Ph.D. School in Information Engineering

Course Catalogue

A.Y. 2017/2018

Rev. 1.8 - 04/04/2018

Summary

General Information

Courses - Soft Skills Area

Courses - Information Engineering Area

Coursework Requirements

Ph.D. students entering in October 2017 (33° cycle) or later are required to take courses for **at least 20 credits** for their degree over the following time span:

- at least 10 credits by the end of the first year;
- a total of at least 20 credits by the end of the second year.

The coursework must also satisfy the following requirements:

- Soft Skills Courses: at least 5 credits should come from courses belonging to the Soft Skills area; students should also attend at least three seminars of the Ph.D. Seminar Series and two modules of the Summer Week event.
- External Courses: up to a maximum of 5 credits may be earned by taking external courses (i.e. courses not listed in the Course Catalogue) falling in the following categories:
    - Courses appearing in the list of External Courses approved by the School Council;
    - Courses from other Ph.D. School catalogues (provided they include a final exam with grading);
    - Other external courses might be considered after submission of a written request by the student. Requests submitted by November 30th and May 31st will be evaluated by the School Council in December and June, respectively. Students should obtain their Supervisor approval before submitting a request. Only courses including a final exam with grading will be considered.
- Ph.D. School Courses: at least 10 credits should be earned by taking courses listed in the Course Catalogue not belonging to the Soft Skills area.

Each first-year student must fill a tentative program of study form and submit it to the Ph.D. School Secretariat within December 31st. The program of study may be subsequently modified by submitting a new form up to June 30th of the second year.

Students are expected to attend classes regularly. Punctuality is expected both from instructors and students. Instructors have to report to the Coordinator of the Ph.D. School students missing classes without proper excuse.

Class Schedule

The class schedule is embedded in the Ph.D. School Calendar. If you have a Google account, you may visualize the class schedule through the following link:

Class Schedule of 2017/18 PhD Courses for Google Calendar

You may also visualize the class schedule using any browser through the following link:

Class Schedule of 2017/18 PhD Courses

Most classes meet in Room 318 DEI/G, located at the 3rd floor of DEI/G Building, Dept. of Information Engineering, via Gradenigo 6/A, Padova.

Please, always check the class schedule in the calendar to verify the class meeting room.

In order to locate the rooms, you may find helpful the map of the Department buildings:

Map of the Department of Information Engineering

1.Technology entrepreneurship and lean start up

Course Area: Soft Skills

Credits: 5

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.

Background material: No background material is necessary. The course will be held in English.

Topics:

- 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, 19th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: familiarity with basic linear algebra.

Examination and grading: homework and take home exam.

2.Statistics For Engineers

Course Area: Soft Skills

Credits: 5

Max attendance: since the course is opened to students from different Ph.D. Schools, the maximum number of students from the Ph.D. School in Information Engineering is 10. Admission will be on a first-come, first-served basis.

Instructor: Prof. Luigi Salmaso, Department of Management and Engineering, University of Padova

e-mail: luigi.salmaso@unipd.it

Website: http://www.salmasoluigi.it/phd2017.html

Aim: The course is an introduction to statistical methods most frequently used for experimentation in Engineering. Lectures are planned both in the classroom and in computer lab also for an introduction to the use of the following statistical software:

1. R
2. Statgraphics (licensed to University of Padova)
3. NPC TEST

Topics:

1. Elements of univariate statistical methods: Elements of descriptive statistics: frequency, indices of synthesis (position, variability and shape) and graphical representations (histogram, boxplot, scatterplot).
2. Elements of probability theory: discrete and continuous probability distributions.
3. Elements of statistical inference: sampling distributions, point and interval estimation, hypothesis testing, One-way ANOVA, Multi-Way ANOVA, Factorial Designs. ([1] Stark, P.B., 1997. SticiGui: Statistics Tools for Internet and Classroom Instruction with a Graphical User Interface).
4. Statistical Modelling: Experiments and observational studies, regression, residuals versus error terms, matrix algebra, standard errors, generalized least squares, normal theory of regression, the F-test, path models, inferring causation from regression, response schedules, types of variables, maximum likelihood, probit and logit models, latent variables, the bootstrap for estimating bias and variance.

References:

[1] Montgomery DC, Design and Analysis of Experiments, 2010, Wiley. Lattin J, Carroll JD, Green PE, Analyzing Multivariate Data, 2003,Duxbury Applied Series.

