Doctoral School of Mathematical Sciences
Department of Mathematics
University of Padova

Courses of the Doctoral School of
Mathematical Sciences
2012

Updated September 3, 2012

INTRODUCTION

The courses offered, for the year 2012, to the Graduate Students in Mathematical Sciences include courses taught by internationally recognized external researchers, who have accepted our invitation; such courses will not necessarily be offered again in the future years. Considering the wide impact of the content of theses courses, we emphasize the important for all graduate students to follow them.
The Faculty of the Graduate School could cancel courses with an excessively low number of registered students.

Also next year, beside the courses that our School directly offers, we have selected some courses of the Graduate School in Information Engineering of the University of Padova that we consider relevant also for our School.

REQUIREMENTS FOR GRADUATE STUDENTS

With the advice of some Faculty member, all students are required to select some courses, either because they are linked with the area of their present or planned research, or just to improve their knowledge of specific subject.

This year, considering the fact that courses may vary in duration, we have decided to indicate a mandatory minimum numbers of hour.
Therefore, students are required, within the **first two years**, to follow and **pass the exam** of

- **At least 2 courses of the School**
- other courses, in addition to the two above, in two areas (**Computational Mathematics or Mathematics**) **or of the School**, with total commitment of **at least 64 hours**.

Students are encouraged to register for other courses; although to sit for the exam is not required for these courses, it is strongly advised. In all cases, students must participate with regularity to the activities of the courses the are registered to. At the end of the course the teacher will inform the Coordinators of the Areas on the activities of the course and of the registered students.

Institutional courses for Master of Science in Mathematics.

Students have the possibility to attend, with acquisition of credits, the courses of the Master of Science in Mathematics.
The interest for these courses must be indicated by the Supervisor or a tutor. The Council of the Area the students is enrolled in, will assign the number of hours that will be computed within the mandatory 64 hours.

HOW TO REGISTER TO COURSES

The online registration to courses has changed from last years, and allows students both to register and to cancel.
The registration is required for the attendance to all courses, independently of the intention to sit for the exam. The list of the courses can be found in the website of the School http://dottorato.math.unipd.it/ at the link Courses Registration (or directly at the address http://dottorato.math.unipd.it/registration/), filling the **online registration form** with all required data, and validating with the command “Register”.
To acknowledge the registration, an email message will be sent to the address indicated in the registration form; this email message must be saved, since it is necessary for possible cancellation.

Registration for a course implies the agreement of the applicant to the participation.
Requests of **cancellation** to a course must be submitted in a timely manner, and **at least one month before the course** (except those that begin in January and February) using the link indicated in the email message of acknowledgment.

REQUIREMENTS FOR PARTICIPANTS NOT ENROLLED IN THE GRADUATE SCHOOL OF MATHEMATICS

The courses in the catalog, although part of activities in the Graduate School in Mathematics and thus offered to its students, are also open to all students, graduate students and researchers of all Graduate Schools and other universities.
For reasons of organization, external participants are required to **indicate their wish to participate at least two months before the beginning of the course for courses taking place from April 2012 and at least one month before for courses that take place until March 2012, following the procedure described in the preceding paragraph.**
Possible **cancellation** to courses must also be notified.

Courses of the School

Courses of the “Computational Mathematics” area

Courses of the "Mathematics" area

1. Proff. Bruno Chiarellotto, Luca Migliorini
   Nearby and vanishing cycles **M-1**
2. Proff. Lawrence Craig Evans, Pierpaolo Soravia, Luca Rossi
   Topics in Nonlinear Partial Differential Equations **M-2**
3. Prof. Alberto Facchini
   Complements on Monoids, Rings and Modules **M-3**
4. Dr. Fabio S. Priuli
   Introduction to control theory **M-4**
5. Prof. Takeshi Saito
   Wild ramification of schemes and sheaves **M-5**
6. Proff. Jan Šťovíček, Jan Trlifaj
   Cohomology of quasi-coherent sheaves via model categories and approximation theory **M-6**

Courses in collaboration with the Doctoral School on "Information Engineering"

1. Prof. Lorenzo Finesso
   Statistical Methods **DEI-1**
2. Prof. Matteo Fischetti
   Polyhedral methods for Integer Linear Programming **DEI-2**
3. Prof. Harald Wimmer
   Applied Linear Algebra **DEI-3**
4. Prof. Gianluigi Pillonetto
   Applied Functional Analysis **DEI-4**
5. Prof. Maria Pia Saccomani
   Algebraic tools for the identifiability of Dinamical Systems **DEI-5**
6. Prof. Shiva Shankar
   The behavioral approach to control of distributed systems **DEI-6**
7. Prof. Francesco Ticozzi
   Topics in Quantum Information **DEI-7**

Courses of the School

Functional analysis and variational methods: a course in analysis, optimization, calculus of variations, and optimal control

Prof. Francis Clarke[1]

[1] *Universit Claude Bernard Lyon 1 (France)*
Institut Camille Jordan - UMR 5208
Email: clarke@math.univ-lyon1.fr

Timetable: 24 hrs. Lectures on May/June 2012 (see the calendar), Room 2BC/30, Torre Archimede. Possible small changes in the timetable will be communicated at the beginning of the course.

Course requirements:

Examination and grading: Seminar on a subject assigned by one of the Instructors

SSD: MAT/05

Aim: This course presents some modern tools for treating nonlinear problems in optimization and control. These include nonsmooth calculus, viscosity solutions, and discontinuous feedback. The need for such tools will be motivated, and applications will be made to central issues in the calculus of variations, and in both optimal and stabilizing control.

Course contents:

Specific topics for the dozen lectures include:

1. Dynamic optimization: from the calculus of variations to the Pontryagin Maximum Principle
2. Some constructs of nonsmooth analysis and geometry, and why we need them
3. Applications to optimization
4. Lyapunov functions and controllability, classical to modern
5. Discontinuous feedback for stabilization
6. Sliding modes and hybrid systems

Semigroup and Markov Processes

Proff. Paolo Dai Pra, Markus Fischer e Paolo Guiotto[1]

[1] *University of Padova*
Department of Mathematics
Email: {daipra, fischer, parsifal}@math.unipd.it

Timetable: 20 hrs. Lectures on February/March 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: Standard knowledge of Probability and measure theory.

Examination and grading: Seminar on a subject assigned by one of the Instructors

SSD: MAT/06

Aim: The course will illustrate the interplay between Functional Analysis and Probability in the construction of Stochastic Processes possessing the Markov Property.

Course contents:

I Part 1(P. Guiotto): Analytic Semigroup Theory (6 hrs.)

- Semigroups and generators
- The Hille-Yoshida Theorem
- Feller semigroups and associated Markov Processes

II Part 2 (P. Dai Pra): Construction of Markov processes: interacting particle systems (6 hrs.)

- Construction of Interacting Particle Systems
- Pathwise (graphical) constructions

III Part 3 (M. Fischer): Martingale problems and Markov processes (8 hrs.)

- Martingale problems: existence, uniqueness, duality
- The Markov property and the forward equation
- Connections with Stochastic Differential Equations

Dynamics in Hamiltonian systems

Proff. Massimiliano Guzzo, Olga Bernardi[1]

[1] *University of Padova*
Department of Mathematics
Email: {guzzo, obern}@math.unipd.it

Timetable: 20 hrs. Lectures on May/July 2012 (see the calendar), Room 2BC/30, Torre Archimede. **Timetable to be confirmed**.

Course requirements: Basic Lagrangian and Hamiltonian mechanics.

