Graduate Course in Information Engineering: Ph.D. program
Department of Information Engineering
University of Padova

Course Catalogue

2016-2017

Requirements for Ph.D. Students of the Graduate Course in Information Engineering:

1. Students are required to take courses from the present catalogue for *a minimum* of 80 hours (20 credits) during the first year of the Ph.D. program.

2. Students are required to take for credit *at least* one out of the following three basic courses “Applied Functional Analysis”, “Applied Linear Algebra”, and “Statistical Methods” during the first year of the Ph.D. program. Moreover, the other two courses are *strongly recommended* to all students.

3. After the first year, students are *strongly encouraged* to take courses (possibly outside the present catalogue) for at least 10 credits (or equivalent) according to their research interests.

Students are requested to enroll in each course they intend to take at least one month before the class starts. To enroll, it is sufficient to send an e-mail message to the secretariat of the course at the address `calore@dei.unipd.it`

Students are expected to attend classes regularly. Punctuality is expected both from instructors and students.

Instructors have to report to the Director of Graduate Studies any case of a student missing classes without proper excuse.

In addition to the courses listed in this catalogue the Graduate Course will promote and organize additional courses and series of lectures, of potential interest to PhD Students, which however will not be valid for credits; these will be advertised through the Graduate Course webpage (see the Seminars and Seasonal Schools *section on the web page* `http://www.dei.unipd.it/en/phd`*) as well as using the PhD Students' mailing list.*

Contents

1 The FFT and its use in digital signal processing

Instructor: Prof. S. Pupolin, Dept. Information Engineering, University of Padova, e-mail: `pupolin@dei.unipd.it`

Aim: The course is intended to give a survey of the basic aspects of signal domains and the effects in digital signal processing in terms of signal distortion.

Topics:

- Review of some notions on Fourier Transform in different time domains (continuous and discrete; aperiodic and periodic). The FFT.
- Definitions and properties of signal energy, convolution, correlation in the time domains and their Fourier transforms
- Signal transformations. Linear transformations. Elementary transformations: sampling and interpolation. Up- and Down-Periodization
- Numerical computation of the Fourier transform of a continuous-time finite energy signal via FFT
- Numerical computation of the convolution (correlation) of two continuous-time finite energy signals via FFT.
- Bandlmited continuous time signal filtering: from analog filters to a mix of analog and digital filters.
- Example of applications: OFDM modulation and cyclic prex.
- Channel estimation in OFDM systems
- Estimate of power spectrum for finite power signals. From definitions to numerical computation.
- FFT output SNR for a quantized input signal. Discussion

References:

All the necessary material can be found in G. Cariolaro book: “Unified Signal Theory”, (Springer-Verlag, London 2011).

Time table: 20 hours, 5 credits. Class meets every Monday and Friday from 10:30 to 12:30. First lecture on Monday, October 17th, 2016. Room 318 DEI/G (3-rd oor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic knowledge of signals and systems.

Examination and grading: Homeworks and final exam.

2 Fluid mechanics for the functional assessment of cardiovascular devices

Instructor: F. M. Susin, Dept. ICEA, University of Padua, e-mail: `francescamaria.su`

Aim: The course is intended to give a survey of research approaches for the assessment of cardiovascular medical devices. Emphasis will be given to methods and techniques adopted for in vitro analysis of hemodynamic performance of prosthetic heart valves and total artificial heart.

Topics: Review of basic fluid mechanics concepts. Fluid mechanics of prosthetic heart valves (PHVs) and ventricular assist devices (VADs). Pulse duplicators for in vitro testing of PHVs and mock circulation loops for preclinical evaluation of VADs. Experimental techniques for the assessment of PHVs and VADs performance. CFD for functional assessment of PHVs and VADs.

References:

[1] M. Grigioni, C. Daniele, G. D'Avenio, U. Morbiducci, C. Del Gaudio, M. Abbate and D. Di Meo. Innovative technologies for the assessment of cardiovascular medical devices: state of the art techniques for artificial heart valve testing. *Expert Rev. Medical Devices*, 1(1) : 81-93, 2004.

[2] K.B. Chandran, A.P. Yoganathan and S.E. Rittgers. Biofluid Mechanics: the uman circulation. CRC Press, Boca Raton, FL, 2007.

[3] A.P. Yoganathan, K.B. Chandran and F. Sotiropoulos. Flow in prosthetic heart valves: state of the heart and future directions. *Annals of Biomedical Engineering*, 33(12) : 1689-1694, 2005.

[4] A.P. Yoganathan, Z. He and S. Casey Jones. Fluid mechanics of heart valves.

[5] A.P. Yoganathan and F. Sotiropoulos. Using computational fluid dynamics to examine the hemodynamics of artificial heart valves. *Business briefing: US cardiology 2004*: 1-5, 2004.

[6] V. Barbaro, C. Daniele and M. Grigioni. Descrizione di un sistema a

flusso pulsatile per la valutazione delle protesi valvolari cardiache. ISTISAN Report 91/7, Rome, Italy, 1991 (in Italian).

[7] M. Grigioni, C. Daniele, C. Romanelli and V. Barbaro. Banco di prova per la caratterizzazione di dispositivi di assistenza meccanica al circolo. ISTISAN Report 03/21, Rome, Italy, 2003 (in Italian).

[8] M.J. Slepian, Y. Alemu, J.S. Soares. R.G. Smith, S. Einav and D. Bluestein. The Syncardia total artificial heart: in vivo, in vitro, and computational modeling studies. *Journal of Biomechanics*,46 (2013): 266-27, 2013.

Time table: Course of 16 hours. Lectures (2 hours) on Wednesday 10:30 - 12:30. First lecture on Wednesday, Oct. 19, 2016. Meeting Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Fundamentals of Fluid Dynamics.

Examination and grading: Homework assignment with final discussion.

3 Information-theoretic Methods in Security

Instructor: Nicola Laurenti, Department of Information Engineering, Univ. of Padova, e-mail: `nil@dei.unipd.it`

Aim: The class aims at providing the students with an information theoretic framework that will allow formal modeling, understanding of the fundamental performance limits, and derivation of unconditionally secure mechanisms for several security-related problems.

