

Degrees in Mathematics

Extract from the Bulletin (*Notiziario*) 2011-2012 (*)

COURSES PROGRAMME

Academic Year 2011/2012

I Semester:

Thursday 3, October 2011 - Friday 13, January 2012

II Semester:

Thursday 1, March 2012 - Friday 15, June 2012

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

Notes

The new 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 is earned by attending 7 or 8 hours of lectures (depending on the year of the didactic organization, labelled d.o.).

All lectures are held in Italian language.

Attendance of the lectures is warmly recommended.

The training offer for the Bachelor and the Master Degrees in Mathematics is also available to the address

http://web.unipg.it/offertaformativa/index.php?option=com_off&controller=corso&layout=default&corso=455&tab=SCH&Itemid=11

http://web.unipg.it/offertaformativa/index.php?option=com_off&controller=corso&layout=default&corso=525&tab=SCH&Itemid=11

AA 2011-2012

Courses at the first level: *Mathematics*

<u>NAME</u>	D.O 2009: 1 CFU = 8 hours D.O. 2010, 2011: 1 CFU = 7 hours	Sector	CFU	Year / Semester	<u>LECTURER</u>
1. ALGEBRA 2 (Algebra 2)	2009	MAT/02	6	3 / II	FAINA Giorgio
2. ALGEBRA I (Algebra I)	2011	MAT/02	6	1 / I	VIPERA Maria Cristina
3. ALGEBRA II (Algebra II)	2011	MAT/02	9	1 / II	LORENZINI Anna
4. ANALISI MATEMATICA I (Mathematical Analysis I)	2011	MAT/05	9	1 / I	PUCCI Patrizia
5. ANALISI MATEMATICA II (Mathematical Analysis II)	2010	MAT/05	9	2 / I	CARDINALI Tiziana
6. ANALISI MATEMATICA III (Mathematical Analysis III)	2010	MAT/05	9	2 / II	FILIPPUCCI Roberta
7. ANALISI MATEMATICA 4 (Mathematical Analysis 4)	2009	MAT/05	6	3 / I	PUCCI Patrizia
8. ANALISI NUMERICA 2 (Numerical Analysis 2)	2009	MAT/08	6	3 / I	GERACE Ivan
9. CALCOLO DELLE PROBABILITA' (Probability)	2009	MAT/06	6	3 / II	REGOLI Giuliana
10. FISICA 2 (Physics 2)	2009	FIS/01	6	3 / II	Borrowed from Physics II
11. FISICA I (Physics I)	2011	FIS/01	9	1 / II	CODINO Antonio
12. FISICA II (Physics II)	2010	FIS/01	9	2 / II	CECCHI Claudia
13. FISICA MATEMATICA 1 (Mathematical Physics 1)	2009	MAT/07	6	3 / I	SALVATORI Maria Cesarina
14. GEOMETRIA I (Geometry I)	2011	MAT/03	9	1 / I	VINCENTI Rita
15. GEOMETRIA II (Geometry II)	2011	MAT/03	9	1 / II	CATERINO Alessandro
16. GEOMETRIA III (Geometry III)	2010	MAT/03	9	2 / I	GUERRA Lucio
17. GEOMETRIA 4 (Geometry 4)	2009	MAT/03	6	3 / I	FATABBI Giuliana
18. GEOMETRIA COMBINATORIA (Combinatorial Geometry)	2009	MAT/03	6	Free / II	VINCENTI Rita
19. INFORMATICA 2 (Computer Science 2)	2009	INF/01	6	3 / I	Borrowed from Programming I and Laboratory , degree in COMPUTER SCIENCE , to be assigned
20. INFORMATICA I (Computer Science I)	2011	INF/01	6	1 / I	BAIOLETTI Marco
21. INFORMATICA II (Computer Science II)	2010	ING- INF/05	9	2 / I	BIOCCHI Rosanna
22. INGLESE (English)	2011	L-LIN/12	3	2 / annual	By the language center CLA

