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

Course Catalogue

2014

Requirements for Ph.D. Students of the Graduate School of 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 have to enroll in the courses 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 school 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.

Contents

1 Applied Functional Analysis

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, operator theory in Hilbert spaces, 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. Hilbert adjoint operator. Self-adjoint operators, unitary operators.

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*: Reproducing Kernel Hilbert Spaces (RKHS): definition and basic properties. Examples of RKHS. Function estimation problems in RKHS. Tikhonov regularization. Review of some basic notions of convex analysis and introduction to nonsmooth loss functions: Vapnik, hinge's loss, Huber. Support vector regression and regularization networks. Representer theorem.

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] 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.
[5] R.T. Rockafellar. Convex Analysis. Princeton University Press, 1970.

Time table: Course of 28 hours (2 two-hours lectures per week): Classes on Tuesday and Thursday, 10:30 – 12:30. First lecture on Tuesday September 23rd, 2014. Room 318 DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Examination and grading: Homework assignments and final test.

2 Applied Linear Algebra

Instructor: Giorgio Picci, University of Padova, Italy e-mail: `picci@dei.unipd.it`

Aim: We study concepts and techniques of linear algebra that are important for applications with a special emphasis on linear Least Squares problems, their numerical treatment and their statistical interpretation. 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 L.A. and matrix theory
2. Deterministic Least Squares and the projection theorem
3. Statistical Least squares
4. Numerical treatment of Least Squares problems and regularization techniques

References:

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

[2] Notes from the instructor

Time table: Course of 20 hours. Class meets every Wednesday and Friday, 10:30 – 12:30. First lecture on Wednesday, March 5th, 2014. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

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.

3 Bayesian Machine Learning

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

Aim: The course will introduce fundamantal 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 Bayesian 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
  - Bayesian estimation
- Graphical models
  - Bayesian networks
  - Two-dimensional probabilistic model
- Evaluation
  - Measures of accuracy
  - Statistical significance testing

References:

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

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

Time table: Course of 16 hours. Class meets every Tuesday and Wednesday from 8:30 to 10:30. First lecture on Tuesday, May 6-th, 2014. 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.

4 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, back-propagation (neural networks), adjoint model (VDA);
- examples with distributed parameter systems;
- HPC implementations and parallel implementations on GPUs;

References:

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

[2] CUDA programming guide, http://docs.nvidia.com/cuda/index.html

Time table: Course of 16 hours (2 two-hours lectures per week): Classes on Tuesday and Thursday, 10:30 - 12:30. First lecture on Tuesday February 25th, 2014. 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.

5 Digital Processing of Measurement Information

Instructor: Prof. Claudio Narduzzi, Department of Information Engineering (DEI), University of Padua, e-mail: `claudio.narduzzi@unipd.it`

Aim: Whenever research involves experimental activities, there is a need to characterize measuring equipment, assess the accuracy of data and, most often, process raw data to extract relevant information. The course introduces advanced measurement algorithms, together with the conceptual tools that allow their characterization in a probabilistic framework. This will provide the student with the skills required to analyze a measurement problem, process experimental data and correctly approach the analysis of uncertainty.

Topics:

1. Uncertainty, quantization and the additive noise stochastic model: a reappraisal.
2. Characterisation of waveform digitizers and data acquisition systems.
3. Analysis of signal processing algorithms: statistical properties of discrete Fourier transform-based spectral estimators, least squares regression and the Cramér-Rao bound.
4. Compensation of measurement system dynamics: inverse problems and ill-posedness.
5. Multi-resolution analysis and the characterization of clock stability
6. Model-based measurements and compressed sensing.
7. The evaluation of uncertainty in measurement: ISO Guide probability-based approach and the alternative approach based on the theory of evidence.

References:
Lecture notes and selected reference material will be handed out during the course.

Time table: Course of 16 hours. Class meets every Monday and Thursday from 10:30 a.m. to 12:30 p.m.. First lecture on Monday, March 24th , 2014. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: None.

Examination and grading: Final project assignment.

6 E. M. Waves in Anisotropic Media

Instructor: Carlo Giacomo Someda, Dept. of Information Engineering, Univ. of Padova
e-mail: `someda@dei.unipd.it`.

Aim: To go beyond the standard limitations of typical courses on e.m. waves. In all those that are currently taught at our Department, and in comparable Universities, the medium where waves propagate is always assumed to be linear and isotropic. This is a severe limitation, which hinders, nowadays, comprehension of how many practical devices work, as well as of some physical concepts that are relevant even to philosophy of science (e.g., reciprocity).