Topics:

- *The Holy Grail of perfect secrecy.* Shannon's cipher system. Perfect secrecy. Ideal secrecy. Practical secrecy. The guessing attack.
- *Secrecy without cryptography.* The wiretap channel model. Rate-equivocation pairs. Secrecy rates. Secrecy capacity for binary, Gaussian and fading channel models.
- *Security from uncertainty.* Secret key agreement from common randomness on noisy channels. Information theoretic models and performance limits of quantum cryptography.
- *Who's who?* An information theoretic model for authentication in noisy channels. Signatures and fingerprinting.
- *The gossip game.* Broadcast and secrecy models in multiple access channels. The role of trusted and untrusted relays.
- *Secrets in a crowd.* Information theoretic secrecy in a random network with random eavesdroppers. Secrecy graphs and large networks secrecy rates.
- *A cipher for free?* Information theoretic security of random network coding.
- *The jamming game.* Optimal strategies for transmitters, receivers and jammers in Gaussian, fading and MIMO channels.
- *Alea iacta est.* Secure and true random number generation. Randomness extractors and smooth guessing entropy.

- *Writing in sympathetic ink.* Information theoretic models of steganography, watermarking and other information hiding techniques.
- *Leaky buckets and pipes.* Information leaking and covert channels. Timing channels.
- *The dining cryptographers.* Privacy and anonymity. Secure multiparty computation.
- *Putting pieces together.* Universally composable security in the computational, information theoretic and quantum information frameworks
- *Information theoretic democracy.* Privacy, reliability and verifiability in electronic voting systems.
- *The Big Brother.* An information theoretic formulation of database security: the privacy vs utility tradeoff.

References:

- Y. Liang, H.V. Poor, and S. Shamai (Shitz), *Information Theoretic Security,* Now, 2007.
- M. Bloch, J. Barros, *Physical-Layer Security: from Information Theory to Security Engineering* Cambridge University Press, 2011.
- A short list of reference papers for each lecture will be provided during class meetings.

Time table: Course of 20 hours. Class meets every Tuesday and Thursday from 10:30 to 12:30. First lecture on Tuesday, October 18th, 2016. Room DEI/D, 1st floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: Basic notions of Information Theory (e.g., those from the *Telecomunicazioni* class in the *Corso di Laurea in Ingegneria dell'Informazione*)

Examination and grading: Each student (or a small group) must submit a project, and grading will be based on its evaluation. Students are encouraged to work from an information theoretic point of view on a security problem related to their research activities.

4 Applied Functional Analysis and Machine Learning

Instructor: Prof. G. Pillonetto, Dept. Information Engineering, University of Padova, e-mail: `giapi@dei.unipd.it`

Aim: The course is intended to give a survey of the basic aspects of functional analysis, machine learning, regularization theory and inverse problems.

Topics:

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.
3. *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.
4. *Reproducing kernel Hilbert spaces, inverse problems and regularization theory*: Representer theorem. Reproducing Kernel Hilbert Spaces (RKHS): definition and basic properties. Examples of RKHS. Function estimation problems in RKHS. Tikhonov regularization. Primal and dual formulation of loss functions. Regularization networks. Consistency/generalization and relationship with Vapnik's theory and the concept of V_γ dimension. Support vector regression and classification. Boosting.

Course requirements:

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

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] W. Rudin. Real and Complex Analysis, McGraw Hill, 2006
[2] E. Kreyszig. Introductory Functional Analysis with Applications, John Wiley and Sons , 1978
[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
[5] R.T. Rockafellar. Convex analysis. Princeton University Press, 1996

Time table: Course of 28 hours (2 two-hours lectures per week): Classes on Tuesday 10:30 - 12:30 and Wednesday, 8:30 - 10:30. First lecture on Wednesday November 23rd, 2016. Sala Riunioni 318 DEI/G 3-rd floor, via Gradenigo 6).

Examination and grading: Homework assignments and final test.

5 Bayesian Machine Learning

Instructor: Giorgio Maria Di Nunzio, e-mail: `dinunzio@dei.unipd.it`

Aim: The course will introduce fundamental topics in Bayesian reasoning and how they apply to machine learning problems. In this course, we will present pros and cons of Bayesian approaches and we will develop a graphical tool to analyse the assumptions of these approaches in practical problems.

Topics:

- Introduction of classical machine learning problems.
  - Mathematical framework
  - Supervised and unsupervised learning
- Bayesian decision theory
  - Two-category classification
  - Minimum-error-rate classification
  - Bayes risk
  - Decision surfaces
- Estimation
  - Maximum Likelihood Estimation
  - Maximum A Posteriori
  - Bayesian approach
- Graphical models
  - Bayesian networks
  - Two-dimensional probabilistic model
- Evaluation
  - Measures of accuracy
  - Statistical significance testing

References:

[1] J. Kruschke, *Doing Bayesian Data Analysis: A Tutorial Introduction With R and Bugs*, Academic Press 2010

[2] Christopher M. Bishop, *Pattern Recognition and Machine Learning (Information Science and Statistics)*, Springer 2007

[3] Richard O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification (2nd Edition)*, Wiley-Interscience, 2000

[4] Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, *Learning from Data*, AMLBook, 2012
(supporting material available at http://amlbook.com/support.html)

[5] David J. C. MacKay, *Information Theory, Inference and Learning Algorithms*, Cambridge University Press, 2003
(freely available and supporting material at http://www.inference.phy.cam.ac.uk/ma

[6] David Barber, *Bayesian Reasoning and Machine Learning*, Cambridge University Press, 2012
(freely available at http://web4.cs.ucl.ac.uk/staff/D.Barber/pmwiki/pmwiki.php?n=

[7] Kevin P. Murphy, *Machine Learning: A Probabilistic Perspective*, MIT Press, 2012
(supporting material http://www.cs.ubc.ca/ murphyk/MLbook/)

Time table: Course of 20 hours. Tentative schedule: Class meets every Thursday from 14:30 to 16:30 and Friday from 11:30 to 13:30. First lecture on Thursday, 12th January, 2017. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: Basics of Probability Theory. Basics of R Programming.