23. LABORATORIO DI FISICA 1 (Laboratory of Physics 1)	2009	FIS/01	6	3 / II	SANTUCCI Aldo
24. MATEMATICHE ELEMENTARI P.V.S. (Elementary Mathematics from a higher point of view)	2009	MAT/04	6	3 / II	CONTI Francesca
25. METODI MATEMATICI PER L'ECONOMIA (Mathematical Methods for Economics)	2009	MAT/05	6	3 / I	BENEDETTI Irene
26. PROBABILITA' E STATISTICA I (Probability and Statistics) Module 1 and Module 2	2010	MAT/06	6	2 / II	REGOLI Giuliana
	2010	MAT/06	6	2 / II	To be assigned
27. STORIA DELLE MATEMATICHE (History of Mathematics)	2009	MAT/04	6	Free / II	NUCCI Maria Clara
28. TEORIA DELL'INFORMAZIONE 1 (Information Theory 1)	2009	INF/01	6	Free / II	BISTARELLI Stefano Borrowed from Computer Security, degree in COMPUTER SCIENCE
29. TOPOLOGIA 1 (Topology 1)	2008	MAT/03	6	Free / II	CATERINO Alessandro

AA 2011-2012

Courses at the second level: *Mathematics*

<u>NAME</u>	D.O. 2010 and 2011: 1 CFU = 7 hours	Sector	CFU	Year / Semester	<u>LECTURER</u>
1. ALGEBRA III (Algebra III)	2011	MAT/02	6	1 / I	LORENZINI Anna
2. ANALISI DI METODI NUMERICI (Analysis of numerical Methods)	2011	MAT/08	6	1 / I	GERACE Ivan
3. ANALISI MATEMATICA V (Mathematical Analysis V)	2011	MAT/05	9	1/ II	PUCCI Patrizia
4. ANALISI MATEMATICA 6 (Mathematical Analysis 6)	2010	MAT/05	6	2 / I	VITILLARO Enzo
5. ANALISI SUPERIORE (Higher Analysis)	2010,2	MAT/05	6	Free / I	MUGNAI Dimitri
6. DIDATTICA DELLA FISICA (Didactics of Physics)	2010,2	FIS/01	6	2 / I and 1/I	COREZZI Silvia
7. DIDATTICA DELLA MATEMATICA (Didactics of Mathematics)	2010,2	MAT/04	6	2 / I and 1/I	UGHI Emanuela
8. EQUAZIONI DIFFERENZIALI (Differential Equations)	2010,2	MAT/05	6	Free / II	CARDINALI Tiziana
9. FISICA MATEMATICA II (Mathematical Physics II)	2011	MAT/07	6	1 / I	DE LILLO Silvana
10. FISICA MATEMATICA 3 (Mathematical Physics 3)	2010	MAT/07	6	2 / I	NUCCI Maria Clara
11. FISICA MODERNA (Modern Physics)	2010	FIS/03	6	2 / I	SACCHETTI Francesco
12. GEOMETRIA V (Geometry V)	2011	MAT/03	9	1 / II	TANCREDI Alessandro
13. GEOMETRIA 6 (Geometry 6)	2010	MAT/03	6	2 / I	TANCREDI Alessandro
14. INFORMATICA 3 (Computer Science 3)	2010	INF/01	6	2 / I	CARPI Arturo Borrowed from Theoretical Computer Science , degree in COMPUTER SCIENCE (*)

15. MATEMATICHE COMPLEMENTARI (Additional Mathematics)	2010	MAT/04	6	Free / II	ZAPPA Paolo
16. MAT. ELEM. PdVS I (Elementary Mathematics from a higher point of view I)	2010	MAT/04	6	2 / I	BRANDI Primo
17. MAT. ELEM. PdVS II (Elementary Mathematics from a higher point of view II)	2011	MAT/04	6	1 / II	CONTI Francesca
18. MECCANICA SUPERIORE (Higher Mechanics)	2011	MAT/07	6	Free / I	MAMONE CAPRIA Marco
19. MODELLI MATEMATICI PER LA FINANZA (Mathematical models for Finance)	2011	MAT/06	6	1 / II	CRETAROLA Alessandra
20. PROCESSI STOCASTICI (Stochastic Process)	2010,2	MAT/06	6	Free / II	CANDELORO Domenico
21. STORIA delle MATEMATICHE (History of Mathematics)	2010	MAT/04	6	Free / II	NUCCI Clara Borrowed from the first level degree .
22. TEORIA DEI CODICI E CRITTOGRAFIA (Coding theory and Cryptography)	2010,2	MAT/03	6	Scelta / II	GIULIETTI Massimo
23. TEORIA DELLE DECISIONI (Decision Theory)	2011	MAT/06	6	1 / I	COLETTI Giulianella
24. TEORIA DELL'INFORMAZIONE II (Information Theory II)	2011	INF/01	6	1 / I	FAINA Giorgio

(*) It can be borrowed alternatively from **Information Security: planning, assessment and computer forensic** (II semester), MILANI Alfredo, degree in **COMPUTER SCIENCE**.