[2] Johnson RA, Wichern DW, Applied Multivariate Statistical Analysis, 1998, Prentice Hall; 4th edition.

[3] Hollander and Wolfe, Nonparametric Statistical Methods, 2nd edition, 1999, Wiley Series in Probability and Statistics. Shumway RH, Stoffer DS, Time Series Analysis and Its Applications (With R Examples), 2nd Edition, 1998, Springer Texts in Statistics, NewYork.

[4] Ad hoc material by Lecturer.

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

Time table: February 5, 7, 8, 12, 13, 14, 19 2018, 9:00-13:00 and 14:00-17:00

Room: laboratori informatici (computer lab), Department of Industrial Engineering, Site V, Via Venezia 1 - Padova

Course requirements: None

Examination and grading: Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on the discussion of a case study within the individual PhD project.

3.Ph.D. School Seminar Series

Tentative program:

1. Etica pubblica: (prof. U. Vincenti)
2. Building a Research Career: A Success Story (prof. F. Nestola)
3. Innovation: feasibility, strategies role of private and public institutions (prof. Sangiovanni Vincentelli)

3.1 Etica pubblica

Important note: This seminar will be held in Italian language

Instructor: Professor Umberto Vincenti, Dipartimento di diritto privato e critica del diritto (DPCD), Università di Padova

e-mail: umberto.vincenti@unipd.it

Aim: L'obiettivo sarà quello di illustrare quale significato assuma l'etica pubblica nel contesto di uno stato repubblicano e democratico. Occorrerà dunque fornire preliminarmente la nozione di etica e distinguerla da quella di morale. Poi si passerà a censire i principi fondamentali dell'etica pubblica occidentale, valorizzando una lunga tradizione che prende le mosse dalla classicità greca e romana. Si procederà ancora ad evidenziare la necessità di un'etica pubblica effettivamente praticata anche in sistemi politici intensamente giuridicizzati quali sono i nostri attuali. Si insisterà sull'imprescindibilità dell' impegno delle istituzioni e, in particolare, della scuola nell' educazione etica dei cittadini: l'etica ha le sue regole, alcune evidenti, altre meno e che, perciò, debbono essere esposte e adeguatamente comprese. Si ha la ragionevole convizione che l'impegno didattico, nel contesto di un programma articolato e, però, uniforme, possa rendere alla repubblica cittadini migliori, cioè virtuosi, almeno in numero cospicuo da poter comunque contribuire alla custodia dei valori etici essenziali, da diffondere anche attraverso l'esempio. Il tema principale sarà quello della contrapposizione tra interesse generale e interessi particolari, privati, individuali, corporativi. In questa prospettiva si leggeranno e commenteranno insieme alcuni passi del "Contratto sociale" di Rousseau. Il metodo di esposizione sarà rigorosamente dialogico, credendosi nell'utilità dell'interazione su questioni che interessano tutti e su cui è facile avere opinioni proprie, ma da testare per verificarne la compatibilità con il modello repubblicano fondato sulla volontà popolare le cui modalità di deliberazione debbono essere rigorosamente strutturate al fine di evitare che prevalgano posizioni marginali o egoiste.

Time table: Thursday, January 18th, 15:00 - 18:00; Thursday, February 1st, 15:00 - 18:00.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

3.2 Building a Research Career: A Success Story

Instructor: Professor Fabrizio Nestola, Department of Earth Sciences, Università di Padova

e-mail: fabrizio.nestola@unipd.it

Aim: Fabrizio Nestola, Full Professor in Mineralogy at the University of Padova, ERC Grant recipient, explains how to start planning a successful career as an academic or industrial researcher right from the beginning of the Ph.D.

Time table: (Tentative) Tuesday, May 22nd, 14:30 - 17:30; Wednesday, May 23rd, 14:30 - 17:30.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

3.3 Innovation: feasibility, strategies role of private and public institutions

Instructor: Professor Alberto Sangiovanni Vincentelli, University of California, Berkeley

e-mail:

Aim:

Time table: Spring 2018

Room: TBD

4.Summer Week

Aim: the Summer Week is a five-day event specifically conceived to help Ph.D. students to increase their soft-skills. Five main areas will be covered (one per day). The final program will be available at the beginning of 2018.