Examination and grading: Seminar on a subject assigned by the Instructors.

SSD: MAT/07

Aim: The aim of this course is to present recent problems concerning the dynamics of quasi-integrable Hamiltonian Systems. Starting from the crisis of classical integrability, established by the Poincaré Theorem on non-existence of prime integrals, we describe the dynamical picture emerging from KAM and Nekhoroshev Theorems, the problem of Arnold diffusion, the Aubry-Mather Theorem for symplectic maps and the weak KAM theory. Special emphasis will be given to applications to specific examples, also through the use of numerical methods.

Course contents:

1. Example of simple dynamical systems, conjugation in dynamical systems, symplectic maps, Poincaré section.
2. Integrability in the classical sense, Hamilton-Jacoby Theory. Crisis of classical integrability: Poincaré Theorem on non-existence of prime integrals.
3. The main Theorems of perturbation theory of Hamiltonian Systems: KAM and Nekhoroshev Theorems
4. Numerical examples: dependence of the structure of the phase space from the perturbation parameter, Arnold web.
5. Aubry-Mather sets in symplectic maps. The Aubry-Mather Theorem. Development of the weak KAM theory: effective Hamiltonian. Dynamical interpretation.
6. Examples of nontrivial dynamics in Hamiltonian Systems: analysis and representation of stable and unstable manifolds. Topological mechanisms of diffusion in phase space. Arnold diffusions. Examples.

Matrices, moments and quadrature with applications

Prof. Gérard Meurant[1]

[1] Bruyeres-le-Chatel (France)
Email: gerard.meurant@gmail.com
http://gerard.meurant.pagesperso-orange.fr/

Timetable: 24 hrs. Lectures on January 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Examination: The final exam will be held by the Professor during his stay.

SSD: MAT/08 Numerical Analysis

Aim: The aim of this series of lectures is to describe the mathematical relationships between matrices, moments, orthogonal polynomials, Gauss quadrature rules and the Lanczos and conjugate gradient (CG) algorithms to compute bounds for quadratic forms $I[f] = u^T f(A)v$ where u and v are given vectors, A is a symmetric matrix and f is a smooth function.

Course contents:

- **Orthogonal polynomials and properties of tridiagonal matrices.**
  We will recall the properties of orthogonal polynomials linked to Gauss quadrature and we will also introduce a less classical topic, matrix orthogonal polynomials.
- **The Lanczos and CG algorithms and computation of Jacobi matrices.**
  The Lanczos algorithm will be used to generate the recurrence coefficients of orthogonal polynomials related to estimation of $I[f]$.
- **Gauss quadrature and bounds for bilinear forms $u^T f(A)v$.**
  Gauss quadrature rules are used to obtain bounds for integrals related to $I[f]$. The nodes and weights are related to orthogonal polynomials and Jacobi matrices describing the three-term recurrence. We will also describe extensions to the case of a nonsymmetric matrix A.
- **Bounds for elements of $f(A)$.**
  We will consider the computation of bounds for elements of $f(A)$. The functions f we are interested in are A^{-1}, $\exp(A)$ and $\sqrt{A}$.
- **Estimates of error norms in CG.**
  We will show how Gauss quadrature is used to obtain bounds of the A-norm of the error during CG iterations.
- **Least squares and total least squares.**
  The method of Total Least Squares (TLS) looks for the solution of $(A + E)x = c + r$ where E and r are the smallest perturbations such that $c + r$ is in the range of $A + E$. Computing the solution involves quadratic forms for which we can obtain bounds.
- **Discrete ill–posed problems.**
  We will consider the determination of the Tikhonov regularization parameter for discrete ill-posed problems. We will mainly study generalized cross-validation (GCV) and the L-curve criteria which involve quadratic forms.

References:

G.H. Golub, G. Meurant, *Matrices, moments and quadrature with applications*, Princeton University Press, (2010).

Profinite groups and Profinite completions

Prof. Dan Segal[1], Prof. Eloisa Detomi[2]

[1]University of Oxford (UK)
Mathematical Institute
Email: dan.segal@all-souls.ox.ac.uk

[2]University of Padova
Department of Mathematics
Email: detomi@math.unipd.it

Timetable: 20 hrs (10+10). Lectures of the first part (Prof. Detomi) on March/April and of the second part (Prof. Segal) on April 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: Basic knowledge of algebra and group theory.

Examination and grading: Oral exam.

SSD: MAT/02 Algebra

Aim: The course will begin with a quick introduction to profinite groups. The second part of the course will be devoted to some special topics. Suppose G is an infinite group. We consider the family $\mathcal{F}(G)$ of all finite quotient groups of G, and ask (1) what can $\mathcal{F}(G)$ tell us about G, and (2) what can G tell us about $\mathcal{F}(G)$? If we assume that G is finitely generated, then knowing $\mathcal{F}(G)$ is equivalent to knowing the *profinite completion* $\widehat{G}$ of G, and question (1) comes down to: what properties of a group are preserved by the functor $G \mapsto \widehat{G}$? These are called 'profinite properties'.

Course contents:
First part (E. Detomi): Topological groups; Inverse limits of groups and profinite groups; Profinite completions of groups; Finitely generated groups.
Second part (D. Segal):
(i) Metamathematical motivation, coming from the area of *decision problems*.
(ii) *Conjugacy separability*: when conjugacy is a profinite property. Examples where it isn't; the case of polycyclic groups, where it is.
(iii) Isomorphism: the $\mathcal{C}$-*genus* of a group G is the set of isomorphism classes of groups $H \in \mathcal{C}$ with $\widehat{H} \cong \widehat{G}$. In general the genus is infinite; when $\mathcal{C}$ is the class of polycyclic groups the genus is finite. We will outline the main ideas in the proof, without full details. This includes some discussion of algebraic groups and arithmetical finiteness theorems.

One version of Question (2) asks: *which profinite groups can be the profinite completions of finitely generated abstract groups*? We will discuss some necessary conditions, related to theorems of Mal'cev and Lubotzky on linear groups. Finally we will outline some sufficient conditions: (a) in the context of Cartesian products of finite groups and (b) in the context of infinitely iterated wreath products, using branch groups.

Courses of the “Computational Mathematics” area

From CAGD to virtual/augmented reality

Prof. Gudrun Albrecht[1], Prof. Serena Morigi[2]

[1] *Université de Valenciennes et du Hainaut-Cambrésis (France) ENSIAME - Laboratoire LAMAV*
Email: gudrun.albrecht@univ-valenciennes.fr

[2] *University of Bologna, Department of Mathematics*
Email: serena.morigi@unibo.it

Timetable: 14–26 May 2012. The course will be held at the University of Bologna, Department of Mathematics-CIRAM, Bologna.

I week: Tuesday 15/05/2012 (11-13; 14-16); Thursday 17/05/2012 (11-13; 14-16)
CIRAM, via Saragozza 8, Bologna, piano terra AULA MUSEO
II week: Tuesday 22/05/2012 (11-13; 14-16); Thursday 24/05/2012 (11-13; 14-17)
CIRAM, via Saragozza 8, Bologna, piano primo AULA SEMINARI
Thursday 31/05/2012 Student seminars/Final Exam

Examination and grading: The final examination can be either an oral presentation about a specific subject based on a research paper, or the completion of a programming project which involves computer modeling using C programming language.

SSD: MAT/08 Numerical Analysis

Aim: The field of geometric modelling or Computer Aided Geometric Design (CAGD), which is mainly based on numerical analysis, analytic, projective and differential geometry as well as computer science, provides the necessary algorithms for the required curve and surface representations. CAGD also supplies the related discipline of Computer Graphics with many of its mathematical and geometrical foundations.