Topics:

1. Features shared by all linear anisotropic media: mathematical description in terms of dyadics. Energy transport in anisotropic media: waves and rays.
2. Propagation of polarization in anisotropic media: the Jones matrix, the Mueller matrix.
3. Linearly birefringent media: Fresnels equations of wave normals. The indicatrix.
4. Applications: fundamentals of crystal optics.
5. Gyrotropic media: constitutive relations of the ionosphere and of magnetized ferrites. The Appleton-Hartree formula
6. Faraday rotation and its applications.
7. Circular birefringence vs. reciprocity in anisotropic media
8. Introduction to the backscattering analysis of optical fibers.

References:

[1] C. G. Someda, Electromagnetic Waves, 2nd Edition, CRC Taylor & Francis, Boca Raton, FL, 2006

[2] M. Born and E. Wolf, Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light, 6th Ed., Pergamon Press, 1986.

[3] J. A. Kong, Electromagnetic Wave Theory, 2nd Ed., Wiley, 1990.

[4] J.F. Nye, Physical Properties of Crystals: Their Representation by Tensors and Matrices, paperback edition, Clarendon Press, 1985.

[5] C.G. Someda and G. I. Stegeman, eds., Anisotropic and Nonlinear Waveguides, Elsevier, 1992.

Time table: Course of 20 hours (two lectures of two hours each per week). Class meets every Monday and Thursday from 2:30 to 4:30. First lecture on Monday, May 5, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic knowledge of e.m. wave propagation in linear isotropic media. Fundamentals of linear algebra.

Examination and grading: Weekly homework assignment. Final mini-project.

7 Fluid mechanics for the functional assessment of cardiovascular devices

Instructor: Francesca Maria Susin, Dept. ICEA, University of Padua,
e-mail: `francescamaria.susin@unipd.it`

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 pre-clinical 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 12 hours. Lectures (2 hours) on Thursday 2:30 – 4:30 PM. Starting on Thursday, October 9, 2014 and ending on Thursday, November 13, 2014. 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.

8 Information theoretic Methods in Security

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

Aim: To provide the students with an information theoretic framework that will allow formal modeling, and understanding fundamental performance limits, in several security-related problems

Topics: Topics will be chosen, according to the students' interests from the following list:
Measuring information. Review of basic notions and results in information theory: entropy, equivocation, mutual information, channel capacity.

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 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.

A different approach. Secrecy capacity from channel resolvability. Secret-key capacity from channel intrinsic randomness.

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.

Who's who? An information theoretic model for authentication in noisy channels. Signatures and fingerprinting.

Writing in sympathetic ink. Information theoretic models of steganography, watermarking and other information hiding techniques.

The jamming game. Optimal strategies for transmitters, receivers and jammers in Gaussian, fading and MIMO channels.

Leaky buckets and pipes. Information leaking and covert channels. Timing channels.

The dining cryptographers. Privacy and anonymity. Secure multiparty computation.

Information theoretic democracy. Privacy, reliability and verifiability in electronic voting systems.

Alea iacta est. Secure and true random number generation. Randomness extractors and smooth guessing entropy.

The Big Brother. An information theoretic formulation of database security: the privacy vs utility tradeoff.

References:

[1] Y. Liang, H.V. Poor, and S. Shamai (Shitz), *Information Theoretic Security,* Now, 2007.

[2] 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 (two lectures of two hours each per week). Class meets every Wednesday and Friday from 10:30 to 12:30, starting on Wednesday, October 1-st and ending on Wednesday, October 31-st, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic notions of Information Theory

Examination and grading: Each student must submit a project, and grading will be based on its evaluation. I encourage students to work from an information theoretic point of view on a security problem related to their research activities.

9 Mathematical modeling of cell Biology

Instructor: Morten Gram Pedersen, Department of Information Engineering, University of Padova, e-mail: `pedersen@dei.unipd.it`

Aim: The aim of this course is to provide an introduction to commonly used mathematical models of cellular biology. At the end of the course, the students should be able to build models of biological processes within the cell, to simulate and analyze them, and to relate the results back to biology. The focus will be on electrical activity and calcium dynamics in neurons and hormone-secreting cells.

Topics: Biochemical reactions; Ion channels, excitablity and electrical activity; Calcium dynamics; Intercellular communication; Spatial and stochastic phenomena (if time allows); Qualitative analysis of nonlinear differential equations.