Timetable: June 4 - 8, 2018

Program:

	Mon. 4th	Tue. 5th	Wed. 6th	Thu. 7th	Fri. 8th	
9:00 10:00	Communicating Science: A Survival Toolbox [1] Max attendance: 35	Universal Design and Research for All. An Inclusive perspective to knowledge construction (Seminar) Max attendance: 100	STEP* - How companies work [4] Max attendance: 100	Logical framework & project cycle management: the basics Top down vs bottom up: different approaches for different objectives Analysis Phase Planning Phase [5] Max attendance: 100	Gender awareness in scientific research (Seminar) Max attendance: 100	Mastering Soft skills for Personal Development (3) Max attendance: 20+20 (two groups working in parallel)
10:00 11:00						
11:00 12:00		Gestione dei diritti in ambiti di ricerca [2] Max attendance: 100	STEP* - Interpret economic and financial dynamics [4] Max attendance: 100	Proposal Writing Laboratory [5] Max attendance: 50	The EURAXESS portal Internationalization of the career: Marie Sklodowska Curie Actions and international foundations[5] Max attendance: 50	
12:00 13:00						
13:00 14:00	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch
14:00 15:30	Communicating Science: A Survival Toolbox [1] Max attendance: 35	Open access e comunicazione scientifica (2) Max attendance: 100	STEP* - Company career development (4) Max attendance: 100	Mastering Soft skills for Personal Development (3) Max attendance: 20+20 (two groups working in parallel)	Good practice in research supervision (Workshop) Max attendance: 100	
15:30 18:00		I progetti europei e la gestione dei dati [2] Max attendance: 100	STEP* - Access to the labor market and Social media marketing [4] Max attendance: 100			

[1] Topic context: Communication/Public speaking.
[2] Topic context: Professional Development.
[3] Topic context: Personal Development/Working with others.
[4] Topic context: Entrepreneurship.
[5] Topic context: Research planning and funding.

5.Introduction to Quantum Optics

Quantum Information, Measurement, and Communication

Course Area: Information Engineering

Credits: 5

Instructor: Professor Alexander Sergienko, Department of Electrical & Computer Engineering and Department of Physics, Boston University, Boston, Massachusetts, USA

e-mail: alexserg@bu.edu

Aim: This course is intended to cover basic concepts of Quantum Information, Quantum Measurement, and Quantum Communications. It will cover many topics that are central in the Quantum Technology Flagship program of European Union, a 10 years project that will start in 2018, in terms of basic concepts, methodology and applications. It will start with review of the underlying concepts of quantum physics. It will be followed by the discussion of entanglement, quantum interference, quantum simulation, and quantum communication.

Specifics of practical implementation of quantum bits and quantum logic gates in optics will be considered. Existing problems of experimental implementation associated with detrimental effects of decoherence will be discussed.

An overview of novel technological approaches based on the use of quantum correlations and quantum entanglement will be presented. Specific concepts of quantum-optical state engineering and design of nontraditional quantum measurement devices that outperform their classical counterparts will be considered. Several novel approaches such as quantum imaging, super-resolution quantum phase measurement, dispersion cancelation, and correlated imaging and microscopy will be discussed.

New opportunities in quantum simulation of Hamiltonians in complex physical systems by executing linear-optical quantum walks with a totally new approach based on directionally-unbiased multiports will be discussed.

The course will also include an overview of latests advances in quantum random number generation and in communication technology in the ground fiber and in free space including satellite-based secure communication.

Topics:

1. Review of Quantum Mechanics;
2. quantization of EM field;
3. entanglement;
4. quantum interferometry;
5. generation and detection of entangled states;
6. linear-optical quantum state engineering;

7. high-resolution quantum interferometry;
8. entangled and correlated quantum imaging;
9. dispersion and aberration cancellation in biological imaging;
10. correlated confocal microscopy;
11. orbital angular momentum states and high-dimensional Hilbert space;
12. quantum walks and simulation of complex Hamiltonians with linearoptical multiports;
13. quantum random number generation and modern technology for quantum communication (by G. Vallone - DEI);
14. quantum secure communication in space (by P. Villoresi - DEI);

References: C. Gerry, P. Knight, "Introductory Quantum Optics", (Cambridge 2005)

Michel Le Bellac, "A Short Introduction to Quantum Information and Quantum Computation", (Cambridge 2006)

Additional reading: D. S. Simon, G. Jaeger, and A. V. Sergienko "Quantum Metrology, Imaging, and Communication", (Springer, New York 2017).

