry*

Year: II Bachelor

Semester: I

Sector: MAT/03

Prerequisites: Linear algebra, affine and euclidean geometry.

Hours of lessons: 63

Lecturer: Lucio Guerra, Dipartimento di Matematica e Informatica,

E-mail: guerra@unipg.it

http://www.dmi.unipg.it/guerra

Content

Projective geometry, extending affine geometry. The linear projective group. The principle of duality. The axiomatic theory of projective spaces. Quadratic polynomials, quadric curves and surfaces, affine and projective.

Textbooks

E. SERNESI, *GEOMETRIA* 1, BOLLATI-BORINGHIERI, 1992.

GEOMETRIA IV - 9 CFU

GEOMETRY IV

Subtitle: *Curves and surfaces.*

Year: III Bachelor

Semester: I

Sector: MAT/03

Prerequisites: Affine and Euclidean Geometry, Linear Algebra, Vector funcions of a vector variable.

Hours of lessons: 63

Lecturer: Giuliana Fatabbi, Dipartimento di Matematica e Informatica – Phone: 075 585 5020 – E-mail: fatabbi@dmi.unipg.it

Content

Topological space and continuos functions, subspace, product space, qoutient spaces, connected sets, arcwise connected sets, compact sets. Local theory of curves,: curvature and torsion. Local theory of surfaces: definition, differentiable functions, tnagent plane. First and Second fundamental formm, Principal curvature and directions,Gausssian and mean curvature. Variety and subvariety.

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.

GEOMETRIA V - 9 CFU

GEOMETRY V

Subtitle: *Smooth manifolds.*

Year: I Master

Semester: II

Sector: MAT/03

Prerequisites: Linear algebra. Point-set topology. Multivariate calculus.

Hours of lessons: 63

Lecturer: Alessandro Tancredi, Dipartimento di Matematica e Informatica – Phone: 075 585 5007 – E-mail: altan@unipg.it

Content
Tangent vectors and derivation. Smooth manifolds. The tangent space. Submanifolds. Smooth vector bundles. Tangent and cotangent bundles. Smooth vector and covector fields. Riemannian manifolds. Orientation. Integration on manifolds.

Textbooks
T. Bröcker, K. Jänich, *Introduction to differential topology*, Cambridge Univ. Press 1982.
J. M. Lee, *Introductions to smooth manifolds*. Springer 2003.
L. W. Tu, *An introduction to manifolds*. Springer 2008.

Further notes and references will be supplied by the lecturer.

GEOMETRIA VI - 9 CFU

GEOMETRY VI

Subtitle: *Algebraic models of smooth manifolds.*
Year: II Master
Semester: I
Sector: MAT/03
Prerequisites: Smooth manifolds
Hours of lessons: 63

Lecturer: Alessandro Tancredi, Dipartimento di Matematica e Informatica – Phone: 075 585 5007 – E-mail: altan@unipg.it

Content
Power series. Real analytic and complex functions. Nash functions. Analytic and Nash subsets. Analytical structure of affine algebraic varieties. Algebraicity of Nash sets. Algebraic models of smooth manifolds.

Textbooks
J. Bochnak, M. Coste, M. F. Roy, *Real algebraic geometry,* Springer 1998.
J. M. Ruiz, *The basic theory of power series,*Vieweg 1993.

GEOMETRIA COMBINATORIA II - 6 CFU

COMBINATORIAL GEOMETRY II

Subtitle: *Galois Geometries and algebraic-geometric codes.*
Year: I Master
Semester: II
Sector: MAT/03
Prerequisites: Algebra I, Algebra II, Geometria I, Geometria II.
Hours of lessons: 48

Lecturer: Rita Vincenti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5022, +39 347 27 095 28, E-mail: alice@unipg.it
http://www.dipmat.unipg.it/~alicew

Content
Galois Fields. The finite geometries PG(r, q), $r \geq 1$. Linear projective groups. Desargues, Pappus, Pascal Theorems. Projective varieties. Quadrics in PG(r, q). Grassmannians. Rational normal Curves. Applications. Linear Codes and projective Systems. Permutation Deconding.