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 in which the course might be attended (if nothing else is specified) otherwise *I master* or *II master* suggests the year 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/s of the scientific area/s 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

8 - 1 ECTS is equivalent to 1 CFU (Crediti Formativi Universitari) that consists of 7 or 8 hours *in lecture-hall* plus 18 or 17 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, finite and infinite cardinals, number systems*

Year: I

Semester: I

Sector: MAT/02

Prerequisites: None

Hours of lessons: 42

Lecturer: Maria Cristina Vipera, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5012, E-mail: vipera@dmf.unipi.it

Content

Sets, subsets, operations. Cartesian product. Mappings. Equivalence relations and partitions. Orders. Peano's axioms. Finite and infinite cardinals. Numerability. Combinatorial calculus. Integer, rational and real numbers. Ring of integers. Residue Classes.

Textbooks

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

ALGEBRA II - 9 CFU

ALGEBRA II

Subtitle: *Groups, rings, fields*

Year: I

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@dmf.unipi.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@dmf.unipi.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 varieties. 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 varieties.

Textbooks

Cox-Little-O'Shea, *Ideals, varieties and algorithms*, Springer (1997)

Atiyah-MacDonald, *Introduction to commutative algebra*, Addison-Wesley (1969).

ALGEBRA 2 - 6 CFU

ALGEBRA 2

Subtitle: *Algorithmic number theory and cryptography*

Year: III

Semester: II

Sector: MAT/02

Prerequisites: None

Hours of lessons: 48

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

This course will cover some topics from algorithmic number theory. The special emphasis will be given to the topics which are relevant for applications in cryptography. Applications of number theory in cryptography are very important in constructions of public key cryptosystems. The most popular public key cryptosystems are based on the problem of factorization of large integers and discrete logarithm problem in finite groups, in particular in the multiplicative group of finite field and the group of points on elliptic curve over finite field. In this course we will study these problems and explain some algorithms for their solution. The starting point in the construction of almost all public key cryptosystems is the choice of one or more large prime numbers. For that reason, the most popular probabilistic and deterministic primality tests will also be described in the course.

Textbooks

S. Leonessi, C. Toffalori, *Numeri e crittografia*, Springer 2006.

Notes will be supplied by the lecturer.

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. Bad-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

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. Indeterminate 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 \mathbf{R}^n .*

Year: II

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:

G. Prodi, *Lezioni di Analisi Matematica 2*, Bollati Boringhieri, 2011

G. Buttazzo, V. Colla, *Temi di esame di Analisi Matematica II*, Pitagora Ed., 2001

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

D. Benedetto, M. Degli Esposti, C. Maffei, *Matematica per le Scienze della Vita*, Casa Ed. Ambrosiana, 2012.

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

ANALISI MATEMATICA III - 9 CFU

MATHEMATICAL ANALYSIS III

Subtitle: *Sequences and series of functions. Differential equations and systems.*

Year: II

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. Convex functions and some 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 4 - 6 CFU

MATHEMATICAL ANALYSIS 4

Subtitle: *Real Analysis.*

Year: III

Semester: I

Sector: MAT/05

Prerequisites: Analisi Matematica 3.

Hours of lessons: 48

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. 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.

G. Leoni, *A first course in Sobolev spaces*, Ch. 2-3,7, Graduate Studies in Mathematics, 105., Amer. Math. Soc., Providence, RI, 2009.

E. Hewitt & K. Stromberg, *Real and abstract analysis. A modern treatment of the theory of functions of a real variable*, Third printing, Graduate Texts in Mathematics, No. 25. Springer-Verlag, New York-Heidelberg, 1975

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, linear 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 6 - 6 CFU

MATHEMATICAL ANALYSIS 6

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

Year: II

Semester: I

Sector: MAT/05

Prerequisites: Analisi Matematica 5

Hours of lessons: 42

Lecturer: Enzo Vitillaro, Dipartimento di Matematica e Informatica,

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

Content

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.