A. V. Sergienko ed. "Quantum Communications and Cryptography", (CRC Press, Taylor & Francis Group 2006).

G. S. Jaeger, "Quantum Information: An Overview", Springer (2010).

Time table: 16 hours. Lectures on: November 2nd, 2017, 10:30 - 12:30; November 6th, 8th, 13th, 15th, 20th, 22nd, 28th, 2017, 14:30 - 16:30.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor, except November 28th, room DEI/D, Dept. of Information Engineering, DEI/D Building, 1st floor.

Course requirements: Basic concept of quantum physics and optics.

Examination and grading: Homeworks

6.Bayesian Machine Learning

Course Area: Information Engineering

Credits: 5

Instructor: prof. 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 classical machine learning problems such as classification and regression.

Topics:

- Introduction of classical machine learning problems.
  - Mathematical framework
  - Supervised and unsupervised learning
- Bayesian decision theory
  - Two-category classification
  - Minimum-error-rate classification
  - Bayes decision theory
  - Decision surfaces
  - Regression
- Estimation
  - Maximum Likelihood Estimation
  - Expectation Maximization
  - Maximum A Posteriori
  - Bayesian approach
- Graphical models
  - Bayesian networks
  - Two-dimensional visualization
- Evaluation
  - Measures of accuracy

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/mackay/

[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. Class meets on Thursday and Friday (lab), 14:30 - 16:30. First lecture on Thursday, November 2nd, 2017.

Room:

- Thursday lectures: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.
- Friday lectures: Te, Dept. of Information Engineering, DEI/G Building, 2nd floor.

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

Examination and grading: Homework assignments and final project.

7.The FFT and its use in digital signal processing

Course Area: Information Engineering

Credits: 5

Instructor: Prof. Silvano 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.
- Bandlimited continuous time signal filtering: from analog filters to a mix of analog and digital filters.
- Example of applications: OFDM modulation and cyclic prefix. 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 on Monday and Friday from 10:30 to 12:30. First lecture on Friday, November 3rd, 2017.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Basic knowledge of signals and systems.

Examination and grading: Homeworks and final exam.

8.Advanced Algorithms and Data Structure for Sequence Analysis

Course Area: Information Engineering

Credits: 4

Instructor: Prof. Cinzia Pizzi , Department of Information Engineering, University of Padova

email: cinzia.pizzi@dei.unipd.it

Aim: The class is intended to give a survey of advanced data structures and algorithms for the analysis of sequences in a variety of application fields, such as text mining, biological sequence analysis, data compression, time series analysis.

Topics:

- Suffix based data structures: suffix trees, suffix arrays, and their applications
- The Burrows-Wheeler transform and compressed indexes
- Alignment free algorithms for sequence comparison
- The Symbolic Aggregate approXimation (SAX) for time series analysis

References:

[1] V.Makinen, D.Belazzougui, F.Cunial, A.I.Tomescu: Genome scale algorithm design, Cambridge University Press, 2015

[2] J.Lin, E. Keogh, L.Wei, S.Lonardi: Experiencing SAX: a novel symbolic representation of time series, Data mining and Knowledge Discovery, 2007

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

Time table: Course of 16 hours (2 two-hours lectures per week), every Tuesday and Thursday, 10:30 - 12:30, starting November 7th, 2017

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Fundamentals of data structures and computational complexity

Examination and grading: Final project on the application of the algorithms and data structures presented during the course to a problem on an application field of interest to the student, or in-depth analysis of a problem and oral presentation of specialized algorithms and/or data structure available in literature to solve it.

9.Fluid mechanics for the functional assessment of cardiovascular devices

Course Area: Information Engineering

Credits: 4

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. Bio fluid Mechanics: the human 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. ISTI-SAN 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 arti cial 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 12:30 - 14:30. First lecture on Wednesday, November 8th, 2017.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Fundamentals of Fluid Dynamics.

Examination and grading: Homework assignment with final discussion.

10.Applied Functional Analysis and Machine Learning

Course Area: Information Engineering

Credits: 7

Instructor: Prof. Gianluigi 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, opera-tors 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 dimension. Support vector regression and classification. Boosting.

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

Time table: Course of 28 hours (2 two-hour lectures per week): Classes on Monday and Wednesday, 10:30 - 12:30. First lecture on Wednesday November 29th, 2017.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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

Examination and grading: Homework assignments and final test.