Textbooks
A. Beutelspacher, U.Rosenbaum, *Projective Geometry: from foundations to applications*, Cambridge University Press, 1998.
G. Tallini, *Geometria di Galois e Teoria dei Codici*, CISU, Roma, 1995.

Notes will be supplied by the lecturer.

INFORMATICA I - 6 CFU

COMPUTER SCIENCE I

Subtitle: *Introduction to computer science*
Year: I Bachelor
Semester: I
Sector: INF/01
Prerequisites: None

Hours of lessons: 42

Lecturer: Marco Baioletti, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5044, E-mail: baioletti@dmi.unipg.it
http://www.dmi.unipg.it/baioletti

Content

Introduction to the basic concepts of computer science (computer organization, operating systems, information representation, algorithms and programming, complexity). The mathematical package Octave. Programming in Matlab/Octave: variables and expressions, functions, conditional and iterative instructions, array processing, recursion, bidimensional graphics. Comparison between C and Matlab.

Textbooks

Notes (in italian) will be supplied by the lecturer

INFORMATICA II - 9 CFU

COMPUTER SCIENCE II

Subtitle: *Management and implementation of the various data structures.*
Year: II Bachelor
Semester: I
Sector: ING-INF/05
Prerequisites: None
Hours of lessons: 63

Lecturer: Rosanna Bicocchi, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5047, E-mail: bicocchi@dmi.unipg.it

Content

Procedures and functions, recursion, pointers and dynamic variables. Algorithms: language for describing algorithms, analysis of algorithms. Sorting algorithms. Abstract data types: specific syntactic, semantic and representation. Lists, stacks, queues, binary trees, binary search trees, hash tables, sets and dictionaries, graphs. Design techniques: divide and conquer, dynamic programming, greedy.

Textbooks

A. Bertossi, A. Montresor, *Algoritmi e Strutture di Dati*, Seconda Edizione, Città Studi Edizioni, 2010.

LINGUA INGLESE - 3 CFU

ENGLISH LANGUAGE

Subtitle: *The English language in studying the Maths degree courses.*
Year: II, Bachelor, Semester: I, for the level A2
Year: III, Bachelor, Semester: I, for the level B1
Sector: L-LIN/12
Prerequisites: noone
Hours of lessons: 60

Curated by CLA-Centro Linguistico d'Ateneo, http://cla.unipg.it/
Tel 075 585 6804

Content

A "placement test" is realized at the beginning to establish the level of each student, then students follow the defined levels.

References

Consult the lecturers.

LINGUA ITALIANA

ITALIAN LANGAGE

Curated by CLA-Centro Linguistico d'Ateneo, http://cla.unipg.it/
TEL 075 585 6804

Consult the wp http://cla.unipg.it/erasmus/53-erasmus-incoming.html

MATEMATICHE COMPLEMENTARI – 6 CFU

COMPLEMENTARY MATHEMATICS

Subtitle: *Applications of Abstract Algebra with MAPLE*
Year: Free, Master
Semester: II
Sector: MAT/04
Prerequisites: Algebra and Geometry from the bachelor degree.
Hours of lessons: 42

Lecturer: Giorgio Faina, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5009, E-mail: faina@dmi.unipg.it
http://www.dmi.unipg.it/faina

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.

Textbooks

Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with* MAPLE**,** CRC Press, 1999.
Notes will be supplied by the lecturer.

MECCANICA RAZIONALE I - 9 CFU

RATIONAL MECHANICS I

Subtitle: *Lagrangian and Hamiltonian Mechanics*
Year: III Bachelor
Semester: I
Sector: MAT/07
Prerequisites: Basic knowledge of calculus in more variables, linear algebra and newtonian mechanics
Hours of lessons: 63

Lecturer: Maria Clara Nucci, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5016, E-mail: nucci@dmi.unipg.it
http://www.dmi.unipg.it/nucci

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.

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.