Recently there are the first approaches of combining geometric modelling applications with the emerging fields of Virtual and Augmented Reality. The discipline of Virtual Reality (VR) completely immerses users inside a synthetic environment whereas Augmented Reality (AR) allows the user to see three-dimensional virtual objects superimposed upon the real world.

The objective of this class is to introduce the mathematical foundations of the field of geometric modelling and computer aided geometric design as well as to give a general overview of the emerging fields of virtual and augmented reality.

Course contents:

1. Polynomial Bézier curves
2. Analytic versus geometric continuity
3. B-spline curves, Rational curves (projective geometry, properties, conic sections)
4. Bézier and B-Spline surfaces
5. Virtual and augmented reality: Introduction and applications,
6. 3D-Viewing, Haptics, VR and AR devices
7. Geometric Modelling in VR/AR

References:

1. D.A. Bowman, E. Kruijff, J.J. LaViola,Jr., I. Poupyrev, 3D User Interfaces, Theory and Practice, Addison-Wesley 2005.
2. G. Farin, Curves and Surfaces for Computer Aided Geometric Design: a practical guide, 5th edition, Morgan Kaufmann 2001.
3. G. J. Kim, Designing Virtual Reality Systems - The Structured Approach, Springer 2005.
4. K. M. Stanney (ed.), Handbook of Virtual Environments - Design, Implementation, and Applications, Lawrence Erlbaum Associates, Inc. 2002.

Extrapolation methods and their applications

Prof. Claude Brezinski[1]

[1] *Laboratoire Paul Painlevé, UMR CNRS 8524*
Université des Sciences et Technologies de Lille, France
Email: Claude.Brezinski@univ-lille1.fr

Timetable: 16 hrs. Lectures on April/May 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: No special requirement is needed for this course. Only some fundamental knowledge of numerical analysis, but it could be acquired simultaneously with the lectures.

Examination and grading: Grading is based on homeworks or a written examination or both.

SSD: MAT/08 Numerical Analysis

Aim: These lectures are intended to students and researchers in pure and applied mathematics, in numerical analysis, and in scientific computing.

Course contents:

1. Sequence transformations and convergence acceleration
   When a sequence is slowly converging, one can transform it, without modifying its terms, into a new sequence which, under some assumptions, converges faster to the same limit. The theory of such sequence transformations will be studied.
2. What is an extrapolation method?
   Sequence transformation are showed to be, in fact, based on the idea of extrapolation which will be explained.
3. Various extrapolation methods
   We will describe various sequence transformations and the recursive algorithms which are used for implementing them.
4. Vector sequence transformations
   There exist special sequence transformations for accelerating the convergence of sequences of vectors. They will be reviewed.
5. Applications
   Sequence transformations and extrapolation algorithms have many applications outside the domain of convergence acceleration. We will consider the following ones
   (a) Treatment of the Gibbs phenomenon
   (b) Web search
   (c) Estimation of the error for linear systems
   (d) Estimation of the trace of the inverse of a matrix
   (e) Regularization of linear systems

References

[1] C. Brezinski, M. Redivo-Zaglia, *Extrapolation Methods. Theory and Practice*, North–Holland, Amsterdam, 1991.

[2] J.P. Delahaye, *Sequence Transformations*, Springer-Verlag, Berlin, 1988.

[3] A. Sidi, *Practical Extrapolation Methods. Theory and Applications*, Cambridge University Press, Cambridge, 2003.

[4] E.J. Weniger, Nonlinear sequence transformations for the acceleration of convergence and the summation of divergent series, Computer Physics Reports, 10 (1989) 189-371.

[5] J. Wimp, *Sequence Transformations and their Applications*, Academic Press, New York, 1981.

Introduction to Geometric Modeling

Prof. Giulio Casciola[1]

[1] Università di Bologna
Dipartimento di Matematica
Email: casciola@dm.unibo.it
Web: www.dm.unibo.it/∼casciola/

Timetable: 16 hours, Torre Archimede, Room 2BC/30:

Tuesday June 26, 2012	10:30-13:00	14:00-16:30
Wednesday June 27, 2012	10:30-13:00	14:00-16:30
Thursday June 28, 2012	10:30-13:00	14:00-16:30

Course requirements: None.

Examination and grading: Oral exam.

SSD: MAT/08 Numerical Analysis

Aim:

Digital 3D models are in high demand in the film and gaming industry, product design and manufacturing, architecture, surgical simulation and planning, medical prothesis design and more. 3D Geometric models are the basis of all modern Computer-Aided Design and Manufacturing systems (CAD/CAM).
Geometric modeling studies methods for the mathematical description of shapes and combines approaches from numerical analysis, approximation theory, and differential geometry for the representation and manipulation of curves and surfaces. This course is concerned with fundamental concepts of geometric modeling.

Course contents:

Geometric primitives for modeling (polygonal meshes, spline/NURBS surfaces, subdivision surfaces), modeling tools, CAD software and application examples.

Valid inequalities for Integer Programs

Prof. Michele Conforti[1]

[1] *University of Padova*
Department of Mathematics
Email: conforti@math.unipd.it

Timetable: 10 hrs.

Course requirements: Linear algebra, advanced knowledge of Linear Programming, basic Graph Theory.

Examination and grading: Seminar on a subject assigned by the Instructor

SSD: MAT/09

Course contents:

- Basic Polyhedral Theory
- Chvatal inequalities
- Split and Mixed-integer inequalitities
- Lift and project
- Closures of rational polyhedra

Multivariate polynomial and non polynomial approximation

Prof. Stefano De Marchi[1]

[1] *University of Padova*
Department of Mathematics
Email: demarchi@math.unipd.it

Timetable: 16 hrs. Lectures on September-October 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: the Numerical Analysis (or Numerical Calculus) university course. Students should have a good background on univariate polynomial and non polynomial approximation (interpolation by polynomials, least-squares approximation, error estimation, basic numerical linear algebra).

Examination and grading: grading is based on the development of a short project on some complementary topics.

SSD: MAT/08 Numerical Analysis

Aim: after an introduction to the polynomial interpolation problem in the multivariate setting (existence and unicity), we shall face the problem of finding good interpolation points for polynomial interpolation problems. This will lead to the problem of the so-called *weakly admissible meshes*, *Padua points*, *approximate Fekete points* and *Discrete Leja points*. A briefly introduction to *radial basis functions* approximation will be also provided.

Course contents:

1. The multivariate approximation problem. Lebegsue constants.
2. Near optimal interpolation points: Padua, Fekete and Leja points.
3. (Weakly) Admissible Meshes ((W)AMs): definition, properties and computations.
4. Applications: least squares approximation, quadrature.
5. (if time left) Radial Basis Functions: construction and applications.

For references, interested students are invited to refer to the web page of the **Constructive Approximation and its Applications** group, between the Universities of Padova and Verona, http://www.math.unipd.it/∼marcov/CAApubl.html.

Numerical methods for ill-posed problems

Prof. Marco Donatelli[1]

[1] *Università dell'Insubria*
Dipartimento di Scienza e Alta Tecnologia
Email: marco.donatelli@uninsubria.it

Timetable: 16 hrs. Lectures on September 2012 (see the calendar), 8 hrs in Room 2BC/30 and 8 hrs. in Numlab Laboratory, Torre Archimede.

Course requirements: numerical linear algebra. In particular, singular value decomposition and iterative methods.

Examination and grading: Project on a specific method.