11. Brain-Computer Interface for Neurorobotics

Course Area: Information Engineering

Credits: 5

Instructor: Dr. Luca Tonin, post-doctoral fellow, EPFL, Lausanne, Switzerland.

e-mail: luca.tonin@epfl.ch

Aim: The course aims to introduce doctoral students to the Brain-Computer Interface (BCI) field, in particular applied to Neurorobotics. The course will provide advanced tools and methodologies for analyzing and decoding brain signals and for translating them into actual actions of external actuators. Multidisciplinary topics will be presented in order to cover the different parts that compose standard BCI systems: methods for processing neurophysiological signals, tools for machine learning and decision making, topics for control strategies of robotic devices. Each topic will be faced from the theoretical and practical point of view, by means of frontal lectures and exercises to be solved both during classes and as homeworks (in Matlab). The final project will focus on the implementation of an online BCI system to mind-drive an external actuator (e.g., a robotic device).

Topics:

- Introduction of current BCI systems based on Electroencephalography (EEG).
- General concepts of BCI: structure, modules and applications for con-trol and rehabilitation. BCI based on evoked potentials. BCI based on sensorymotor rhythms. BCI based on voluntary attention focus.
- Application of signal processing techniques to analyze EEG signals.
- Stationarity and non-stationarity of brain signals. EEG bands. Spatial and spectral lters.
- Application of machine Learning algorithms to classify EEG signals
- Machine learning approaches to BCI. Classical classi ers exploited in BCI eld (e.g., LDA, QDA, Gaussian). Concepts of calibration and testing sessions. Stability of the classi er over sessions.
- Application of probabilistic frameworks to decode intention to move
- Decision making algorithms. Applications of bayesian probabilistic frame-work to decode sensorymotor rhythms.
- High-level BCI control of robotic actuators
- From the BCI output to the device control. Dealing with a noisy control signal. Common approaches to drive complex robotic devices.
- Implementation of an online BCI system from the beginning
- A real BCI experiment: subject setup, recording, calibration and testing. Experiment will be performed during the class. Critical points in the implementation of a working BCI loop. The recorded data will be used by students for the nal project.

References:

[1] D. J. McFarland and J. R. Wolpaw, Brain-Computer interface operation of robotic and prosthetic devices, Computer (Long. Beach. Calif)., vol. 41, no. 10, pp. 5256, 2008.

[2] J. R. Wolpaw, Brain-computer interfaces for communication and control, Clin. Neurophysiol., vol. 113, no. 6, pp. 76791, 2002.

[3] N. Birbaumer, Breaking the silence: Brain-computer interfaces (BCI) for communication and motor control., Psychophysiology, vol. 43, no. 6, pp. 51732, 2006.

[4] J. d. R. Millan, et al., Combining brain-computer interfaces and assistive technologies: State-of-the-art and challenges., Front. Neurosci., vol. 4, no. September, pp. 115, 2010.

[5] G. R. Muller-Putz, et al., Tools for Brain-computer interaction: A general concept for a hybrid BCI., Front. Neuroinform., vol. 5, no. November, p. 30, 2011.

[6] C. M. Michel, et al., eds. Electrical Neuroimaging. 1st ed. Cambridge: Cambridge University Press, 2009.

[7] C. M. Bishop, Neural Networks for Pattern Recognition. Oxford University Press, Inc., New York, NY, USA, 1995.

Additional selected reference material will be handed out during the course.

Time table: Course of 20 hours. Class meets every day from 14:30 to 16:30. First week of lectures starting on Monday, January 8th, 2018. Second week of lectures starting on Monday, April 9th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Basic knowledge of signal processing. Basic knowledge of machine learning. Knowledge of Matlab.

Examination and grading: Homework assignments and final project.

12.Social Robotics

Course Area: Information Engineering

Credits: 5

Instructor: Dr. Salvatore M. Anzalone. CHArt Lab, Université Paris 8, Saint-Denis, France.

e-mail: sanzalone@univ-paris8.fr

Aim: The goal of the course is to give the basic knowledge for analysing, modeling, and developing robotics systems able to interact with humans in a natural way. At the end of the module the students will have acquired theoretical, procedural and practical concepts of social robotics. In particular, by employing the acquired knowledge in robotics, the students will be able to develop interactive systems using the humanoid robot Nao, through the use of the software Choreographe proposed by Softbank Robotics.

Topics:

1. Introduction to robotics
2. Autonomous robots
3. Social robotics
4. Verbal and non-verbal communication
5. Design and evaluation of interactive systems
6. Ethics

References:

[1] Brooks, Rodney A. Elephants don't play chess. Robotics and autonomous systems 6.1-2 (1990): 3-15.