METODI GEOMETRICI IN TEORIA DELLA RELATIVITÀ - 6 CFU

GEOMETRICAL METHODS IN RELATIVITY THEORY

Subtitle: *Geometry and the theory of relativity*
Year: I Master
Semester: I
Sector: MAT/03

Prerequisites: Basic concepts of linear algebra and mathematical analysis in several variables. Elements of classical physics.
Hours of lessons: 42

Lecturer: Marco Mamone Capria, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5006, E-mail: mamone@dmi.unipg.it
http://www.dmi.unipg.it/mamone

Content

The principle of relativity in classical physics. Newtonian space-time. The origins of special relativity. Deductions of the Lorentz transformation. Pseudoeuclidean affine geometry. Poincaré group and its subgroups. Minkowski space-time. Proper time. Relativistic dynamics.
Shock. Equivalence mass-energy. Electromagnetism. Some notions of general relativity and cosmology.

Textbooks

R. D'Inverno, *Introducing Einstein's Relativity*, Cambridge Univ. 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 Univ. Press 1986.
V. A. Ugarov, *Teoria della relatività ristretta*, Edizioni Mir, 1982.

Notes will supply by the lecturer.

METODI MATEMATICI PER L'ECONOMIA – 6 CFU

MATHEMATICAL METHODS FOR ECONOMICS

Subtitle: *Main mathematical tools which apply to microeconomics*
Year: Free, Bachelor
Semester: I
Sector: MAT/05
Prerequisites: Basic concepts of the course Analisi Matematica 2
Hours of lessons: 42

Lecturer: Irene Benedetti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5017, E- mail: irene.benedetti@dmi.unipg.it

Content

The aim of the course is to give the main tools which are useful to understand some elements in microeconomics: demand and consumer theory, marshallian and hicksian demand, Pareto's optima, Walrasian equilibria and welfare economy theorems. With this aim the following mathematical subjects will be covered: free optimization theory, optimization theory with equality and inequality constraints, Lagrange multipliers, homotetic, concave and convex functions.

Textbooks

J C. P. Simon, L.E. Blume, *Mathematics for Economists*, Norton and Company Ink, 1994

Notes will be supplied by the lecturer.

METODI MATEMATICI PER PROCESSI STOCASTICI - 6 CFU

MATHEMATICAL METHODS FOR STOCHASTIC PROCESSES

Subtitle: *Main stochastic processes and elements of stochastic integration*
Year: I Master
Semester: I
Sector: MAT/05
Prerequisites: Probability Theory, Calculus.
Hours of lessons: 42

Lecturer: Domenico Candeloro, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5034, E-mail: candelor@dmi.unipg.it
http://www.dmi.unipg.it/candelor

Content

Random Walks: generalities, recurrence times, reflection principle. Markov Chains: general concepts, classification of states, invariant distributions and relations with mean recurrence times. Martingales: definition and examples, main convergence theorems, optional theorem. Stationary Processes: the ergodic theorems with applications. Gaussian Processes: definitions, examples, Wiener Process and construction

of Brownian Motion. Stochastic Calculus: basic concepts for the Ito integral, Ito's formulas, and linear stochastic differential equations.

Textbooks

Grimmett-Stirzaker: *Probability and Random Processes*; Clarendon Press, Oxford, 1982.
Mikosch: *Elementary Stochastic Calculus*; World Scientific Publ. Co. Singapore, 1998.

Notes will be supplied by the lecturer.

MODELLI GEOMETRICI - 6 CFU

GEOMETRICAL MODELS

Subtitle: *Mathematics Teaching*
Year: I Master
Semester: I
Sector: MAT/03
Prerequisites: None
Hours of lessons: 42

Lecturer: Emanuela Ughi, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5008, E-mail: ughi@dmi.unipg.it

Content

Formal and informal didactics: examples of puzzles, exhibitions, shows having mathematical aspects. Difficulties in mathematics: teaching tools, proposals to help children having problems and/or handicaps. New technologies in teaching mathematics: in particular, Geogebra and its features.