SSD: MAT/08 Numerical Analysis

Aim: The course will begin with a quick introduction to ill-posed problems. Regularization methods and parameter choice methods are discussed. An application to image deblurring problems is presented in detail and some numerical experiments are proposed.

Course contents:

- Ill-posed problems: definition and examples.
- Direct methods: truncated SVD and Tikhonov method.
- Iterative methods: Landweber method, CGLS, iterated Tikhonov.
- Parameter choice methods: generalized cross validation (GCV), discrepancy principle, and L-curve.
- Fast Fourier transform (FFT) and discrete cosine transform.
- Image deblurring.
- Some numerical experiments with Matlab.

Numerical methods for Functional Differential Equations

Prof. Stefano Maset[1]

[1] *University of Trieste*
Department of Mathematics and Computer Science
Email: maset@units.it

Timetable: 16 hrs. The course will take place in 2013 (March or April).

Course requirements: Numerical methods for ordinary differential equations.

Examination and grading: written examination.

SSD: MAT/08 Numerical Analysis.

Aim: to introduce students to functional differential equations and their numerical solution.

Course contents:

1. Functional Differential Equations (FDEs). Retarded Functional Differential Equations (RFDEs). Particular types of RFDEs: Delay Differential Equations (DDEs), Integro-Differential Equations (IDEs), State-Dependent DDEs (SDDDEs), State-Dependent IDEs (SDIDEs). Neutral Functional Differential Equations (NFDEs). Mathematical models based on such equations.
2. Existence and uniqueness of the solution and continuous dependence on the data for an initial problem of RFDEs.
3. Continuous Runge-Kutta (CRK) methods for RFDEs. Discrete order, uniform order and global order of a CRK method for RFDEs. Order conditions.
4. Stability of CRK methods for RFDEs.
5. Boundary value problems for FDEs.

Topics in Mathematical Finance

Prof. Tiziano Vargiolu[1]

[1] University of Padova
Department of Mathematics
Email: vargiolu@math.unipd.it

Timetable: 12 hrs. Lectures on June 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: A previous knowledge of the basics of continuous time mathematical finance, as given for example in the course "Metodi Matematici per la Finanza".

Examination and grading: Seminar.

SSD: MAT/06 Probability and Mathematical Statistics

Course contents:

The program will be fixed with the audience according to its interests. Some examples could be:

- continuous time stochastic control;
- pricing in incomplete markets;
- tree methods.

Numerical stability of dynamical systems described by delay differential equations

Proff. Rossana Vermiglio, Dimitri Breda[1]

[1] *University of Udine*
Department of Mathematics and Informatics
Email: {rossana.vermiglio,dimitri.breda}@uniud.it

Timetable: 12 hrs (6+6). Lectures on October/November 2012 (to be defined), Room 2BC/30, Torre Archimede.

Course requirements: basic course on Numerical Analysis.

Examination and grading: exercises and/or computer experiments or brief essay on an argument treated during the course.

SSD: MAT/08 Numerical Analysis

Course contents:

The study of the dynamical systems that are encountered in diverse natural evolutive phenomena is focused on the possibility of foreseeing the time behavior by varying either some control parameters or initial conditions. The stability of the solutions represents a key aspect and the numerical analysis, through the development of efficient and accurate algorithms, can furnish an important contribution in the comprehension and description of the dynamics over the long period (equilibria, cycles, chaos).

Object of this course are the dynamical systems described by differential equations with delay(s), characterized by a future evolution depending on the past history. Interesting applications can be found in control theory, where the delay can be used to stabilize the system, or in population models, where it acts, e.g., as gestation time.

The basic concepts of stability, asymptotic stability and the relevant conditions will be defined by generalizing the same concepts for linear and autonomous systems of ordinary differential equations. Then, the most recent numerical approaches for the study of the stability of equilibria and limit cycles in the retarded case will be presented, based on the discretization with pseudospectral methods of the solution operators or their infinitesimal generator. Eventually, example of applications will be given, relevant to the bifurcation analysis and the stability maps following the variation of the parameters.

With regards to nonautonomous problems, finally, the concepts of Lyapunov exponents and spetrum will be introduced, always starting from the ordinary case, passing then to the theory and numerical methods recently developed for delay differential equations.

Numerical methods for Ordinary Differential Equations

Prof. Marino Zennaro[1], Prof. Rossana Vermiglio[2]

[1] *University of Trieste, Mathematics and Computer Science*
Email: zennaro@units.it

[2] *University of Udine, Department of Mathematics and Computer Science*
Email: Rossana.Vermiglio@uniud.it

Timetable: 16 hrs (Part I, Prof. Zennaro), January (see the calendar, Rooms 2AB/45 and 2BC/30) + 12 hours (Part II, Prof. Vermiglio), March (see the calendar, Rooms 2BC/30 and 2BC/60). Torre Archimede.

Course requirements: it is advisable to have attended a basic course in Numerical Analysis.

Examination and grading: A unique written exam for both Part I and Part II.

SSD: MAT/08 Numerical Analysis
Aim: We present basic numerical methods for initial value problems in ordinary differential equations and we analyse their convergence and stability properties.

Course contents:
Part I
Existence and uniqueness of the solution and continuous dependence on the data for the initial value problem $y'(x) = f(x, y(x)), y(x_0) = y_0$.
Classical Lipschitz constant and right hand side Lipschitz constant.
General one-step methods; explicit and implicit Runge-Kutta methods.
Definition of local truncation and discretization error for one-step methods and definition of consistency of order p.
Convergence theorem with order p for one-step methods. Order conditions for Runge-Kutta methods. Order barriers for explicit and implicit methods.
Variable stepsize implementation. Embedded pairs of methods of Runge-Kutta-Fehlberg and Dormand-Prince type.

Part II
Introduction to the stability of numerical methods. Stiff problems.
Definition of A-stability, AN-stability and BN-stability of a numerical method.
Analysis of A-stability for Runge-Kutta methods: A-stability regions. L-stability.
Analysis of AN-stability and BN-stability for Runge-Kutta methods. Algebraic stability.
The phenomenon of the order reduction: an example. B-convergence.
Short analysis of A-stability for linear multistep methods.A(α)-stability and stiff-stability. Backward differentiation formulas.

References:

- E. Hairer, S.P. Norsett, G. Wanner: Solving Ordinary Differential Equations I, Nonstiff Problems, Springer-Verlag, Berlin, 1993
- E. Hairer, G. Wanner: Solving Ordinary Differential Equations II, Stiff Problems, Springer-Verlag, Berlin, 1993
- J.C. Butcher: Numerical methods for ordinary differential equations. Second edition, John Wiley & Sons, Ltd., Chichester, 2008
- J.D. Lambert: Numerical methods for ordinary differential systems. John Wiley & Sons, Ltd., Chichester, 1991
- Lecture notes by the professors

Courses of the “Mathematics” area

Nearby and vanishing cycles

Prof. Bruno Chiarellotto[1], Prof. Luca Migliorini[2]

[1]University of Padova
Department of Mathematics
Email: chiarbru@math.unipd.it

[2]University of Bologna
Department of Mathematics
Email: luca.migliorini@unibo.it

Timetable: 10 hrs. Lectures on April 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: Basic algebraic and differential geometry. sheaf theory. basic homology and cohomology theories.

Examination and grading: Oral exam.

SSD: MAT/03 Geometry

Aim: We will investigate the behaviour of some invariants of a family of varieties when they approach a singularity. This study can be understood in a geometric framework but also in a more differential and arithmetic ones (heart of categories and algebraic analysis).