References: The following books will provide the core material, which will be supplemented by research articles:

1. C.P. Fall, E.S. Marland, J.M. Wagner, J.J. Tyson. *Computational Cell Biology.* Springer, NY, USA (2002).
2. J. Keener, J. Sneyd: *Mathematical Physiology.* Springer, NY, USA (2004).

Time table: Course of 20 hours (2 two-hours lectures per week). Class meets every Monday from 10:30 to 12:30 and Wednesday from 1:30 to 3:30. First lecture on Monday, October 20, 2014. Room 318 DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic courses of linear algebra and ODEs. Basic experience with computer programming. Knowledge of cellular biology is not required.

Examination and grading: Homeworks and/or final project.

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

Instructors: G. Meneghesso, E. Zanoni, M. Meneghini, F.A. Marino, Dept. Ingegneria dell'Informazione (DEI), University of Padova, e-mail: `gauss@unipd.it, zanoni@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 efficiency 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.

To understand the capabilities of this technology, and to be able to design advanced systems based on LEDs, lasers and HEMTs, it is important to study the physics and the operating principles of these devices. 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

Topics:

1. physics of heterostructures, band diagrams, carrier transport in heterostructures;

2. recombination processes in semiconductors;

3. properties of compound semiconductors;

4. basic structure of heterojunction transistors, MESFET, HEMT, GIT;

5. trapping, parasitics and reliability in heterojunction based transistors;

6. operating principles of LEDs and lasers;

7. parasitics and reliability in LEDs and lasers;

8. methods for advanced characterization of heterojunction based devices;

References:
[**1**] Umesh Mishra, Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2008
[**2**] Ruediguer Quay, Gallium Nitride Electronics, Springer 2008.
[**3**]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 2:30 – 4:30 and Thursday, 4:30 – 6:30. First lecture on Monday, January 20, 2014. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

Course requirements: Introductory course of device physics: Microelectronics, Optoelectronic and Photovoltaic Devices

Examination and grading: Written test at the end of the course

11 Random Graphs and Stochastic Geometry in Networks

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

Aim: To provide graduate students with some basic concepts of random graphs and stochastic geometry and illustrate their applications to relevant engineering problems involving networks, such as multiagent control networks, wireless communication networks etc.

Topics:

- *Introduction to random graphs*: basic models and properties, random regular graphs, giant component, connectivity, degree sequence (2 lectures)
- *Basic Percolation Theory*: Tree percolation, lattice bond percolation (1 lecture)
- *Small world and scale free networks* (1 lecture)
- *Consensus and Gossip algorithms*: a short survey for distributed averaging, consensus over random switching graphs, consensus and gossip algorithms for distributed estimation (2 lectures)
- *Connectivity and capacity in wireless multihop networks* (1 lecture)
- *Stochastic Geometry and its applications*: Basic Point Process theory and properties, hardcore and Gibbs processes, Applications to characterizing interference and outage in networks (2 lectures)
- *Applications of Stochastic Geometry to wireless networks* (1 lecture)

References:

[1] Bella Bollobas, *Random Graphs*, Second Edition, Cambridge Studies in Advanced Mathematics, Cambridge University Press, UK, 2001.

[2] M. Haenggi, *Stochastic Geometry for Wireless Networks*, Cambridge University Press, New York, 2013.

[3] M. Grossglauser and P. Thiran, "Networks out of Control: Models and Methods for Random networks", Lecture notes, EPFL, 2012.

[4] M. Franceschetti and R. Meester, *Random Networks for Communication: From Statistical Physics to Information Systems*, Cambridge University Press, UK, 2007.

Various articles and papers will be referenced during the course for further reading.

Time table: Course of 20 hours. Course of 20 hours. Class meets every Tuesday and Thursday from 2:30 to 4:30. First lecture on Tuesday, June 10-th, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Advanced calculus, and probability theory and random processes.

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

12 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: 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.
- 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, February 18, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic knowledge of Operating System concepts.

Examination and grading: Each student will develop a survey report based on one or several articles related to the material covered in class and referring to some field of application for real-time systems.

13 Resonant converters and inverters: topologies and modeling

Instructor: Giorgio Spiazzi, e-mail: `spiazzi@dei.unipd.it`

Aim: the increased demand for more efficient and compact power supplies for a variety of applications together with the availability of faster switching devices, has pushed the switching frequency of modern power supply from tens of kilohertz toward the megaherz range. At such frequency values, the corresponding switching losses become unacceptable and soft-commutations become mandatory. In this contest, resonant converter and inverter topologies have been rediscovered as valid alternative to classical PWM topologies. The aim of this course is to provide basic knowledge of resonant converter topologies, their operation as well as their modeling and control, together with suggestions on the best design procedures for different applications.