Textbooks

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

L.Evans, *Partial Differential Equations. Graduate Studies in Mathematics,19, American Mathematical Society 1998.*

Notes will be supplied by the lecturer.

ANALISI NUMERICA 2 - 6 CFU

NUMERICAL ANALYSIS 2

Subtitle: *Basic concepts of numerical approximation of continuous problems.*

Year: III

Semester: I

Sector: MAT/08
Prerequisites: None
Hours of lessons: 48

Lecturer: Ivan Gerace, Dipartimento di Matematica e Informatica

Tel. 075 585 5050, E-mail: gerace@dmi.unipg.it

Content

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

Textbooks

Bevilacqua, Bini, Capovani, Menchi, *Metodi numerici per l'algebra lineare*, Zanichelli, 1996.

ANALISI SUPERIORE - 6 CFU

HIGHER ANALYSIS

Subtitle: *Nonlinear analysis and partial differential equations*

Year: II Master

Semester: I

Sector: MAT/05

Prerequisites: Mathematical Analysis 5

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 Spaces. 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 - 6 CFU

PROBABILITY THEORY

Subtitle: Intermediate course on probability theory

Year: III

Semester: II

Sector: MAT/06

Prerequisites: Analisi Matematica 1, Analisi Matematica 2, Analisi Matematica 3, Geometria 1, Algebra 1, Probabilità e statistica

Hours of lessons: 48

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 multivariate random variables; independence, conditional independence.

Weak convergence. Convergence in probability. Almost sure convergence. Limit Theorems: Law of Large Numbers; Central Limit Theorems.

Textbooks

G. Dall'Aglio, *Calcolo delle probabilità*, Ed. Zanichelli, 2001.

Y. A. Rozanov, *Probability Theory (A concise course)*, Dover Publ., Inc. New York, 1977.

Summarizing notes will be supplied by the lecturer.

DIDATTICA DELLA FISICA - 6 CFU

DIDACTICS OF PHYSICS

Subtitle: *Non-classical experimental tools in Physics Teaching*

Year: Master

Semester: I

Sector: FIS/01

Prerequisites: Fisica I, Fisica II

Hours of lessons: 42

Lecturer: Silvia Corezzi, Dipartimento di Fisica, Tel. +39 075 585 2799,

E-mail: corezzi@fisica.unipg.it

Content

The course is an advanced laboratory of modern physics, consisting of an introductory module and a module in which they are

conducted laboratory experiments: measurement methods, laser diffraction, Rutherford experiment, experiment of Franck-Hertz, Millikan's experiment, time resolution of a photomultiplier.

Textbooks

Contact the lecturer.

DIDATTICA DELLA MATEMATICA - 6 CFU

DIDACTICS OF MATHEMATICS

Subtitle: *Mathematics Teaching*

Year: Master

Semester: I

Sector: MAT/04

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.

EQUAZIONI DIFFERENZIALI - 6 CFU

DIFFERENTIAL EQUATIONS

Subtitle: *Differential equations*

Year: 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 \mathbf{R}^n* , Ed. Liguori, 1978.

FISICA I - 9 CFU

PHYSICS I

Subtitle: *Mechanics and thermodynamics*

Year: I

Semester: II

Sector: FIS/01

Prerequisites: Vectors, operations with vectors. Derivatives and integrals of one variable functions.

Hours of lessons: 63

Lecturer: Antonio Codino, Dipartimento di Fisica,

Tel. +39 075 585 2743, E-mail: antonio.codino@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

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

Semester: I

Sector: MAT/07

Prerequisites: Analisi Matematica 3

Hours of lessons: 48

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 - 6 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: 42

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 3 - 6 CFU

MATHEMATICAL PHYSICS 3

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: 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

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: Differential operators, eigenvalue equations, linear space, norm and inner product

Hours of lessons: 42

Lecturer: Francesco Sacchetti, Dipartimento di Fisica, Tel. +39 075 585 2737,

E-mail: francesco.sacchetti@pg.infn.it,

<http://www.fisica.unipg.it/homes/sacchetti/matematica/fisicamoderna.html>

Content

The reference systems in physics. Reformat axioms of physics. Mathematical formalization of Restricted Relativity. Possible simplifications with educational purposes. Axiomatization of Quantum Mechanics. The observable in the microscopic world. The problem of identical particles and its consequences. The phenomenon of entanglement quantum. The Bell inequality and the problem of realism. Reductionism and complexity.