Course contents:

1. The derived category of constructible sheaves. Verdier duality.
2. Intersection cohomology and perverse sheaves.
3. The perverse cohomology and some related theorems.
4. The decomposition theorem.
5. Some recent development. Ngo's support theorem

Topics in Nonlinear Partial Differential Equations

Prof. Lawrence Craig Evans[1], Proff. Pierpaolo Soravia, Luca Rossi[2]

[1] *University of California at Berkeley (USA)*
Department of Mathematics
Email: evans@math.berkeley.edu

[2] *University of Padova*
Department of Mathematics
Email: {soravia,lucar}@math.unipd.it

Timetable: 16 (8+8) hrs. Lectures of the first part (Proff. Soravia and Rossi) on April/May and of the second part (Prof. Evans) on May, Torre Archimede, (see the calendar).

SSD: MAT/05 Mathematical Analysis

Course contents:

The course will begin with an introduction to the basic theory of first order fully nonlinear Partial Differential Equations, in particular of Hamilton-Jacobi type. The case of convex, space-independent Hamiltonians will be dealt with by means of the Hopf-Lax formula. More general equations will be treated by introducing the notion of viscosity solution. Its basic properties will be derived, together with the comparison principle. An introduction to optimal control theory will lead to existence and uniqueness results for the Hamilton-Jacobi-Bellman equation. We will also overview the extension to non-convex equations by means of differential games. The main part of the course will then focus on more advanced and recent topics about fully nonlinear partial differential equations. It will start by illustrating some aspects of optimization theory. Some estimates for nonlinear equations will be derived by introducing the adjoint of the linearized operator. These will be applied to the study of non-convex Hamilton-Jacobi equations, as well as the infinity Laplace operator.

Complements on Monoids, Rings and Modules

Prof. Alberto Facchini[1]

[1] *University of Padova*
Department of Mathematics
Email: facchini@math.unipd.it

Timetable: 20 hrs. Lectures on April/May (see the calendar), Torre Archimede, Room 2BC/30.

Course requirements: Standard notions on rings and modules, at the level of the course ”An Introduction to Ring Theory” for the Master Course Algant in Padua.

Examination and grading: Oral examination.

SSD: MAT/02 Algebra

Aim: To improve the mathematical knowledge of the student in commutative monoids and noncommutative rings.

Course contents:

Commutative monoids. Pre-ordered groups, positive cones. The monoid V(C), discrete valutations. Essential morphisms. Further results on Krull monoids. Sets and classes. Semisimple rings and modules. Free rings and free algebras. Free modules. Projective modules and radical. Projective covers, injective envelopes. The monoid V(R).

Introduction to control theory

Dr. Fabio S. Priuli[1]

[1] University of Padova
Department of Mathematics
Email: priuli@math.unipd.it

Timetable: 16 hrs. Lectures on March 2012 (see the calendar), Meeting room 7th floor, Torre Archimede.

Course requirements: Calculus in several variables, measure theory and basic elements of ODEs.

Examination and grading: At the end of the course, students will give a seminar on an argument related to the course.

SSD: MAT/05 Mathematical Analysis

Course contents:

The course will focus on the basic concepts in control theory for ODEs. Control theory naturally arises when studying models which allow to choose some parameters to obtain a prescribed goal, e.g. to steer trajectories in a neighborhood of a given state or to optimize an assigned cost functional. In particular, control theory has been applied successfully to biology, medicine, engineering, robotics and economics.

In this course, we will focus our attention to the main theoretical questions in the topic, but we will also give some examples of applications. Namely, we will consider controllability and stabilizability problems, both for linear systems and for nonlinear ones; we will study optimization problems, giving necessary and sufficient conditions for the existence of optimal feedback controls, with a particular attention to the tools required by the analysis of discontinuous differential equations which become necessary in this context.

Wild ramification of schemes and sheaves

Prof. Takeshi Saito[1]

[1] University of Tokyo (Japan)
Department of Mathematical Sciences
Email: t-saito@ms.u-tokyo.ac.jp

Timetable: 10 hrs.

Course requirements:

Examination and grading: Oral exam.

SSD: MAT/02-MAT/03 Geometry, Number theory and Algebra

Course contents:
To discuss some new developments on arithmetic ramification theory starting from the classical ramification theory.

Cohomology of quasi-coherent sheaves via model categories and approximation theory

Proff. Jan Šťovíček, Jan Trlifaj[1]

[1]Charles University in Prague (Czech Republic)
Department of Algebra
Email: {stovicek,trlifaj}@karlin.mff.cuni.cz

Timetable: 16 (8+8). Lectures on March/April 2012 (see the calendar), Room 2BC/30, Torre Archimede.

Course requirements: Basic notions on rings and modules and on category theory.

Examination and grading: Seminar on a subject assigned by one of the Instructors.

SSD: MAT/02

Aim: The course provides an introduction to the theory of Quillen's model categories and to triangulated categories with applications to cohomology theory and representability of functors.

Course contents:

Lectures will be concerned with recent methods of computation of cohomology of quasi-coherent sheaves, with emphasis on the role of Drinfeld vector bundles.

The starting point will be basic general ideas going back to Quillen and Hovey leading to the recent results in papers by Šťovíček-Saorin, Guil Asensio-Estrada-Prest -Trlifaj.

A series of lectures will concern triangulated categories and representability of functors.

Courses in collaboration with the Doctoral School on “Information Engineering”

Statistical Methods

Prof. Lorenzo Finesso[1]

[1] *Istituto di Ingegneria Biomedica, ISIB-CNR, Padova*
Email: lorenzo.finesso@isib.cnr.it

Timetable: 24 hrs. Class meets every Tuesday and Thursday from 10:30 to 12:30. First lecture on Tuesday, June 12, 2012. Room DEI/G (3-rd floor, Dept. of Information Engineering, Via Gradenigo 6/a).

Course requirements: Basics of Probability Theory and Linear Algebra.

Examination and grading: homework assignments and take-home exam.

Aim: The course will present a survey of statistical techniques which are important in applications. The unifying power of the information theoretic point of view will be stressed.

Course contents:

Background material. The noiseless source coding theorem will be quickly reviewed in order to introduce the basic notions of entropy and informational divergence (Kullback-Leibler distance) of probability measures. The analytical and geometrical properties of the divergence will be presented.

Divergence minimization problems. Three basic minimization problems will be posed and, on simple examples, it will be shown that they produce the main methods of statistical inference: hypothesis testing, maximum likelihood, maximum entropy.

Multivariate analysis methods. Study of the probabilistic and statistical aspects of the three main methods: Principal Component Analysis (PCA), Canonical Correlations (CC) and Factor Analysis (FA). In the spirit of the course these methods will be derived also via divergence minimization. Time permitting there will be a short introduction to the Nonnegative Matrix Factorization method as an alternative to PCA to deal with problems with positivity constraints.

EM methods. The Expectation-Maximization method was introduced as an algorithm for the computation of Maximum Likelihood (ML) estimator with partial observations (incomplete data). We will present the EM method as an alternating divergence minimization algorithm (à la Csiszár Tusnády) and show its application to the ML estimation of Hidden Markov Models.

The MDL method. The Minimum Description Length method of Rissanen will be presented as a general tool for model complexity estimation.

References: A set of lecture notes and a list of references will be posted on the web site of the course.