Examination and grading: Homework assignments and final project.

6 Technology entrepreneurship and lean start up

Instructor: Dr. Ruggero Frezza, Dr. William Vespi, M31 Spa, Padova, e-mail: `ruggero.frezza@m31.com`

Aim: The course will present how to bring an high technology idea to market applying the lean start up methodology. The aim is to give the students a basic set of tools to launch their own business if they will ever wish to do so. The course will apply a learn by doing approach and the instructors will pose real challenges to the students in hackathon style events.

Topics:

- *Background material.* No background material is necessary. The course will be held in English.
- *Corporations* What is a company and how it is governed. Managers, board members, shareholders and stakeholders. What is a start up company. Customer versus product development. The phases of the life of a company.
- *Market opportunity analysis* Business Model Canvas; Value proposition; customer segments; customer development process; minimum viable product; business metrics.
- *Intellectual property strategy* When and why deposit a patent application. The process of a patent application. The value of a patent.
- *Funding the start up phase* Crowdfunding; equity funding; business angels and venture capital.
- *Call to action* Presentation of real challenges in a hackathon like events.
- *Venture creation* Launch of the company; leave the building and experiment with the customers.
- *Funding the growth phase* Debt; private equity; IPO.

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

Time table: Course of 20 hours. Class meets every Friday from 14.30 to 16.30. First lecture on January, 13th, 2017. Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: familiarity with basic linear algebra.

Examination and grading: homework and take home exam.

7 Tissue Engineering: Principles and Applications

Instructor: Prof. Andrea Bagno, Department of Industrial Engineering, University of Padova. e-mail: andrea.bagno@unipd.it

Aim: The course will provide the basic knowledge of materials and methods for tissue engineering (TE) techniques. The course will also present some practical applications with regard to the production of engineered tissues.

Topics:

1. Fundamentals of TE.
2. Engineering biomaterials for TE.
3. Biomimetic materials.
4. Regeneration templates.
5. TE of biological tissues (cartilage, hearth valves, bone).

References:

[1] B. Palsson, J.A. Hubbel, R. Plonsey, J.D. Bronzino (Eds). Tissue engineering. CRC Press, Boca Raton, 2003.

[2] K.C. Dee, D.A. Puleo, R. Bizios. An introduction to tissue-biomaterials interactions. Wiley, Hoboken, New Jersey, 2002.

[3] J.B. Park, J.D. Bronzino, Biomaterials. CRC Press, Boca Raton, 2003.

Other material and research papers will be available online for download.

Time table: Course of 16 hours (2 two-hours lectures per week). Classes on Monday and Wednesday, 10:30 – 12:30. First lecture on Monday, January 23, 2017. Meeting Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic courses of chemistry, biology and physiology, biomaterials.

Examination and grading: Homework assignments and final test.

8 Real-Time Systems and applications

Instructor: Gabriele Manduchi, Consiglio Nazionale delle Ricerche
e-mail: `gabriele.manduchi@igi.cnr.it`

Aim: The course will provide an insight in the realm of real-time system. Knowledge in this field is normally fragmented and scattered among different engineering disciplines and computing sciences, and the the aim of the course is present aspects related to theory and practice in a way which is holistic enough to prepare graduates to embark on the development of real-time systems, frequently complex and imposing safety requirements. For this reason, after presenting in the first part of the course a surveys of related topics, including scheduling theory and real-time issues in operating systems, the control system of a Nuclear Fusion experiment will be presented as Use Case and analyzed in the second part of the course.

Topics:

- Concurrent Programming Concepts Remind: the role of parallelism and multithreading, deadlocks, interprocess communication, network communication.
- Real-time scheduling analysis:task-based scheduling, schedulability analysis based on utilization, schedulability analysis based on response time analysis, task interaction and blocking.
- Internal structures and operating principles of Linux real-time extensions.
- Data Acquisition systems: general concepts and architectures.
- An introduction of massive parallel operation in real-time applications using GPUs.
- Analysis of a real-time control system for nuclear fusion experiment.

References:

[1] I C Bertolotti, G Manduchi. Real-Time Embedded Systems. Open Source Operating Systems Perspective. CRC Press, 2012

[2] G C Buttazzo. Hard Real-Time Computing Systems. Predictable Scheduling Algorithms and Applications. Springer 2005.

Time table: Course of 20 hours. Class meets every Tuesday and Thursday from 8:30 to 10:30. First lecture on Tuesday, January 24, 2017. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic knowledge of Operating System and concurrent programming concepts.

Examination and grading: Each student will develop a case study, possibly related to his/her own research activity, addressing some topic presented in the course.

9 Low Power Wide Area Networks

Instructor: Prof. Lorenzo Vangelista , e-mail: `lorenzo.vangelista@unipd.it`

Aim: Introduce and explain the major characteristics of a new paradigm in the wireless sensors and actuators networks: the Low Power Wide Area Networks (LPWAN)

Topics:

- The concept of Internet of Things (IoT)
- The connectivity as an integral part of the IoT: the regulatory framework, licensed vs unlicensed bands, standardisation bodies
- The connectivity as an integral part of the IoT: cellular networks and mesh networks
- The connectivity as an integral part of the IoT: the new paradigm of LPWANs
- Review of current LPWAN systems: SigFox, Ingenu, Waviot etc.
- Review of one of the most promising LPWAN systems: Lo-Ra; system architecture, protocols, performance
- NB-IoT: the cellular alternative to LPWANs

References:

1 *Long-range communications in unlicensed bands: The rising stars in the IoT and smart city scenarios* M. Centenaro, L. Vangelista, A. Zanella, M. Zorzi - arXiv preprint arXiv:1510.00620, 2015

2 *Long-Range IoT Technologies: The Dawn of LoRa*, L. Vangelista, A. Zanella, M. Zorzi, Future Access Enablers for Ubiquitous and Intelligent Infrastructures, 2015

3 *The challenges of M2M massive access in wireless cellular networks* A. Biral, M. Centenaro, A. Zanella, L. Vangelista, M. Zorzi - Digital Communications and Networks, 2015

Time table: Course of 16 hours. Class meets every Tuesday and Thursday from 16:30 to 18:30. First lecture on January, 31 16:30, 2017. Room DEI/D, 1st floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: Basic knowledge of (wireless) communication systems

Examination and grading: Project work assigned by the instructor

10 Computational Inverse Problems

Instructor: Fabio Marcuzzi, Dept. of Mathematics, University of Padova
e-mail: `marcuzzi@math.unipd.it`

Aim: We study numerical methods that are of fundamental importance in computational inverse problems. Real application examples will be given for distributed parameter systems. Computer implementation performance issues will be considered also.