Topics:

1. Switching losses in Pulse Width Modulated converters.
2. Basic dc-dc resonant converter topologies.
    - state-plane analysis;
    - fundamental component analysis.
3. LLC resonant converter.
4. Bidirectional resonant converters (Dual Active Bridge).
5. LCC resonant inverter for fluorescent lamps.
6. Modeling of resonant converters and inverters.

References:

[1] Lecture notes and written material on specific topics

Time table: Course of 20 hours. Class meets every Tuesday and Friday from 10:30 to 12:30. First lecture on Tuesday, June 3-rd, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basic knowledge of Power Electronics.

Examination and grading: homework and final examination.

14 Statistical Methods

Instructor: Lorenzo Finesso, Istituto di Ingegneria Biomedica, ISIB-CNR, Padova
e-mail: `lorenzo.finesso@isib.cnr.it`

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.

Topics:

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 the Maximum Likelihood (ML) estimator with partial observations (incomplete data). We will derive the EM method for the classic mixture decomposition problem and also interpret it as an alternating divergence minimization algorithm *à la* Csiszár Tusnády.

Hidden Markov models. We will introduce the simple yet powerful class of Hidden Markov models (HMM) and discuss parameter estimation for HMMs via the EM method.

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.

Time table: Course of 24 hours (two lectures of two hours each, per week). Class meets every Monday and Wednesday from 10:30 to 12:30. First lecture on Monday, June 16, 2014. Room DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Course requirements: Basics of Probability Theory and Linear Algebra.

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

15 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:

1. Review of some notions on Fourier Transform in different time domains (continuous and discrete; aperiodic and periodic). The FFT.
2. Definitions and properties of signal energy, convolution, correlation in the time domains and their Fourier transforms
3. Signal transformations. Linear transformations. Elementary transformations: sampling and interpolation. Up- and Down-Periodization
4. Numerical computation of the Fourier transform of a continuous-time finite energy signal via FFT
5. Numerical computation of the convolution (correlation) of two continuous-time finite energy signals via FFT.
6. Bandlimited continuous time signal filtering: from analog filters to a mix of analog and digital filters.
7. Example of applications: OFDM modulation and cyclic prefix.
8. Estimate of power spectrum for finite power signals. From definitions to numerical computation.

Course requirements:
Basic knowledge of signals and systems.

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

Time table: Course of 16 hours (2 two-hours lectures per week): Classes on Tuesday and Friday, 10:30 – 12:30. First lecture on Tuesday April 29-th, 2014. Room 318 DEI/G (3-rd floor, Dept. of Information Engineering, via Gradenigo Building).

Examination and grading: Homeworks and final exam.

16 Tissue Engineering: Principles and Applications

Instructor: 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 12 hours (2 two-hours lectures per week). Classes on Monday and Wednesday, 10:30 – 12:30. First lecture on February 3, 2014. 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.

January 2014

December 2013						
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January 2014						
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February 2014						
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Ph.D. Courses: Room DEI/G

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

February 2014

January 2014

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February 2014

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March 2014

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Ph.D. Courses: Room DEI/G

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

March 2014

February 2014						
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March 2014						
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April 2014						
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Ph.D. Courses: Room DEI/G

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

April 2014

March 2014

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April 2014

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May 2014

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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
31 10:30 PM Prof. Nar-duzzi	1	2 10:30 AM Prof. Picci	3 10:30 PM Prof. Nar-duzzi	4 10:30 AM Prof. Picci	5	6
7 10:30 PM Prof. Nar-duzzi	8	9	10 10:30 PM Prof. Nar-duzzi	11	12	13
14 10:30 PM Prof. Nar-duzzi	15	16	17 10:30 PM Prof. Nar-duzzi	18	19	20
21	22	23	24	25 Holiday	26	27
28	29 10:30 AM Prof. Pupolin	30	1 Holiday	2	3	4

May 2014

April 2014						
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June 2014						
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Ph.D. Courses: Room DEI/G