Polyhedral methods for Integer Linear Programming

Prof. Matteo Fischetti[1]

[1] *Dept. of Information Engineering*
University of Padova
Email: matteo.fischetti@unipd.it

Timetable: 20 hrs. Class meets every Tuesday and Friday from 12:00 to 14:00. First lecture on Friday, March 23, 2012. Room DEI/201 (Dept. of Information Engineering, DEI/A Building, Via Gradenigo 6/a).

Course requirements: Basics courses on linear algebra and graphs.

Examination and grading: Grading is based on a project assigned by the Instructor.

Aim: The purpose of this Course is to introduce polyhedral methods for Integer Linear Programs and to enable the students to develop sound polyhedral (branch-and-cut) solution methods.

Course contents:

- Basic Linear and Integer Programming
- The branch-and-cut paradigm
- Linear Programming geometry: polyhedra, dimension, vertices, faces, and facets
- Proving the facet-defining property: direct and indirect methods
- Polyhedral structure of the Asymmetric Travelling Salesman Problem
- Design of a branch-and-cut algorithm for the Asymmetric Travelling Salesman Problem

References: Notes will be available with further references.

Applied Linear Algebra

Prof. Harald Wimmer[1]

[1] University of Würzburg, Germany
Email: wimmer@mathematik.uni-wuerzburg.de

Timetable: 16 hours. Class meets on Tuesday (Room Ke) from 8:15 to 10:15 and Thursday (Room De) from 16:15 to 18:15. First lecture on Tuesday, March 13, 2012. Other lectures on March 15, 20, 22, 27, 29 and April 17, 19. Dept. of Information Engineering, Via Gradenigo 6/a.

Course requirements: A good working knowledge of basic notions of linear algebra, as e.g. presented in [1].

Examination and grading: Grading is based on homeworks or a written examination or both.

Aim: We study concepts and techniques of linear algebra, which are important for applications and computational issues. A wide range of exercises and problems will be presented such that a practical knowledge of tools and methods of linear algebra can be acquired.

Course contents:

- *Kronecker products*
- *Linear matrix equations (Sylvester equations, Lyapunov equations)*
- *Systems of linear difference and differential equations with applications (e.g. damped linear vibrations)*
- *Structured matrices (e.g. stochastic and doubly stochastic matrices)*

References:

[1] E. Gregorio and L. Salce. *Algebra Lineare*. Edizioni Libreria Progetto, Padova, 2005.

[2] A.J. Laub. *Matrix Analysis for Scientists and Engineers*, SIAM, Philadelphia, 2005,

[3] C.D. Meyer. *Matrix Analysis and Applied Linear Algebra*, SIAM, Philadelphia, 2000.

Applied Functional Analysis

Prof. Gianluigi Pillonetto[1]

[1] *Dept. of Information Engineering*
University of Padova
Email: giapi@dei.unipd.it

Timetable: 28 hrs. Class meets on Tuesday and Thursday from 10:30 to 12:30. First lecture on Tuesday, September 10, 2012. Room DEI/G (Dept. of Information Engineering).

Course requirements: The classical theory of functions of real variable: limits and continuity, differentiation and Riemann integration, infinite series and uniform convergence. The arithmetic of complex numbers and the basic properties of the complex exponential function. Some elementary set theory. A bit of linear algebra.

Examination and grading: Homework assignments and final test.

Aim: The course is intended to give a survey of the basic aspects of functional analysis, operator theory in Hilbert spaces, regularization theory and inverse problems.

Course contents:

1. *Review of some notions on metric spaces and Lebesgue integration*: Metric spaces. Open sets, closed sets, neighborhoods. Convergence, Cauchy sequences, completeness. Completion of metric spaces. Review of the Lebesgue integration theory. Lebesgue spaces.
2. *Banach and Hilbert spaces*: Normed spaces and Banach spaces. Finite dimensional normed spaces and subspaces. Compactness and finite dimension. Bounded linear operators. Linear functionals. The finite dimensional case. Normed spaces of operators and the dual space. Weak topologies. Inner product spaces and Hilbert spaces. Orthogonal complements and direct sums. Orthonormal sets and sequences. Representation of functionals on Hilbert spaces. Hilbert adjoint operator. Self-adjoint operators, unitary operators.
3. *Fourier transform and convolution*: The convolution product and its properties. The basic L^1 and L^2 theory of the Fourier transform. The inversion theorem.
4. *Compact linear operators on normed spaces and their spectrum*: Spectral properties of bounded linear operators. Compact linear operators on normed spaces. Spectral properties of compact linear operators. Spectral properties of bounded self-adjoint operators, positive operators, operators defined by a kernel. Mercer Kernels and Mercer's theorem.
5. *Reproducing kernel Hilbert spaces, inverse problems and regularization theory*: Reproducing Kernel Hilbert Spaces (RKHS): definition and basic properties. Examples of RKHS. Function estimation problems in RKHS. Tikhonov regularization. Support vector regression and regularization networks. Representer theorem.

All the necessary material can be found in W. Rudin's book Principles of Mathematical Analysis (3rd ed., McGraw-Hill, 1976). A summary of the relevant facts will be given in the first lecture.

References:

[1] E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons , 1978.
[2] M. Reed and B. Simon, Methods of Modern Mathematical Physics, vol. I, Functional Analysis, Academic Press, 1980.
[3] G. Wahba. Spline models for observational data. SIAM, 1990.
[4] C.E. Rasmussen and C.K.I. Williams. Gaussian Processes for Machine Learning. The MIT Press, 2006.

Algebraic tools for the identifiability of Dinamical Systems

Prof. Maria Pia Saccomani[1]

[1] *Dept. of Information Engineering*
University of Padova
Email: pia@dei.unipd.it

Timetable: 16 hrs. Class meets every Monday and Wednesday from 10:30 to 12:30. First lecture on Wednesday, November 7, 2012. Room DEI/G (3-rd floor, Dept. of Information Engineering, Via Gradenigo 6/a).

Examination and grading: Homework and a final written examination.

Aim: The course is intended to illustrate the modern methods used to assess a priori identifiability of linear and especially nonlinear dynamical systems. In particular, the course is intended to provide a deep comprehension of the modern commutative algebra and differential algebra tools which can be applied to the study of a priori identifiability of dynamic systems described by polynomial or rational equations [1, 2, 3, 4]. Some hint will be given also to application of these mathematical tools to system and control theory problems. Emphasis will be given to systems describing biological phenomena [5].

Course contents:
State space models of polynomial and rational dynamical systems. Global and local parameter identifiability. Basic concepts of commutative algebra. Gröbner bases and the Buchberger algorithm. Basic concepts of differential algebra. The Ritt algorithm. Software tool implementations. Case studies.

References:

[1] B. Buchberger. Grbner Bases and System Theory. In Multidimensional Systems and Signal Processing, Kluwer Academic Publishers, Boston (2001).

[2] K. Forsman. Constructive Commutative Algebra in Nonlinear Control Theory, Linköping Studies in Science and Technology. Dissertation No. 261, Linköping University, Sweden (1991).

[3] L. Ljung, and S.T. Glad. On global identifiability for arbitrary model parameterizations, Automatica, 30, 2, 265-276 (1994).

[4] M.P. Saccomani, S. Audoly, and L. D'Angiò. Parameter identifiability of nonlinear systems: the role of initial conditions, Automatica, 39, 619-632 (2004).

[5] M.P. Saccomani, S. Audoly, G. Bellu, and L. D'Angiò. Testing global identifiability of biological and biomedical models with the DAISY software, Computers in Biology and Medicine, 40, 402-407 (2010).