[2] Brooks, Rodney A. Intelligence without reason. Artificial intelligence: critical concepts 3 (1991): 107-63.

[3] Kajita, Shuuji, et al. Biped walking pattern generation by using preview control of zero-moment point. Robotics and Automation, 2003. Proceedings. ICRA'03. IEEE International Conference on. Vol. 2. IEEE, 2003.

[4] Breazeal, Cynthia L. Designing sociable robots. MIT press, 2004.

[5] Siciliano, Bruno, and Oussama Khatib, eds. Springer handbook of robotics. Springer Science & Business Media, 2008.

[6] Metta, Giorgio, et al. The iCub humanoid robot: an open platform for research in embodied cognition. Proceedings of the 8th workshop on performance metrics for intelligent systems. ACM, 2008.

[7] Pot, Emmanuel, et al. Choregraphe: a graphical tool for humanoid robot programming. Robot and Human Interactive Communication, 2009. ROMAN 2009. The 18th IEEE International Symposium on. IEEE, 2009.

[8] Delaherche, Emilie, et al. Interpersonal synchrony: A survey of evaluation methods across disciplines. IEEE Transactions on Affective Computing 3.3 (2012): 349-365.

[9] Anzalone, Salvatore M., et al. Evaluating the engagement with social robots. International Journal of Social Robotics 7.4 (2015): 465-478.

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

Time table: Course of 20 hours (2 two-hours lectures per week). Class meets on

10/01/18	11/01/18	17/01/18	18/01/18	24/01/18	25/01/18	31/01/18	01/02/18
16:30 18:30	10:30 12:30	16:30 18:30	10:30 12:30	15:30 18:30	10:30 13:30	15:30 18:30	10:30 13:30

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Basic Python scripting. No other background material is necessary.

Examination and grading: The students will be evaluated using written tests, through multiple choices questionnaires, essay questions and a mini project. An evaluation grid will be given to the students at the same time with the tests.

13.Real-Time Systems and applications

Course Area: Information Engineering

Credits: 5

Instructor: Dr. 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 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.
- Integration of CPU and FPGA for high demanding real-time applications.

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 on Tuesday and Thursday from 8:30 to 10:30 starting from Tuesday, January 16th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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.

14. Positioning, location and navigation: theory and applications

Course Area: Information Engineering

Credits: 5

Instructors: prof. Nicola Laurenti, Dr. Gianluca Caparra, Department of Information Engineering, Universiy of Padova; Dr.Oscar Pozzobon, Qascom srl.

e-mail: nil@dei.unipd.it, caparragg@dei.unipd.it, oscar.pozzobon@qascom.it

Aim: The need for providing positioning, location and navigation services is rapidly increasing in modern communication networks and infrastructure systems, e.g., for device-to-device communication and control, mobile and vehicular ad hoc networks, for search-and-rescue and crisis management, or as enablers of location based services.

Today more than 7% of European Gross Domestic Product (GDP) relies on positioning and time applications based on satellite and mobile networks, from global satellite navigation systems (GNSS) to indoor location, and the recently introduced positioning service in 4G LTE cellular networks.

The class aims at introducing the students to these crucial element of future technologies, linking classical fundamental notions with more recent state of the art results from industry and research, and providing them with knowledge and expertise they can apply in connection to their own research interests.

Topics:

1. principles and methods of signal processing for ranging and positioning
2. ranging signals requirements and design
3. location based services
4. positioning in cellular networks
5. positioning in safety critical applications
6. satellite based position and navigation
7. GNSS receiver design
8. distance bounding protocols
9. secure positioning
10. cooperative positioning
11. location privacy

References:

[1] S. A. (Reza) Zekavat, R. M. Buehrer, eds., Handbook of position location: theory, practice, and advances, Wiley, 2011.

[2] E. D. Kaplan, C. Hegarty, Understanding GPS/GNSS, principles and applications, 3rd ed., Artech House, 2017.

Other material and research papers will be pointed out in class and available online for download.

Time table: Course of 20 hours (2 two-hours lectures per week). Class meets on Monday, 14:30 - 16:30, and Friday, 10:30 - 12:30, starting from Friday, January 19th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Basic notions on radio transmission, communications, and networks.

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 on a problem in positioning and/or navigation related to their research activities.