Topics:

- definition of inverse problems, basic examples and numerical difficulties.
- numerical methods for QR and SVD and their application to the square-root implementation in PCA, least-squares, model reduction and Kalman filtering; recursive least-squares;
- regularization methods;
- numerical algorithms for nonlinear parameter estimation: Gauss-Newton, Levenberg-Marquardt,
- examples with distributed parameter systems;
- HPC implementations

References:

[1] F.Marcuzzi "Analisi dei dati mediante modelli matematici", http://www.math.unipd.it/~marcuzzi/MNAD.html

Time table: Course of 20 hours (2 two-hours lectures per week): Classes on Monday and Wednesday, 10:30 - 12:30. First lecture on Monday February 27th, 2017. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements:

- basic notions of linear algebra and, possibly, numerical linear algebra.
- the examples and homework will be in Python (the transition from Matlab to Python is effortless).

Examination and grading: Homework assignments and final test.

11 Diagnostics of Electron Devices

Instructor: Proff. Giovanna Mura, Massimo Vanzi - Department of Electrical and Electronic Engineering (DIEE) University of Cagliari
e-mail: `gmura@diee.unica.it` `vanzi@diee.unica.it`

Aim: this course provides an overview of the Failure Analysis techniques for the diagnostics of electron devices.

Failure analysis is the process of analyzing the failed electron devices to determine the reason for degraded performance or catastrophic failure and to provide corrective actions able to fix the problem.

It is a proactive tool with three fundamental tasks: 1) Technical/scientific: 2) Technological 3) Economical. The purpose of this course is to teach what Failure Analysis should be and should do, to show how and why it often does not, to state that F.A. has Logics and has Rules.

Microscopy, in its several forms (optical, electron, scanning, transmission, emission, ionic) and tools is the playground for practical FA, and its fundamentals will be described. Device basic technology, working principle and failure physics are the other pillars for a successful study.

Several case studies will be proposed with the aim to demonstrate that if sometimes Failure Analysis looks unclear or not problem solving is merely because it was badly conducted.

Topics: The course will cover the following topics:

a) Reverse engineering

b) Failure modes and failure mechanisms

c) Principles and fundamental methods in Electron Microscopy

d) Methodology for the Failure Analysis

References: Failure Analysis of Integrated Circuits - Tools and Techniques

Springer International Series - Wagner, Lawrence C.

Slides

Time table: Course of 16 hours. Class meets starting March 6th, 2017 with the following schedule: March 6th from 15.30 to 17:30, March 7th from 9.30 to 11:30, March 13th from 15.30 to 17:30, March 14th from 13.30 to 15:30, March 23rd from 14.30 to 16:30, March 24th from 9.30 to 11:30, March 30th from 14.30 to 16:30 March 31st from 9.30 to 11:30.

Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: Electron Devices, Microelectronics, Optoelectronics devices.

Examination and grading: Written test/ presentation of a report at the end of the course.

12 Applied Linear Algebra

Instructors: Prof. F. de Terán, Universidad Carlos III de Madrid,
e-mail: `fteran@math.uc3m.es` .
Prof. Michael Karow, Technische Universität Berlin,
e-mail: `karow@math.tu-berlin.de`

Aim: We study concepts and techniques of linear algebra that are important for applications with special emphasis on the topics: (a) *solution of systems of linear equations* (with particular attention to the analysis of the *backward error* and *computational cost* of the basic algorithms) and (b) *matrix equations and inequalities.* A wide range of exercises and problems will be an essential part of the course and constitute homework required to the student.

Topics:

1. Review of some basic concepts of linear algebra and matrix theory.
2. Gaussian elimination.
3. LU factorization.
4. Positive (semi) definite matrices and Cholesky factorization.
5. Matrix exponential.
6. Sylvester and Lyapunov equations, Riccati equation.
7. Applications to Control Theory.

References:

[1] Gilbert Strang's linear algebra lectures, from M.I.T. on You Tube

[2] Nicholas J. Higham. *Accuracy and Stability of Numerical Algorithms.* SIAM, Philadelphia, 2002.

[3] Notes from the instructors

Time table: Course of 16 hours.

- First part (De Terán): Class meets on Tuesday and Thursday, from 10.30 to 12.30. First Lecture on March 14th, 2017
- Second part (Karow): Class meets on Tuesday and Thursday, from 10.30 to 12.30. First Lecture on March 28th, 2017

Course requirements: A good working knowledge of basic notions of linear algebra as for example in [1]. Some proficiency in MATLAB.

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

13 Physics and operation of heterostructure-based electronic and optoelectronic devices

Instructors: E. Zanoni, M. Meneghini and C. De Santi
e-mail: {gauss,menego,desantic}@dei.unipd.it

Aim: This course provides an introduction to the physics and operating principles of advanced electronic and optoelectronic devices based on compound semiconductors. These devices are particularly important for several applications: high electron mobility transistors (HEMTs) represent excellent devices for the realization of high frequency communication systems, radars, satellite applications, and high effciency power converters. On the other hand, LEDs and lasers are high-efficiency monochromatic light sources, that can be used both for lighting applications (with a considerable energy saving), in the biomedical field, and in in photochemistry. Special focus will be given to Gallium Nitride (GaN) based devices, that represent the most promising devices for future power electronics applications. This course will focus on the main aspects related to the physics of heterostructures, on the recombination processes in semiconductors, on carrier transport in heterostructures, on the structure and operating principles of MESFET, HEMTs, GITs, on the trapping and reliability in compound semiconductor devices, on the operating principles of LEDs and lasers, and on parasitics and reliability in LEDs and lasers. An overview of real applications highlighting the capabilities of these devices will also be given.