Textbooks

Notes will be supplied by the lecturer.

GEOMETRIA I - 9 CFU

GEOMETRY I

Subtitle: *Basic linear algebra, affine geometry.*

Year: I

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 \mathbb{R} . Vector spaces over a field K . Linear systems over \mathbb{R} . Geometry of the affine plane and of the 3-dimensional affine space over \mathbb{R} . Generalization. Linear applications. Groups of linear transformations and affinities.

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.

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

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. Topological and metric spaces. Connected and compact spaces.

Textbooks

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

M. Stoka, *Corso di geometria*, Cedam, Padova, 1995

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

A. Basile, *Algebra lineare e geometria cartesiana*, Margiacchi-Galeno Editore, Perugia, 1997.

Notes will be supplied by the lecturer.

GEOMETRIA III - 9 CFU

GEOMETRY III

Subtitle: *Projective geometry*

Year: II

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. Conics and quadrics, affine and projective.

Textbooks

E. Sernesi, *Geometria 1*, Bollati-Boringhieri, 1989.

M. Reid and B. Szendroi, *Geometry and Topology*, Cambridge University Press, 2005.

GEOMETRIA 4 - 6 CFU

GEOMETRY 4

Subtitle: *Algebraic plane curves*

Year: III

Semester: I

Sector: MAT/03

Prerequisites: Algebra I, Geometria I, Geometria II

Hours of lessons: 48

Lecturer: Giuliana Fatabbi, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5020, E-mail: fatabbi@dmi.unipg.it

Content

Rings of polynomials in several variables. Affine and projective plane curves. Local study of plane curves. Flexes. Intersections of projective curves.

Textbooks

C. G. Gibson, *Elementary geometry of algebraic curves*, Cambridge University Press, 1998.

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

Smooth manifolds. Vector bundles. Smooth vector fields. Differential forms. Integration on manifolds.

Textbooks

R. Narasimhan, *Analysis on real and complex manifolds*, North Holland 1985.

L. W. Tu, *An introduction to manifolds*, Springer 2008.

GEOMETRIA 6 - 6 CFU

GEOMETRY 6

Subtitle: *Algebraic models analytic objects.*

Year: II Master

Semester: I

Sector: MAT/03

Prerequisites: Geometria 5

Hours of lessons: 42

Lecturer: Alessandro Tancredi, Dipartimento di Matematica e Informatica – Phone: 075 585 5007 –

E-mail: altan@unipg.it

Content

Nash functions. Algebraic and Nash sets. Algebraic approximations.

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 - 6 CFU

COMBINATORIAL GEOMETRY

Subtitle: *Galois Geometries and algebraic-geometric codes.*

Year: III

Semester: II

Sector: MAT/03

Prerequisites: Algebra 1, Algebra 2, Geometria 1, Geometria 2.

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.dmi.unipg.it/alicew>

Content

The geometry $PG(r, q)$, $r \geq 1$. Linear projective groups. Desargues, Pappus, Pascal Theorems. Projective varieties. Quadrics in $PG(r, q)$. Grassmannians. Rational normal curves. Applications. Linear codes. Projective systems. Permutation Decoding.

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

Semester: I

Sector: INF/01
Prerequisites: None
Hours of lessons: 42

Lecturer: Marco Baiocchi, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5044, E-mail: baiocchi@dmi.unipg.it
<http://www.dmi.unipg.it/baiocchi>

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

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.

INFORMATICA 2

COMPUTER SCIENCE 2

BORROWED FROM **PROGRAMMING I AND LABORATORY** (COMPUTER SCIENCE DEGREE)
TO BE ASSIGNED

INFORMATICA 3 - 6 CFU

COMPUTER SCIENCE 3

1- borrowed from **Information security: planning, assessment and computer forensic**

Subtitle: *Information security: planning, assessment and computer forensic*

Year: II Master

Semester: II

Sector: INF/01

Prerequisites: None

Hours of lessons: 42

Lecturer: Alfredo Milani, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5049, E-mail: milani@unipg.it
<http://www.dmi.unipg.it/milani>

Content

Information security policies. Certification of security products and security processes. The ISO/IEC 15408 and ISO/IEC 27001:2005 certification standards. Analysis of information security risk. Prevention and management of information security incidents. Secure Programming and software vulnerability. Principle and methods of computer forensics.