The behavioral approach to control of distributed systems

Prof. Shiva Shankar[1]

[1] *Chennai Mathematical Institute, India*
Email: sshankar@cmi.ac.in

Timetable: 20 hrs. Class meets every Tuesday and Friday. First lecture on Tuesday, September 18, 2012. Dept. of Information Engineering. **Timetable to be confirmed.**

Course requirements: The basic of Kalman's state space theory, linear algebraStandard linear algebra and probability theory.

Examination and grading: Homework and final examination.

Aim: To introduce the key ideas of the behavioral approach to control of open dynamical systems, and to show how the ideas of J.C.Willems, developed first as a generalization of the Kalman theory to the case of lumped systems, carry over naturally to distributed systems. Just as linear algebra is the language in which the Kalman theory of state space systems is written, the behavioral theory of distributed systems is written in the language of commutative algebra. The course will not assume any background, but will develop the required results from commutative and homological algebra along the way.

Course contents:

Lecture 1. A quick review of controllability in the Kalman theory of state space systems; how do we generalize this theory to the case when first order operators are replaced by operators of arbitrary order and when we ignore input-output structures.

Lecture 2. A little commutative algebra (commutative rings, modules, localization, Hom and tensor product).

Lecture 3. The generalization to distributed systems (described by constant coefficient partial differential operators); controllability as a patching problem, controllability versus potential.

Lecture 4. Necessary and sufficient conditions for controllability of C1 behaviors; controllable and autonomous behaviors.

Lecture 5. A little more commutative and homological algebra (injective and at modules); The Fundamental Principle of Malgrange-Palamodov (statement).

Lecture 6. Consequences of the Fundamental Principle for C1 behaviors - elimination, lattice structure etc.

Lecture 7. Behaviors in other function spaces such as the space of compactly supported smooth functions; the Nullstellensatz problem for systems of partial differential equations, the problem of calculating Willems closures.

Lecture 8. A last bit of commutative algebra (associated primes, primary decomposition); the Nullstellensatz for systems of PDE.

Lecture 9. Other structures on behaviors - causality, interconnections, feedback, stability.

Lecture 10. Further research directions.

References:

There is no textbook in the subject (yet) but I shall pronotes. Apart from papers in the subject, there is a comprehensive survey: J.C.Willems: *The behavioral approach to open and interconnected systems*, IEEE Control Syst. Mag., 27:46-99, 2007.

Topics in Quantum Information

Prof. Francesco Ticozzi[1]

[1] *Dept. of Information Engineering*
University of Padova
Email: ticozzi@dei.unipd.it

Timetable: 16 hrs. Class meets on Monday and Wednesday from 10:30 to 12:30. First lecture on Monday, February 13, 2012.

Course requirements: Standard linear algebra and probability theory.

Examination and grading: Homeworks and final project.

Aim: The Course aims to serve as an introduction to a selection of topics of interest in quantum information theory, with a focus on the role of uncertainty and noise. A mathematically consistent approach will be developed, in order to tackle problems of information encoding, communication and error-correction for finite-dimensional systems.

Topics:

1. **Quantum Theory as a Probability Theory;** Densities, observable quantities, measurements in a non-commutative setting. Unitary dynamics. Composite systems and entanglement. Partial trace and marginal densities.
2. **Quantum Information Distances, Uncertainty and Distinguishability;** Entropy, relative entropy, trace norm, their interpretation and basic properties. Fidelity and related quantities.
3. **Quantum Dynamical Systems and Noise;** Open quantum systems and quantum operations. Kraus representation theorem. Errors and Markov noise models. Examples for two-level systems.
4. **Encoding Information in Quantum Systems;** The logical qubit. Encoding qubits in physical systems, operational requirements and "good codes".
5. **Classical and Quantum Information over Quantum Channels;** No-cloning theorem. Schumacher's quantum noiseless coding theorem. The Holevo-Schumacher-Westmoreland theorem.
6. **Advanced topics;** To be selected, depending on the research focus and interest of the attending students.

References: The main reference is M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum information (Cambridge, 2000). Other relevant references, on-line notes and research papers will be provided during the course.

Calendar

gennaio 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
26	27	28	29	30	31	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19 * Zennaro-Vermiglio 14-18	20 * Zennaro-Vermiglio 9:00-13:00	21	22
23 * Meurant 9:00-11:00	24	25 * Meurant 9:00-11:00	26 * Zennaro-Vermiglio 14-18	27 * Zennaro-Vermiglio 9:00-13:00	28	29
30 * Meurant 9:00-11:00	31	1	2	3	4	5

febbraio 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
30	31	1 * Meurant 9:00-11:00	2	3 * Meurant 9:00-11:00	4	5
6 * Meurant 9:00-11:00	7	8 * Meurant 9:00-11:00	9	10 * Meurant 9:00-11:00	11	12
13 * Ticozzi 10:30-12:30 * Meurant 9:00-11:00	14 * Dai Pra-Fischer-Guiotto 9:00-11:00	15 * Ticozzi 10:30-12:30 * Meurant 9:00-11:00	16 * Dai Pra-Fischer-Guiotto 9:00-11:00	17	18	19
20 * Meurant 9:00-11:00 * Ticozzi 10:30-12:30	21 * Dai Pra-Fischer-Guiotto 9:00-11:00	22 * Ticozzi 10:30-12:30	23 * Dai Pra-Fischer-Guiotto 9:00-11:00	24 * Meurant 9:00-11:00	25	26
27 * Ticozzi 10:30-12:30	28	29 * Dai Pra-Fischer-Guiotto 9:00-11:00 * Ticozzi 10:30-12:30	1	2	3	4
5	6	7	8	9	10	11

marzo 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
27	28	29	1 * Zennaro-Vermiglio 11:00-13:00, 15:00-18:00 * Dai Pra-Fischer-Guiotto 9:00-11:00	2 * Zennaro-Vermiglio 9:00-12:00, 14:00-17:00	3	4
5 * Ticozzi 10:30-12:30	6 * Priuli 15.00-17.00	7 * Ticozzi 10:30-12:30	8 * Priuli 15.00-17.00	9	10	11
12	13 * Dai Pra-Fischer-Guiotto 9:00-11:00 * Priuli 15.00-17.00 * Wimmer 8:15-10:15	14	15 * Dai Pra-Fischer-Guiotto 9:00-11:00 * Wimmer 16:15-18:15 * Priuli 15.00-17.00	16	17	18
19	20 * Segal-Detomi 11:30-13:30 * Priuli 15.00-17.00 * Wimmer 8:15-10:15	21 * Dai Pra-Fischer-Guiotto 9:00-11:00	22 * Segal-Detomi 11:30-13:30 * Wimmer 16:15-18:15 * Priuli 15.00-17.00	23 * Dai Pra-Fischer-Guiotto 9:00-11:00 * Fischetti 12:00-14:00	24	25
26 * Stovicek-Trlifaj 9:00-11:00	27 * Priuli 15.00-17.00 * Wimmer 8:15-10:15 * Fischetti 12:00-14:00 * Stovicek-Trlifaj 9:00-11:00	28 * Stovicek-Trlifaj 11:00-13:00	29 * Wimmer 16:15-18:15 * Stovicek-Trlifaj 11:00-13:00 * Priuli 15.00-17.00	30 * Fischetti 12:00-14:00	31	1
2	3	4	5	6	7	8