Topics:

- physics of heterostructures, band diagrams, carrier transport in heterostructures;
- recombination processes in semiconductors;
- properties of compound semiconductors;
- basic structure of heterojunction transistors, MESFET, HEMT, GIT;
- parasitics and reliability in HEMTs, LEDs and lasers;

- operating principles of LEDs and lasers;
- methods for advanced characterization of heterojunction based devices;
- applications of GaN based HEMTs, LEDs and lasers;
- modeling of semiconductor-based devices

References:

Umesh Mishra, Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2008 Ruediguer Quay, Gallium Nitride Electronics, Springer 2008. Tae-Yeon Seong, Jung Han, Hiroshi Amano, Hadis Morko, III-Nitride Based Light Emitting Diodes and Applications, Springer 2013

Time table: Course of 20 hours. (2 two-hours lectures per week) Classes on Monday 14:30 - 16:30 and Thursday, 16:30 - 18:30. First lecture on Monday March 20, 2017

Course requirements: Introductory course of device physics: Microelectronics, Optoelectronic and Photovoltaic Devices **Examination and grading**: Written test at the end of the course

14 Optimization and Optimal Control

Instructor: Prof. John Hauser, University of Colorado Boulder, e-mail: ducati.motogp@gmail.com

In this course, we will study the use of a nonlinear projection operator in the development of a novel function space approach for the optimization of trajectory functionals. Given a bounded state-control trajectory of a nonlinear system, one may make use of a simple (e.g., linear time-varying) trajectory tracking control law to explore the set of nearby bounded state-control trajectories. Such a trajectory tracking control system defines a nonlinear projection operator that maps a set of bounded curves onto a set of nearby bounded trajectories.

We will use the projection operator approach to develop a Newton descent method for the optimization of dynamically constrained functionals. By projecting a neighboring set of state-control curves onto the trajectory manifold and then evaluating the cost functional, the constraint imposed by the nonlinear system dynamics is subsumed into an unconstrained trajectory functional. Attacking this equivalent optimization problem in an essentially unconstrained manner, we will discover an algorithm defined in function space that produces a descending sequence in the Banach manifold of bounded trajectories. The specific computations for this algorithm will be implemented by solving ordinary differential equations.

Of special interest is the trajectory representation theorem: trajectories near a given trajectory can be represented uniquely as the projection of the sum of that trajectory and a tangent trajectory, providing a local chart for the trajectory manifold. The composition of the cost functional with this mapping is thereby a mapping from the Banach space of tangent trajectories into the real numbers and it is this local mapping that may or may not possess (local) convexity properties. When the second Frechet derivative of this mapping is positive definite (in an appropriate sense), the mapping is locally convex which is useful for many applications including the existence of a Newton descent direction, second order sufficient condition (SSC) for optimality, quadratic convergence, and continuous dependence of optimal trajectories on initial conditions.

We will make use of the PRojection Operator based Newton method for Trajectory Optimization (PRONTO) to do some numerical ”trajectory exploration” on some interesting nonlinear systems, including possible student selected systems. Throughout the course, various concepts will be illustrated with examples and followed by homework assignments designed to enhance understanding.

References: Lecture notes and references will be posted on the web site of the course.

Time table: Course of 20 hours. Class meets every Tuesday and Thursday from 10.30 to 12.30. First lecture on April, 11th, 2017. Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: familiarity with basic linear algebra.

Examination and grading: homework and final project.

15 Statistical Methods

Instructor: Dr. Lorenzo Finesso, Istituto di Elettronica e di Ingegneria dell'Informazione e delle Telecomunicazioni, IEIIT-CNR, Padova, e-mail: lorenzo.finesso@unipd.it

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

Topics:

- *Background material.* The noiseless source coding theorem will be quickly reviewed in order to introduce the basic notions of entropy and I-divergence.
- *Divergence minimization problems.* Three I-divergence minimization problems will be posed and, via examples, they will be connected with basic methods of statistical inference: ML (maximum likelihood), ME (maximum entropy), and EM (expectation-maximization).
- *Multivariate analysis methods.* The three standard multivariate methods, PCA (Principal component analysis), Factor Analysis, and CCA (Canonical Correlations analysis) will be reviewed and their connection with divergence minimization discussed. Applications of PCA to least squares (PCR principal component regression, PLS Partial least squares). Approximate matrix factorization and PCA, with a brief detour on the approximate Nonnegative Matrix Factorization (NMF) problem. The necessary linear algebra will be reviewed.
- *EM methods.* The Expectation-Maximization method will be introduced as an algorithm for the computation of the Maximum Likelihood (ML) estimator with partial observations (incomplete data) and interpreted as an alternating divergence minimization algorithm *à la* Csiszár Tusnády.
- *Applications to stochastic processes.* Introduction to HMM (Hidden Markov Models). Maximum likelihood estimation for HMM via the EM method. If time allows: derivation of the Burg spectral estimation method as solution of a Maximum Entropy problem.

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

Time table: Course of 24 hours. Class meets every Monday and Wednesday from 10.30 to 12.30. First lecture on April, 19th, 2017. Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: familiarity with basic linear algebra.

Examination and grading: homework and take home exam.