Textbooks

*Lecture Notes supplied by the lecturer on the elearning platform <http://estudium.unipg.it>
ISO/IEC 27001:2005 Standard official report – ISO Press*

INFORMATICA 3 - 6 CFU

COMPUTER SCIENCE 3

2- borrowed from **Theoretical Computer Science**

Subtitle: *Computability Theory and Complexity Theory*

Year: II Master

Semester: I

Sector: INF/01

Prerequisites: None

Hours of lessons: 42

Lecturer: Arturo Carpi, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5014, E-mail: carpi@dmf.unipg.it

Content

Computability Theory: Alphabets, strings, languages.

Turing machine. Turing machines and languages. Turing machines and functions, Goedel coding.

Church-Turing thesis. Turing machines with several tapes. Non-deterministic Turing machines.

Algorithmically solvable problems and unsolvable problems. Universal Turing machine. Halting problem.

Decidable and semi-decidable sets. Hilbert 10-th problem. Primitive recursive functions. Church-computable functions. Partial recursive functions.

Complexity Theory: Time complexity classes. The complexity class P and the Edmonds-Cook-Karp thesis. The complexity class NP. The problem P=NP. NP-complete problems. Cook-Levin Theorem.

Space complexity classes. The complexity classes L, NL, PSPACE, NPSpace. Savitch Theorem.

Textbooks

C. Toffalori, F. Corradini, S. Leonesi, S. Mancini, *Teoria della computabilità e della complessità*, McGraw-Hill

J. Hopcroft, R. Motwani, J. Ullman, *Automi, linguaggi e calcolabilità*, Pearson

M. Davis, *Computability and Unsolvability*, Dover (ediz. Italiana: Abete, 1974).

LABORATORIO DI FISICA I – 6 CFU

LABORATORY OF PHYSICS I

Subtitle: *Basic concepts of measurement, errors and data processing theory*

Year: III

Semester: II

Sector: FIS/01

Prerequisites: Analisi Matematica 1, Fisica 1

Hours of lessons: 48

Lecturer: Aldo Santucci, Dipartimento di Fisica

Tel. +39 075 5852717, E-mail: symbio@fisica.unipg.it

Content

Systems of measurement units, fundamental quantities. Measurement errors. Functional relationships between physical quantities, introduction to the use of graphs. Laboratory experiences: callipers, precision balance, simple pendulum, gratings and lenses. Wheatstone's bridge.

Textbooks

G. Cannelli, *Introduzione alla Esperimentazione fisica*, Ed. EDISES (Napoli).

Notes will be supplied by the lecturer.

MATEMATICHE COMPLEMENTARU – 6 CFU

COMPLEMENTARY MATHEMATICS

Subtitle: *Algebraic numbers.*

Year: I Master

Semester: II

Sector: MAT/03

Prerequisites: Basic abstract algebra and basic analysis.

Hours of lessons: 42

Lecturer: Paolo Zappa, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5016, E-mail: zappa@dmi.unipg.it

Content

Continued fractions. Elements of Galois Theory.

Textbooks:

A. M. Rockett, P. Szűsz, *Continued fractions*, World Scientific, 1992.

I. Stewart, *Galois theory*, Chapman and Hall, Ltd, London, 1973.

MATEMATICHE ELEMENTARI DA UN PUNTO DI VISTA SUPERIORE - 6 CFU

ELEMENTARY MATHEMATICS FROM A HIGHER POINT OF VIEW

Subtitle: *Foundations and Education in Mathematics.*

Year: III

Semester: II

Sector: MAT/04

Prerequisites: Algebra 2, Geometria 4

Hours of lessons: 48

Lecturer: Francesca Conti, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5023, E-mail: fconti@dmi.unipg.it

Content

Formalization of Geometry: from an axiomatic theory non-definitively formal to a formal axiomatic theory (Euclid, Hilbert, Choquet). Non-Euclidean Geometries and their models. The theory of metric planes. Learning-teaching Mathematics: problems and expectations. In choosing and using Maths tools for teaching.

Textbooks

Euclide, *Gli Elementi*, Classici UTET, 1970.

Hilbert D., *Fondamenti di Geometria*, Feltrinelli, 1970.

Choquet, *L'insegnamento della Geometria*, Feltrinelli, 1967.