15.Model Predictive Control

Course Area: Information Engineering

Credits: 5

Instructors: Prof. Ruggero Carli, Dr. Mattia Bruschetta, Dr. Simone Del Favero, Department of Information Engineering, University of Padova

e-mail : carlirug@dei.unipd.it, mattia.bruschetta@dei.unipd.it, simone.delfavero@unipd.it

Aim: The course will provide the basic knowledge of Model Predictive Control (MPC). The course will also present some practical examples related to Automotive and Bioengineering applications.

Topics:

1. Introductory Material: State Space Models; Prediction and Current State Estimation (Kalman Filter); Linear Quadratic Problem, Dynamic Programming Solution.
2. Getting started with Model Predictive Control : The Infinite Horizon LQ Problem, Convergence of the Linear Quadratic Regulator.
3. Model Predictive Control - Regulation : Formulation, Main ideas be-hind MPC, Dynamic Programming Solution, Stability properties, MPC for Unconstrained Systems, MPC for Systems with Control Constraints, MPC for Systems with Control and State Constraints, Suboptimal MPC,Tracking.
4. Robust MPC and explicit MPC: Types of Uncertainty, Nominal robust-ness, tube-based robust MPC, Explicit Control Laws for Constrained Lin-ear Systems.
5. Fast Nonlinear MPC: Direct and Indirect methods for NLP, Condensing, Sequential Quadratic Programming, Real Time Iteration Scheme.
6. Automotive applications: Motion Cueing Algorithms, Virtual Rider, Au-tonomous Driver.
7. Bioengineering application, the Arti cial Pancreas: The Blood Glucose Regulation Problem, possible MPC Approaches (modular MPC, zone MPC, non-linear MPC), Clinical Testing.

References:

[1] J. B. Rawlings and D. Q. Mayne. Model predictive control : Theory and design. Nob Hill Publisher.

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

Time table: Course of 20 hours (2 two-hours lectures per week). Class meets on Tuesday and Thursday from 10:30 to 12:30. First lecture on Tuesday, 30th January, 2018. Note: Thursday, February 1st lesson moved to Wednesday, January 31st.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Basic Calculus and Linear Algebra.

Examination and grading: Homework and take home exam

16. Tissue Engineering: Principles and Applications

Course Area: Information Engineering

Credits: 4

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 four-hours lectures per week). Classes on Monday and Wednesday, 8:30 - 12:30. First lecture on Monday, January 22nd, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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

Examination and grading: Homework assignments and final test.

17.Computational Inverse Problems

Course Area: Information Engineering

Credits: 5

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 in continuum mechanics. Computer implementation performance issues will be considered as well.

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 in continuum mechanics; 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 26th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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.

18.Diagnostics of Electron Devices

Course Area: Information Engineering

Credits: 4

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 x 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:

1. Reverse engineering
2. Failure modes and failure mechanisms
3. Principles and fundamental methods in Electron Microscopy
4. Methodology for the Failure Analysis

References: Failure Analysis of Integrated Circuits - Tools and Techniques, Springer International Series - Lawrence C. Wagner.

Slides

Time table: Course of 16 hours. Class meets with the following schedule: March 8th, 9th, 19th, 20th, 2018, from 14.30 to 17:30; April 16th, 2018, from 14:30 to 18:30.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: Electron Devices, Microelectronics, Optoelectronics devices.

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

19. Applied Linear Algebra

Course Area: Information Engineering

Credits: 4

Instructors: Prof. Fernando De Terán, Universidad Carlos III de Madrid, Prof. Michael Karow, Technische Universität Berlin.

e-mail: fteran@math.uc3m.es, 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) de nite 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 13th, 2018.
- Second part (Karow): Class meets on April 4th, 2018, 14:30 - 16:30, April 5th, 6th and 10th, 2018, from 10:30 to 12:30.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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.

20.Statistical Methods

Course Area: Information Engineering

Credits: 6

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 prob-lems will be posed and, via examples, they will be connected with basic methods of statistical inference: ML (maximum likelihood), ME (maxi-mum entropy), and EM (expectation-maximization).
- *Multivariate analysis methods*. The three standard multivariate meth-ods, 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 a la Csiszar Tusnady.
- *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 Friday from 10:30 to 12:30. First lecture on Monday, April 9th, 2018, no lecture on Friday, April 20th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Course requirements: familiarity with basic linear algebra.

Examination and grading: homework and take home exam.