16 Distributed Optimization and Applications

Instructor: Professor Subhrakanti Dey, Signals and Systems, Uppsala University, Sweden
e-mail: `Subhra.Dey@signal.uu.se`

Aim: The aim of this course is to introduce postgraduate students to the topical area of Distributed Optimization. As we enter the era of *Big Data*, engineers and computer scientists face the unenviable task of dealing with massive amounts of data to analyse and run their algorithms on. Often such data reside in many different computing nodes which communicate over a network, and the availability and processing of the entire data set at one central place is simply infeasible. One needs to thus implemented distributed optimization techniques with message passing amongst the computing nodes. The objective remains to achieve a solution that can be as close as possible to the solution to the centralized optimization problem. In this course, we will start with some history on the origins of distributed optimization algorithms such as the Alternating Direction Method of Multipliers (ADMM), discuss its properties, and applications to both convex and non-convex problems, and explore alternative techniques such as game theoretic methods as well as distributed stochastic optimization methods, and finish with discussions on very recent and largely open areas such as networked optimization and distributed machine learning algorithms. This course will provide a glimpse into this fascinating subject, and will be of relevance to graduate students in Electrical, Mechanical and Computer Engineering, Computer Science students, as well as graduate students in Applied Mathematics and Statistics, along with students dealing with large data sets and machine learning applications to Bioinformatics.

Topics:

- *Lectures 1 and 2:* Precursors to distributed optimization algorithms: parallelization and decomposition of optimization algorithms (dual decomposition, proximal minimization algorithms, augmented Lagrangian and method of multipliers)

- *Lecture 3:* The Alternating Direction Method of Multipliers (ADMM): (Algorithm, convergence, optimality conditions, stopping criteria, constrained convex optimization)
- *Lecture 4:* Applications of ADMM to machine learning problems: l_1 norm problems
- *Lecture 5:* ADMM based methods for solving consensus and sharing problems, ADMM for non-convex problems and examples
- *Lecture 6:* ADMM Implementation issues and numerical examples
- *Lecture 7:* Distributed optimization using non-cooperative game theory (basic theory of Nash equilibrium, existence, uniqueness and efficiency)
- *Lecture 8:* Distributed stochastic optimization and Stochastic Approximation algorithms
- *Lecture 9:* Networked Optimization (e.g. over a graph) and distributed optimization under communication constraints
- *Lecture 10*: Applications of distributed optimization to distributed machine learning: a survey for recent results

References:

[1] S. Boyd, N. Parikh, E. Chu, B. Peleato, and J. Eckstein, *Distributed Optimization and Statistical Learning via the Alternating Direction Method of Multipliers*, Foundations and Trends in Machine Learning, 3(1):1122, 2011.

[2] Dimitri Bertsekas and John N. Tsitsiklis, *Parallel and Distributed Computation: Numerical Methods*, Athena Scientific, 1997.

[3] S. Boyd and L. Vandenverghe, *Convex Optimization*, Cambridge University Press.

[4] M. Zhu and S. Martinez, *Distributed Optimization-Based Control of Multi-Agent Networks in Complex Environments*, Springer, 2015.

[5] Relevant recent papers will be referred to and distributed during the lectures.

Time table: Course of 20 hours (2 two-hours lectures per week). Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Class meets every Tuesday and Thursday from 14:30 to 16:30. First lecture on May 2nd, 2017 (one week break from May 29th to June 2nd)

Course requirements: Advanced calculus, Basic optimization Theory, and Linear Algebra, Basic Probability Theory and Random Variables.

Examination and grading: A project assignment for students in groups of 2 requiring about 20 hours of work.

17 From Electric Grids to Smart Grids

Instructor: Prof. Reza Arghandeh , Florida State University, Center for Advanced Power Systems, USA, reza@caps.fsu.edu

Aim: This course is an introduction to the power systems, its structure, its components, and what is called the **Smart Grid**. The course reviews power apparatus, including transformers, generators, and transmission lines from system perspective. Analysis tools such as one-line diagram, per-unit representation, efficiency, and electricity market regulation. The course will briefly introduce the subjects of power flow analysis. It is a conceptual approach to study power systems and is supported by a wide range of exercises and problems.

Topics:

1. Analyze the building blocks of power system (transformer, transmission line, generators, loads) after learning: i) form the electrical circuit model of the device. ii) use the per unit system in circuit analysis iii) understand three phase delta and wye/star connections.
2. Analyze the performance of a simple power system after learning: i) construct electrical circuit representation of a three-phase system with connecting different components. ii) model electrical loads. ii) calculate the voltages and current in a power circuit.
3. Power flow analysis: i) introduce different power flow analysis methods. ii) Discuss the numerical methods for power flow analysis. iii) Implement the power flow analysis on circuit models such as IEEE models.
4. Smart Grid: i) How smart is the grid? ii) What is the smart grid? iii) New opportunities and research paradigms in smart grid areas.

References:

[1] P. Glover et. al, *Power System Analysis & Design*, Cengage Learning, 2015.

[2] L. Powell, *Power system load flow analysis*, McGraw Hill , 2004.

Class lectures and other material and research papers will be available online for download.

Time table: Course of 16 hours (2 two-hours lectures per week). Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building. Class meets every Tuesday and Thursday from 10:30 to 12:30. First lecture on June 6th, 2017.

Course requirements: familiarity with basic linear algebra. Knowledge of electric circuits also helps, but it is not a requirement.

Examination and grading: homework and take home exam.

18 Numerical Simulation of Semiconductor Devices

Instructor: Professor Andrea Cester, Dept. Information Engineering, University of Padova,
e-mail: cester@dei.unipd.it

Aim: The course is intended to give a survey of the basic aspects of the numerical simulation of electronic devices

Topics:

- Review of the charge transport in semiconductor devices
- Some notions about the numerical solution of partial differential equations
- Numerical solution for the steady-state drift diffusion equation in semiconductor: Gummel's Iteration Method, Newton's Iteration Method.
- Generation and Recombination.
- Numerical solution for the time dependent drift diffusion equation in semiconductor: simulation of the small-signal impedance.
- Case studies: the metal-semiconductor junction and, the pn junction.
- Some notions about the 2D numerical solution of the drift diffusion equation in semiconductor devices. partial differential equations

Time table: Course of 20 hours (2 two-hours lectures per week). Room DEI/G, 3rd floor, Dept. of Information Engineering, via Gradenigo Building.