Textbooks

Notes will be supplied by the lecturer.

MODELLI MATEMATICI PER LA FINANZA - 6 CFU

MATHEMATICAL MODELS FOR FINANCE

Subtitle: *Arbitrage theory for discrete and continuous time market models and its applications to pricing and hedging problems for financial derivatives*.
Year: I Master
Semester: II
Sector: MAT/06
Prerequisites: Probability Theory and Mathematical Analysis.
Hours of lessons: 42

Lecturer: Alessandra Cretarola, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5021, E-mail: alessandra.cretarola@dmi.unipg.it

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. Itô'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. Interest rate models.

Textbooks

T. Björk, *Arbitrage Theory in Continuous Time,* Oxford University Press, 2004.
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 University Press, Springer, 2011.
D. Revuz, M. Yor, *Continuous Martingales and Brownian Motion*, 3rd edn., Springer–Verlag, Berlin, 1999.

PROBABILITÀ E STATISTICA 1 - 12 CFU

PROBABILITY AND STATISTICS

Subtitle: *Introductory course on probability and statistics*
Year: II Bachelor
Semester: II
Sector: MAT/06
Prerequisites: main contents from the courses Analisi Matematica I, Geometria I, Algebra I, Informatica I
Hours of lessons: 84

Lecturer: *Module 1* - **Giuliana Regoli, Dipartimento di Matematica e Informatica,**
Tel. +39 075 *585 5022,* E-mail: regoli@dmi.unipg.it
Module 2 – **Module 2 Andrea Capotorti - Dipartimento di Matematica e Informatica -**
Tel.+39 075 *585 5011*, E-mail: capot@dmi.unipg.it

Content

Module 1- 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.
Module 2 –Descriptive statistics: graphs, mode, median, sample moments. Statistical models, parametric estimation, interval estimation., hypothesis test Linear regression. Basic Bayesian inference.

Textbooks

Antonelli S., Regoli G.: *Probabilità discreta: Esercizi con richiami di Teoria*, Liguori editore,ed. 2005
Baldi P.: *Calcolo delle Probabilità* . McGraw-Hill ed., 2011.
Forcina A., Stanghellini E.: Elementi di statistica per economia , Morlacchi Editore 2005.
Iacus S.M., Masarotto G.*: Laboratorio di statistica con* R. McGraw-Hill.

STORIA DELLE MATEMATICHE I - 6 CFU

HISTORY OF MATHEMATICS I

Subtitle: *From the Ishango bone to Fibonacci*
Year: Free, Bachelor
Semester: II
Sector: MAT/04
Prerequisites: None
Hours of lessons: 42

Lecturer: Maria Clara Nucci, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5016, E-mail: nucci@dmi.unipg.it
http://www.dmi.unipg.it/nucci

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.

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.

TEORIA DELLE DECISIONI - 6 CFU

DECISION THEORY

Subtitle: *Decisional models in the presence of certainty, uncertainty and risk.*
Year: I Master
Semester: I
Sector: MAT/06
Prerequisites: Algebra 1, Analisi Matematica 2, Probabilità e Statistica
Hours of lessons: 42

Lecturer: Giulianella Coletti, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5019, E-mail: coletti@dmi.unipg.it

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.

Textbooks

References will be supplied by the lecturer.

TOPOLOGIA I - 6 CFU

TOPOLOGY I

Subtitle: *Topological spaces and topological properties*
Year: Free, Bachelor
Semester: I
Sector: MAT/03
Prerequisites: Basic concepts of topology
Hours of lessons: 42

Lecturer: Alessandro Caterino, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5013 E-mail: caterino@dmi.unipg.it
http://www.dmi.unipg.it/caterino

Content

Topological spaces and continuous functions. Subspaces, product spaces and quotient spaces. Separation and countability axioms. Compactness and weak compactness. Metrizability. Connectedness. Homotopy.

Textbooks

J. R. Munkres, *Topology: a first course*, Prentice-Hall, 1975
S. Willard, *General Topology*, Addison-Wesley Publishing, 1970.