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

June 2014

May 2014						
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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
26 2:30 PM Prof. Someda	27 8:30 AM Prof. Di Nunzio 10:30 AM Prof. Pupolin	28 8:30 AM Prof. Di Nunzio	29 2:30 PM Prof. Someda	30	31	1
2 Holiday	3 10:30 AM Prof. Spiazzi	4	5 2:30 PM Prof. Someda	6 10:30 AM Prof. Spiazzi	7	8
9 2:30 PM Prof. Someda	10 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	11	12 2:30 PM Prof. Dey	13 Holiday	14	15
16 10:30 AM Prof. Finesso	17 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	18 10:30 AM Prof. Finesso	19 2:30 PM Prof. Dey	20 10:30 AM Prof. Spiazzi	21	22
23 10:30 AM Prof. Finesso	24 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	25 10:30 AM Prof. Finesso	26 2:30 PM Prof. Dey	27 10:30 AM Prof. Spiazzi	28	29
30 10:30 AM Prof. Finesso	1 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	2 10:30 AM Prof. Finesso	3 2:30 PM Prof. Dey	4 10:30 AM Prof. Spiazzi	5	6

July 2014

June 2014

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July 2014

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August 2014

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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
30 10:30 AM Prof. Finesso	1 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	2 10:30 AM Prof. Finesso	3 2:30 PM Prof. Dey	4 10:30 AM Prof. Spiazzi	5	6
7 10:30 AM Prof. Finesso	8 10:30 AM Prof. Spiazzi 2:30 PM Prof. Dey	9 10:30 AM Prof. Finesso	10 2:30 PM Prof. Dey	11	12	13
14 10:30 AM Prof. Finesso	15	16 10:30 AM Prof. Finesso	17	18	19	20
21 10:30 AM Prof. Finesso	22	23 10:30 AM Prof. Finesso	24	25	26	27
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August 2014

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September 2014						
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Ph.D. Courses: Room DEI/G

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September 2014

August 2014

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September 2014

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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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22	23 10:30 AM Prof. Pillonetto	24	25 10:30 AM Prof. Pillonetto	26	27	28
29	30 10:30 AM Prof. Pillonetto	1 10:30 AM Prof. Laurenti	2 10:30 AM Prof. Pillonetto	3 10:30 AM Prof. Laurenti	4	5

October 2014

September 2014

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October 2014

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November 2014

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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
29	30 10:30 AM Prof. Pil-lonetto	1 10:30 AM Prof. Lauren-ti	2 10:30 AM Prof. Pil-lonetto	3 10:30 AM Prof. Lauren-ti	4	5
6	7 10:30 AM Prof. Pil-lonetto	8 10:30 AM Prof. Lauren-ti	9 10:30 AM Prof. Pil-lonetto 2:30 PM Prof. Susin	10 10:30 AM Prof. Lauren-ti	11	12
13	14 10:30 AM Prof. Pil-lonetto	15 10:30 AM Prof. Lauren-ti	16 10:30 AM Prof. Pil-lonetto 2:30 PM Prof. Susin	17 10:30 AM Prof. Lauren-ti	18	19
20 10:30 AM Prof. Peder-sen	21 10:30 AM Prof. Pil-lonetto	22 10:30 AM Prof. Lauren-ti 1:30 PM Prof. Pedersen	23 10:30 AM Prof. Pil-lonetto 2:30 PM Prof. Susin	24 10:30 AM Prof. Lauren-ti	25	26
27 10:30 AM Prof. Peder-sen	28 10:30 AM Prof. Pil-lonetto	29 10:30 AM Prof. Lauren-ti 1:30 PM Prof. Pedersen	30 10:30 AM Prof. Pil-lonetto 2:30 PM Prof. Susin	31 10:30 AM Prof. Lauren-ti	1 Holiday	2

November 2014

October 2014						
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November 2014						
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December 2014						
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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
27 10:30 AM Prof. Pedersen	28 10:30 AM Prof. Pilonetto	29 10:30 AM Prof. Laurenti 1:30 PM Prof. Pedersen	30 10:30 AM Prof. Pilonetto 2:30 PM Prof. Susin	31 10:30 AM Prof. Laurenti	1 Holiday	2
3 10:30 AM Prof. Pedersen	4 10:30 AM Prof. Pilonetto	5 1:30 PM Prof. Pedersen	6 10:30 AM Prof. Pilonetto 2:30 PM Prof. Susin	7	8	9
10 10:30 AM Prof. Pedersen	11	12 1:30 PM Prof. Pedersen	13 2:30 PM Prof. Susin	14	15	16
17 10:30 AM Prof. Pedersen	18	19 1:30 PM Prof. Pedersen	20	21	22	23
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December 2014

November 2014						
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December 2014						
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January 2015						
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Ph.D. Courses: Room DEI/G

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4