Class meets every Tuesday and Friday from 14:00 to 16:00. First lecture on June 20th, 2017

Course requirements: knowledge of semiconductor physics and semiconductor devices.

Examination and grading: Homeworks and final exam.

October 2016

September 2016

M	T	W	T	F	S	S
			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		

October 2016

M	T	W	T	F	S	S
					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						

November 2016

M	T	W	T	F	S	S
	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				

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17 10:30 Prof. Pupolin	18 10:30 Dott. Laurenti	19 10:30 Prof. Susin	20 10:30 Dott. Laurenti	21 10:30 Prof. Pupolin	22	23
24 10:30 Prof. Pupolin	25 10:30 Dott. Laurenti	26 10:30 Prof. Susin	27 10:30 Dott. Laurenti	28 10:30 Prof. Pupolin	29	30 Ora solare
31	1 Ognissanti All Saints' Day	2 10:30 Prof. Susin	3 10:30 Dott. Laurenti	4 10:30 Prof. Pupolin	5	6

November 2016

October 2016

M	T	W	T	F	S	S
					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						

November 2016

M	T	W	T	F	S	S
	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				

December 2016

M	T	W	T	F	S	S
			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	

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
31	1 Ognissanti All Saints' Day	2 10:30 Prof. Susin	3 10:30 Dott. Laurenti	4 10:30 Prof. Pupolin	5	6
7 10:30 Prof. Pupolin	8 10:30 Dott. Laurenti	9 10:30 Prof. Susin	10 10:30 Dott. Laurenti	11 10:30 Prof. Pupolin	12	13
14 10:30 Prof. Pupolin	15 10:30 Dott. Laurenti	16 10:30 Prof. Susin	17 10:30 Dott. Laurenti	18 10:30 Prof. Pupolin	19	20
21 10:30 Prof. Pupolin	22 10:30 Dott. Laurenti	23 08:30 Prof. Pillonetto 10:30 Prof. Susin	24	25	26	27
28	29 10:30 Prof. Pillonetto	30 08:30 Prof. Pillonetto 10:30 Prof. Susin	1	2	3	4

December 2016

November 2016

M	T	W	T	F	S	S
	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				

December 2016

M	T	W	T	F	S	S
			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	

January 2017

M	T	W	T	F	S	S
						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					

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
28	29 10:30 Prof. Pillonetto	30 08:30 Prof. Pillonetto 10:30 Prof. Susin	1	2	3	4
5	6 10:30 Prof. Pillonetto	7 08:30 Prof. Pillonetto 10:30 Prof. Susin	8 Immacolata Concezione 09:00 December 8th	9	10	11
12	13 10:30 Prof. Pillonetto	14 08:30 Prof. Pillonetto	15	16	17	18
19	20 10:30 Prof. Pillonetto	21 08:30 Prof. Pillonetto	22	23 Christmas' break	24 09:00 Christmas eve	25 Natale 09:00 Christmas
26 Christmas' break Santo Stefano 09:00 S. Stephen's day	27	28	29	30	31 San Silvestro 09:00 New Year eve	1 Primo dell'anno 09:00 New Year Day

January 2017

December 2016

M	T	W	T	F	S	S
			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	

January 2017

M	T	W	T	F	S	S
						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					

February 2017

M	T	W	T	F	S	S
		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					

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26 Christmas' break Santo Stefano 09:00 S. Stephen's day	27	28	29	30	31 San Silvestro 09:00 New Year eve	1 Primo dell'anno 09:00 New Year Day
2 Christmas' break	3	4	5	6 Epifania	7	8
9	10 10:30 Prof. Pillonetto	11 08:30 Prof. Pillonetto	12 14:30 Prof. Di Nunzio	13 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	14	15
16	17 10:30 Prof. Pillonetto	18 08:30 Prof. Pillonetto	19 14:30 Prof. Di Nunzio	20 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	21	22
23 10:30 Bagno	24 08:30 Prof. Manduchi 10:30 Prof. Pillonetto	25 10:30 Bagno	26 08:30 Prof. Manduchi 14:30 Prof. Di Nunzio	27 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	28	29
30 10:30 Bagno	31 08:30 Prof. Manduchi 16:30 Prof. Vangelista	1 10:30 Bagno	2 08:30 Prof. Manduchi 14:30 Prof. Di Nunzio 16:30 Prof. Vangelista	3 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	4	5

February 2017

January 2017						
M	T	W	T	F	S	S
						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					

February 2017						
M	T	W	T	F	S	S
		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					

March 2017						
M	T	W	T	F	S	S
		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		

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
30 10:30 Bagno	31 08:30 Prof. Manduchi 16:30 Prof. Vangelista	1 10:30 Bagno	2 08:30 Prof. Manduchi 14:30 Prof. Di Nunzio 16:30 Prof. Vangelista	3 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	4	5
6 10:30 Bagno	7 08:30 Prof. Manduchi 16:30 Prof. Vangelista	8 10:30 Bagno	9 08:30 Prof. Manduchi 14:30 Prof. Di Nunzio 16:30 Prof. Vangelista	10 11:30 Prof. Di Nunzio 14:30 Dr. Frezza	11	12
13 10:30 Bagno	14 08:30 Prof. Manduchi 16:30 Prof. Vangelista	15 10:30 Bagno	16 08:30 Prof. Manduchi 16:30 Prof. Vangelista	17 14:30 Dr. Frezza	18	19
20 10:30 Bagno	21 08:30 Prof. Manduchi 16:30 Prof. Vangelista	22 10:30 Bagno	23 08:30 Prof. Manduchi 16:30 Prof. Vangelista	24 14:30 Dr. Frezza	25	26
27 10:30 Prof. Marcuzzi	28	1 10:30 Prof. Marcuzzi	2	3 14:30 Dr. Frezza	4	5