21. Physics and operation of heterostructure-based electronic and optoelectronic devices

Course Area: Information Engineering

Credits: 5

Instructors: Prof Enrico Zanoni, Prof. Gaudenzio Meneghesso, Dr. Matteo Meneghini, DEI, University of Padova.

e-mail: zanoni@dei.unipd.it, meneghesso@dei.unipd.it, meneghini@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. 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 16:30 - 18:30 and Thursday, 16:30 - 18:30. First lecture on Monday April 9th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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

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

22.From Electric Grids to Smart Grids

Course Area: Information Engineering

Credits: 4

Instructor: Prof. Reza Arghandeh , Florida State Univ., Center for Advanced Power Systems, USA.

e-mail: 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 brie y introduce the subjects of power ow 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 ow analysis: i) introduce different power ow analysis methods. ii) Discuss the numerical methods for power ow analysis. iii) Implement the power ow 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 ow 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). Class meets every Tuesday and Thursday from 10:30 to 12:30. First lecture on Tuesday, May 15th, 2018.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

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.

23. 5G, Enablers and Cloudification

Course Area: Information Engineering

Credits: 5

Instructor: Dr. Emilio Calvanese Strinati, , Scientific and Innovation Director, CEA-LETI, France

e-mail: emilio.calvanese-strinati@cea.fr

Aim: The course is an introduction to 5G wireless networks and on its technology enablers. Lectures are planned in the classroom.

In the last years, information communication, computation and storage technologies are jointly reshaping the way we use technology, meeting the future needs of a wide range of big data and artificial intelligence applications and, paving the way for a full customized autonomous user experience. In 2020 the 5G -Next Generation Communication Networks is expected to be operational and a global game changer from a technological, economic, societal and environmental perspective. 5G industry is intensively working today on designing, prototyping and testing fundamental technological advances to de-liver the promised performance in terms of latency, energy efficiency, wireless broadband capacity, elasticity, etc. Nevertheless, many experts says that the next big step for cellular networks is not 5G, it is the cloud. This lecture will cover both architecture and detail technical tools for understanding the key enabling technologies that will enable 5G networks to meet its challenging performance targets and how 'the cloud' will play an operational role in future wireless networks.

Topics:

1. Introduction to evolution of Wireless Networks from 3G+ to 5G. De-tails on technologies enabling the revolution between 4G and future 5G networks.
2. Network densification, resource management and heterogeneous networks
3. Advanced interference management techniques from heuristics to information theory
4. Millimeter waves, Massive MIMO and antenna design Energy efficiency and its advanced techniques
5. The 'cloudification' of 5G: from central-RAN to mobile edge cloud. Details examples of convex optimization tools and millimeter wave spectrum use
6. Energy efficiency and its advanced techniques
7. The overall perspective of 5G, what is expected to be beyond 5G and conclusions.

References:

[1] Emilio Calvanese Strinati, chapter editor Green Femtos/Energy Efficiency Issues of 4G and Beyond Femto Networks: On the road to Small Cells and Smart Heterogeneous Networks, Wiley, 2013.

[2] A De Domenico, E Calvanese Strinati, M-Di Benedetto, A survey on MAC strategies for cognitive radio networks, IEEE Journal on Communications Surveys & Tutorials, 14 (1), 21-44, 2012.

[3] A De Domenico, E Calvanese Strinati, A Capone, Enabling Green cellular networks: A survey and outlook, Computer Communications 37, 5-24, 2014

[4] K. Sakaguchi, G. K. Tran, H. Shimodaira, S. Namba, T. Sakurai, I. Siaud, K. Takinami, E. Calvanese Strinati, A. Capone, I. Karls, R. Are , T. Haustein, Millimeter-wave Evolution for 5G Networks, IEICE Trans. Communications, 2015.

[5] K. Sakaguchi, T. Haustein, S. Barbarossa, E. Calvanese Strinati, R. W Heath Jr, et al., Where, When, and How mmWave is Used in 5G and Beyond, IEICE Transactions on Communications, 2017.

[6] Ad hoc material by Lecturer.

Time table: Course of 20 hours. Class meets on May 24th, 25th, 28th and 29th, 2018, from 14:30 to 18:30, and May 30th and 31st, 2018, from 14:30 to 16:30.

Room: 318 DEI/G, Dept. of Information Engineering, DEI/G Building, 3rd floor.

Examination and grading: Attendance is required for at least 2/3 of the lecture hours. Final evaluation will be based on the discussion of a case study within the individual PhD project.