Resnick L.B, Ford W.W., *Psicologia della matematica e apprendimento scolastico*, SEI, Torino, 1991.

Spagnolo, *Insegnare matematica nella scuola secondaria*, La Nuova Italia, 1999.

D'Amore B., *Didattica della Matematica*, Pitagora Editrice, Bologna, 2001.

Papers from specialized review in mathematical didactics will be supplied by the lecturer.

MATEMATICHE ELEMENTARI DA UN PUNTO DI VISTA SUPERIORE I - 6 CFU

ELEMENTARY MATHEMATICS FROM A HIGHER POINT OF VIEW I

Subtitle: *Elementary mathematical models*

Year: II Master

Semester: I

Sector: MAT/04

Prerequisites: None

Hours of lessons: 42

Lecturer: Primo Brandi, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5037 or 3821, E-mail: primo.brandi@alice.it

Content

Elementary mathematical models in applications and didactics.

Textbooks

P.Brandi, A.Salvadori, *Matematica&Realtà. Laboratori di sperimentazione didattica*. Università degli Studi di Perugia, 2006-2011.

MATEMATICHE ELEMENTARI DA UN PUNTO DI VISTA SUPERIORE II - 6 CFU

ELEMENTARY MATHEMATICS FROM A HIGHER POINT OF VIEW II

Subtitle: *Maths foundations and Maths education.*

Year: I Master

Semester: II

Sector: MAT/04

Prerequisites: Algebra and Geometry from the bachelor degree.

Hours of lessons: 42

Lecturer: Francesca Conti, Dipartimento di Matematica e Informatica,

Tel. +39 075 585 5023, E-mail: fconti@dmi.unipg.it

Content

Projective geometry of the plane and of the 3-dimensional space: history, theory and didactics. Groups of transformations and the Erlangen program. Main foundations of the projective geometry and the classification from both historical-epistemological and educational point of view.

Textbooks

W.T. Fishback, *Projective and Euclidean Geometry*, Wiley & Sons N.Y., 1969

F. Speranza, *Matematiche Complementari* – Univ. Parma, 2008.

Papers from specialized reviews in mathematical didactic will be supplied by the lecturer.

MECCANICA SUPERIORE - 6 CFU

HIGHER MECHANICS

Subtitle: *Foundations of the theory of relativity*

Year: Master

Semester: I

Sector: MAT/07

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. Deduction of the Lorentz transformation. Pseudoeuclidean affine geometry. Poincaré group and its subgroups. Minkowski space-time. Proper time. Relativistic dynamics. Shock. Equivalence massaenergia. Electromagnetism. Relations between the elements of relativity and quantum mechanics.

Textbooks

R. D'Inverno, *Introducing Einstein's Relativity*, Cambridge Univ. Press, 1992.

M. Mamone Capria (a cura di), *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 I – 6 CFU

MATHEMATICAL METHODS FOR ECONOMICS I

Subtitle: *Main mathematical tools which apply to microeconomics*

Year: III

Semester: I

Sector: MAT/05

Prerequisites: Basic concepts of the course Analisi Matematica 2

Hours of lessons: 48

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, *Matematica 2*, Università Bocconi Editore, 2002

J C. P. Simon, L.E. Blume, *Matematica Generale*, Università Bocconi Editore, 2002.

Notes will be supplied by the lecturer.

MODELLI MATEMATICI PER LA FINANZA - 6 CFU

MATHEMATICAL MODELS FOR FINANCE

Subtitle:

Year: I Master

Semester: II

Sector: MAT/06

Prerequisites: basic concepts of probability 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

Tools of the fundamental basic concepts of Probability and Mathematical Analysis.

Introduction to financial markets. Elements of probability. Market models in discrete time. Continuous time stochastic processes. Elements of theory of stochastic Itô formula. Black-Scholes model. Differential stochastic equations, geometric Brownian motion, representatio formula of Feynmann-Kac. Interest rate models.

Textbooks

T. Björk, *Arbitrage Theory in Continuous Time*, Oxford University Press, 2004.

M. E. De Giuli, M. A. Maggi, U. Magnani, E. Rossi, *Derivati – Teoria e Applicazioni*, G. Giappichelli Editore, Torino, 2002.