March 2017

February 2017

M	T	W	T	F	S	S
		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					

March 2017

M	T	W	T	F	S	S
		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		

April 2017

M	T	W	T	F	S	S
					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

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
27 10:30 Prof. Marcuzzi	28	1 10:30 Prof. Marcuzzi	2	3 14:30 Dr. Frezza	4	5
6 10:30 Prof. Marcuzzi 15:30 Proff. Mura and Vanzi	7 09:30 Proff. Mura and Vanzi	8 10:30 Prof. Marcuzzi	9	10 14:30 Dr. Frezza	11	12
13 10:30 Prof. Marcuzzi 15:30 Proff. Mura and Vanzi	14 10:30 Prof. De Teran (ALA) 13:30 Proff. Mura and Vanzi	15 10:30 Prof. Marcuzzi	16 10:30 Prof. De Teran (ALA)	17 14:30 Dr. Frezza	18	19
20 10:30 Prof. Marcuzzi 14:30 Proff. Meneghini, Zanoni, De Santi	21 10:30 Prof. De Teran (ALA)	22 10:30 Prof. Marcuzzi	23 10:30 Prof. De Teran (ALA) 14:30 Proff. Mura and Vanzi 16:30 Proff. Meneghini, Zanoni, De Santi	24 09:30 Proff. Mura and Vanzi	25	26 Ora legale
27 10:30 Prof. Marcuzzi 14:30 Proff. Meneghini, Zanoni, De Santi	28 10:30 Prof. Karow (ALA)	29 10:30 Prof. Marcuzzi	30 10:30 Prof. Karow (ALA) 14:30 Proff. Mura and Vanzi 16:30 Proff. Meneghini, Zanoni, De Santi	31 09:30 Proff. Mura and Vanzi	1	2

April 2017

March 2017

M	T	W	T	F	S	S
		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		

April 2017

M	T	W	T	F	S	S
					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

May 2017

M	T	W	T	F	S	S
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				

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
27 10:30 Prof. Marcuzzi 14:30 Proff. Meneghini, Zanoni, De Santi	28 10:30 Prof. Karow (ALA)	29 10:30 Prof. Marcuzzi	30 10:30 Prof. Karow (ALA) 14:30 Proff. Mura and Vanzi 16:30 Proff. Meneghini, Zanoni, De Santi	31 09:30 Proff. Mura and Vanzi	1	2
3 14:30 Proff. Meneghini, Zanoni, De Santi	4 10:30 Prof. Karow (ALA)	5	6 10:30 Prof. Karow (ALA) 16:30 Proff. Meneghini, Zanoni, De Santi	7	8	9
10 14:30 Proff. Meneghini, Zanoni, De Santi	11 10:30 Prof. Hauser	12	13 10:30 Prof. Hauser 16:30 Proff. Meneghini, Zanoni, De Santi	14 Easter Break Venerdì Santo	15 Easter Break	16 Easter Break Pasqua
17 Easter Break Lunedì dell'Angelo	18 10:30 Prof. Hauser	19 10:30 Prof. Finesso	20 10:30 Prof. Hauser 16:30 Proff. Meneghini, Zanoni, De Santi	21	22	23
24	25 Anniversario della Liberazione Liberation Day	26 10:30 Prof. Finesso	27 10:30 Prof. Hauser 16:30 Proff. Meneghini, Zanoni, De Santi	28	29	30

May 2017

April 2017						
M	T	W	T	F	S	S
					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

May 2017						
M	T	W	T	F	S	S
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				

June 2017						
M	T	W	T	F	S	S
			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		

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1 Workers' Day Festa dei lavoratori	2 10:30 Prof. Hauser 14:30 Prof. Dey	3 10:30 Prof. Finesso	4 10:30 Prof. Hauser 14:30 Prof. Dey	5	6	7
8 10:30 Prof. Finesso	9 10:30 Prof. Hauser 14:30 Prof. Dey	10 10:30 Prof. Finesso	11 10:30 Prof. Hauser 14:30 Prof. Dey	12	13	14
15 10:30 Prof. Finesso	16 10:30 Prof. Hauser 14:30 Prof. Dey	17 10:30 Prof. Finesso	18 14:30 Prof. Dey	19	20	21
22 10:30 Prof. Finesso	23 14:30 Prof. Dey	24 10:30 Prof. Finesso	25 14:30 Prof. Dey	26	27	28
29 10:30 Prof. Finesso	30	31 10:30 Prof. Finesso	1	2 Republic Day Festa della Repubblica	3	4

June 2017

Public Holidays in Italy
Ph.D. Classes: Room DEI/G
Festività italiane

May 2017

M	T	W	T	F	S	S
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				

June 2017

M	T	W	T	F	S	S
			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		

July 2017

M	T	W	T	F	S	S
					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						

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
29 10:30 Prof. Finesso	30	31 10:30 Prof. Finesso	1	2 Republic Day Festa della Repubblica	3	4
5 10:30 Prof. Finesso	6 10:30 Prof. Arghandeh 14:30 Prof. Dey	7 10:30 Prof. Finesso	8 10:30 Prof. Arghandeh 14:30 Prof. Dey	9	10	11
12	13	14	15 10:30 Prof. Arghandeh	16	17	18
19	20 10:30 Prof. Arghandeh 14:00 Prof. Cester	21	22 10:30 Prof. Arghandeh	23 14:00 Prof. Cester	24	25
26	27 10:30 Prof. Arghandeh 14:00 Prof. Cester	28	29 10:30 Prof. Arghandeh	30 14:00 Prof. Cester	1	2

July 2017

June 2017						
M	T	W	T	F	S	S
			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		

July 2017						
M	T	W	T	F	S	S
					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						

August 2017						
M	T	W	T	F	S	S
	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			

- Public Holidays in Italy
- Ph.D. Classes: Room DEI/G
- Festività italiane

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26	27 10:30 Prof. Arghandeh 14:00 Prof. Cester	28	29 10:30 Prof. Arghandeh	30 14:00 Prof. Cester	1	2
3	4 10:30 Prof. Arghandeh 14:00 Prof. Cester	5	6	7 14:00 Prof. Cester	8	9
10	11 14:00 Prof. Cester	12	13	14 14:00 Prof. Cester	15	16
17	18 14:00 Prof. Cester	19	20	21 14:00 Prof. Cester	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6