aprile 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
26	27	28	29	30	31	1
2 * Segal-Detomi 11:30-13:30 * Stovicek-Trlifaj 9:00-11:00	3 * Segal-Detomi 11:30-13:30 * Stovicek-Trlifaj 9:00-11:00	4 * Segal-Detomi 11:30-13:30 * Stovicek-Trlifaj 9:00-11:00	5 * Stovicek-Trlifaj 9:00-11:00	6	7	8 * Easter
9 * Holiday	10	11	12 * Chiarellotto-Migliorini 11:00-13:00	13 * Chiarellotto-Migliorini 11:00-13:00	14	15
16 * Chiarellotto-Migliorini 11:00-13:00 * Segal-Detomi 9:00-11:00	17 * Wimmer 8:15-10:15 * Fischetti 12:00-14:00 * Segal-Detomi 9:00-11:00	18 * Segal-Detomi 9:00-11:00	19 * Wimmer 16:15:18:15 * Segal-Detomi 9:00-11:00	20 * Fischetti 12:00-14:00 * Brezinski 11:00-13:00 * Segal-Detomi 9:00-11:00	21	22
23 * Chiarellotto-Migliorini 11:00-13:00 * Evans-Soravia-Rossi 9-11	24 * Facchini 9:00-11:00 * Chiarellotto-Migliorini 11:00-13:00 * Fischetti 12:00-14:00	25 * Holiday	26 * Evans-Soravia-Rossi 9-11 * Brezinski 11:00-13:00	27 * Facchini 9:00-11:00 * Fischetti 12:00-14:00 * Brezinski 11:00-13:00	28	29
30 * Evans-Soravia-Rossi 11.30-13.30	1	2	3	4	5	6

maggio 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
30	1 * Fischetti 12:00-14:00 * Holiday	2 * Evans-Soravia-Rossi 9-11 * Brezinski 11:00-13:00	3 * Facchini 9:00-11:00 * Brezinski 11:00-13:00	4 * Fischetti 12:00-14:00 * Facchini 9:00-11:00	5	6
7 * Evans-Soravia-Rossi 11.30-13.30	8 * Fischetti 12:00-14:00 * Facchini 9:00-11:00	9 * Brezinski 11:00-13:00 * Evans-Soravia-Rossi 9-11	10 * Facchini 9:00-11:00 * Brezinski 11:00-13:00	11	12	13
14 * Evans-Soravia-Rossi 11.30-13.30	15 * Albrecht-Morigi 11-13, 14-16 * Facchini 9:00-11:00	16 * Evans-Soravia-Rossi 9-11 * Brezinski 11:00-13:00	17 * Facchini 9:00-11:00 * Albrecht-Morigi 11-13, 14-16	18 * Facchini 9:00-11:00	19	20
21 * Clarke 11:30-13:30	22 * Clarke 11:30-13:30 * Facchini 9:00-11:00 * Albrecht-Morigi 11-13, 14-16	23 * Clarke 9:00-11:00	24 * Clarke 11:30-13:30 * Facchini 9:00-11:00 * Albrecht-Morigi 11-13, 14-17	25 * Clarke 9:00-11:00	26	27
28	29 * Albrecht-Morigi (seminars/exam)	30 * Guzzo-Bernardi 11:00-13:00	31	1	2	3
4	5	6	7	8	9	10

giugno 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
28	29	30	31	1 * Holiday	2	3
4 * Clarke 9:00-11:00 * Guzzo-Bernardi 11:30-13:30	5 * Clarke 11:00-13:00 * Vargiolu 15:00-17:00	6 * Clarke 11:00-13:00	7 * Vargiolu 15:00-17:00	8 * Clarke 9:00-11:00 * Guzzo-Bernardi 11:00-13:00	9	10
11 * Guzzo-Bernardi 11:30-13:30	12 * Vargiolu 15:00-17:00 * Finesso 10:30-12:30	13 * Holiday	14 * Vargiolu 15:00-17:00 * Finesso 10:30-12:30	15 * Guzzo-Bernardi 11:00-13:00	16	17
18 * Guzzo-Bernardi 11:30-13:30	19 * Vargiolu 15:00-17:00 * Finesso 10:30-12:30	20	21 * Vargiolu 15:00-17:00 * Finesso 10:30-12:30	22 * Guzzo-Bernardi 11:00-13:00	23	24
25 * Clarke 15:00-17:00 * Guzzo-Bernardi 11:30-13:30	26 * Finesso 10:30-12:30 * Casciola 10:30-13:00, 14:00-16:30	27 * Clarke 15:00-17:00 * Casciola 10:30-13:00, 14:00-16:30	28 * Finesso 10:30-12:30 * Casciola 10:30-13:00, 14:00-16:30	29 * Guzzo-Bernardi 11:00-13:00 * Clarke 15:00-17:00	30	1
2	3	4	5	6	7	8

luglio 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
25	26	27	28	29	30	1
2 * Guzzo-Bernardi 11:30-13:30	3 * Finesso 10:30-12:30	4	5 * Finesso 10:30-12:30	6	7	8
9	10 * Finesso 10:30-12:30	11	12 * Finesso 10:30-12:30	13	14	15
16	17 * Finesso 10:30-12:30	18	19 * Finesso 10:30-12:30	20	21	22
23	24	25	26	27	28	29
30	31	1	2	3	4	5

agosto 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
30	31	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	1	2
3	4	5	6	7	8	9

settembre 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
27	28	29	30	31	1	2
3	4 * Donatelli 9.00:11.00 - 11.30-13.30	5 * Donatelli 9.00:11.00 - 11.30-13.30	6 * Donatelli 9.00:11.00 - 11.30-13.30	7 * Donatelli 9.00:11.00 - 11.30-13.30	8	9
10 * Pillonetto 10:30-12:30	11	12	13 * Pillonetto 10:30-12:30	14	15	16
17 * Pillonetto 10:30-12:30	18 * Shankar	19	20 * Pillonetto 10:30-12:30	21 * Shankar	22	23
24 * Pillonetto 10:30-12:30	25 * Shankar * De Marchi 11:00-13:00	26 * De Marchi 11:00-13:00	27 * Pillonetto 10:30-12:30 * De Marchi 15:00-17:00	28 * Shankar * De Marchi 11:00-13:00	29	30
1	2	3	4	5	6	7

ottobre 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
1 * Pillonetto 10:30-12:30	2 * Shankar * De Marchi 11:00-13:00	3 * De Marchi 11:00-13:00	4 * De Marchi 15:00-17:00 * Pillonetto 10:30-12:30	5 * Shankar * De Marchi 11:00-13:00	6	7
8 * Pillonetto 10:30-12:30	9 * Shankar	10	11 * Pillonetto 10:30-12:30	12 * Shankar	13	14
15 * Pillonetto 10:30-12:30	16 * Shankar	17	18 * Pillonetto 10:30-12:30	19 * Shankar	20	21
22 * Pillonetto 10:30-12:30	23	24	25 * Pillonetto 10:30-12:30	26	27	28
29	30	31	1	2	3	4
5	6	7	8	9	10	11

novembre 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
29	30	31	1	2	3	4
5	6	7 * Saccomani 10:30-12:30	8	9	10	11
12 * Saccomani 10:30-12:30	13	14 * Saccomani 10:30-12:30	15	16	17	18
19 * Saccomani 10:30-12:30	20	21 * Saccomani 10:30-12:30	22	23	24	25
26 * Saccomani 10:30-12:30	27	28 * Saccomani 10:30-12:30	29	30	1	2
3	4	5	6	7	8	9

dicembre 2012

lunedì	martedì	mercoledì	giovedì	venerdì	sabato	domenica
26	27	28	29	30	1	2
3 * Saccomani 10:30-12:30	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31 * a	1	2	3	4	5	6