J. C. Hull, *Opzioni, Futures e altri Derivati*, Pearson Italia S.p.a., 2006.

D. Lamberton, B. Lapeyre, *Introduction to Stochastic Calculus Applied to Finance*, Chapman and Hall London 1996.

A. Pascucci, *Calcolo Stocastico per la Finanza*, Springer-Verlag Italia, Milano, 2008.

PROCESSI STOCASTICI - 6 CFU

STOCHASTIC PROCESS

Subtitle: *A summary of the most common stochastic processes*

Year: Master

Semester: II

Sector: MAT/06

Prerequisites: Calculus, Probability

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.

PROBABILITÀ E STATISTICA 1 - 12 CFU

PROBABILITY AND STATISTICS

Subtitle: *Introductory course on probability and statistics*

Year: II

Semester: II

Sector: MAT/06

Prerequisites: 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 – not yet assigned

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. Multivariate random variables: joint and marginal distributions, conditional distributions. Relations among random variables; transforms of random variables. Common probability distributions. Approximations.

Textbooks

P. Baldi, *Calcolo delle Probabilità*. McGraw-Hill ed., 2011.

S. Antonelli, G. Regoli, *Probabilità discreta: Esercizi con richiami di Teoria*, Liguori editore, ed. 2005

STORIA DELLE MATEMATICHE - 6 CFU

HISTORY OF MATHEMATICS

Subtitle: *From the Ishango bone to Fibonacci*

Year: III

Semester: II

Sector: MAT/04

Prerequisites: None

Hours of lessons: 48

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, Bollettino 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 DEI CODICI E CRITTOGRAFIA - 6 CFU

THEORY OF CODES AND CRYPTOGRAPHY

Subtitle: *Linear codes, algebraic geometric codes, elliptic curves, cryptography*

Year: I Master
Semester: II
Sector: MAT/03
Prerequisites: None
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

Linear codes and projective codes. Basic inequalities and bounds. Algebraic curves over finite fields. Fields of rational functions, divisors, Riemann-Roch spaces. Rational maps between algebraic curves. Algebraic Geometric codes. One point Goppa codes. Hermitian codes. Elliptic curve cryptography. Isogenies. Weil pairing and MOV attack to the elliptic curve cryptography.

Textbooks

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.

TEORIA DELLE DECISIONI - 6 CF

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.

TEORIA DELL' INFORMAZIONE I - 6 CFU

INFORMATION THEORY I

BORROWED FROM COMPUTER SECURITY

Subtitle: *Information Security and some concepts of Network and Data Security*

Year: Any

Semester: II

Sector: INF/01

Prerequisites: None

Hours of lessons: 52

Lecturer: Stefano Bistarelli, Dipartimento di Matematica e Informatica,
Tel. +39 075 585 5045, E-mail: bista@dmi.unipg.it
<http://www.dmi.unipg.it/bista/>

Content

Introduction to Security: Policies; Policies on confidentiality: Bell-LaPadula; Policies for integrity: Biba and Clark-Wilson; Mixed policies: Chinese Wall Model, ORCON, RBAC; Encryption, digital signatures,

PKI and certificates, Authentication Protocols (Needham-Schroeder, Woo-Lam) ; Authentication methods, Kerberos; Malicious logic; Firewalls and Network Security; Seminars by the students (which vary from year to year).

Textbooks

Books and materials suggested by the teacher at lessons.

Notes will be supplied by the lecturer.

TEORIA DELL' INFORMAZIONE II - 6 CFU

INFORMATION THEORY II

Subtitle: *Information theory and codes*

Year: I Master

Semester: I

Sector: INF/01

Prerequisites: None

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: Review of probability theory. Entropy. Mutual information. Data compression. Huffman coding. Asymptotic equipartition property. Universal source coding. Channel capacity. Differential entropy. Block codes and Convolutional codes.

Textbooks

R. Togneri - C.J. De Silva, Fundamentals of Information Theory and Coding Design, Chapman-Hall, London, 2003.

Notes will be supplied by the lecturer.

TOPOLOGIA 1 - 6 CFU

TOPOLOGY 1

Subtitle: *Topological spaces and topological properties*

Year: III

Semester: II

Sector: MAT/03

Prerequisites: Basic concepts of topology

Hours of lessons: 48

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. Metrizable. Connectedness. Homotopy.

Textbooks

J. R. Munkres, Topology: a first course, Prentice-Hall, 1975

S. Willard, General Topology, Addison-Wesley Publishing, 1970.