# MORE INFO ABOUT THE LECTURES AND THE LECTURERS

**Lecture title: Cybersecurity**

**Lecturer: Roberto Baldoni**

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**Short CV**

Roberto Baldoni conducts research (from theory to practice) in the fields of distributed, pervasive and p2p computing, middleware platforms and information systems infrastructure with a specific emphasis on dependability and security aspects. He is the founder of MIDdleware LABoratory (MIDLAB) and he has been PI of many national and european research projects. A partial list of his publications can be found at DBLP, at Scholar Google and atMIDLAB publication repository.

Roberto Baldoni has been visiting researcher at INRIA, Cornell Univ. and EPFL. He regularly participates and chairs committees of premiership international conferences and workshops. Recently he has been General Chair of OPODIS 2012, of ACM DEBS 2008 and in December 2013, with Marteen van Steen, Roberto Baldoni will be the PC Co Chair of 17th International Conference On Principles Of DIstributed Systems (OPODIS2013). From Jan. 1st 2013, Roberto Baldoni is Chair of the IEEE committee on Dependable Computing and Fault Tolerance and Chair of the Steering Committee of the International Conference on Dependable Systems and Networks. He is also member of the IFIP WG 10.4, member of the steering committees of ACM DEBS (Conference on Distributed Event Based Systems), OPODIS (Conference on Distributed Systems Principles) and member of the editorial boad of IEEE Transactions on Parallel and Distributed Systems. He has been Dean of the School of Engineering in Computer Science at Sapienza University (2011-2014).

**Description of the lecture:**

Protecting the National Cyber Space: from National Strategies to Recent Malware Campaigns
cyber threats
national security
economics of cyber attacks
recent malware campaigns

**Lecture title: Object-Oriented Simulations with Modelica**

**Lecturer: Massimo Ceraolo**

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**Short CV**

Born in 1960, he took his Ms Degree in Electrical Engineering from the University of Pisa, with honours, in 1985.

He is full professor of Electric Power Systems since 2002, and teaches *Electric and Hybrid Vehicles* at the University of Pisa and *Naval Electric Systems* at the *Accademia Navale* of Livorno.

He is author or co-author of more than 100 National and International scientific papers, mainly regarding electrochemical energy storage, and electric and hybrid vehicles.

In 2014 he has authored the IEEE/Wiley book "Fundamentals of Electric Power Engineering – From Electromagnetics to Power Systems)"

During his career he has worked a lot on time simulations, using many tools. During nineties he used ATP/EMTP simulation program mainly for research. Later, he used Matlab/ Simulink/ SimPowerSys for research and teaching. Since 2011 he's been using Modelica-based models for research and teaching, especially for simulation of electrical converters, machines, transmission lines, and full electric vehicles. He represents the University of Pisa in the OpenModelica association.

**Description of the lecture:**

This *Seminar and Workshop* course has the purpose to illustrate to the students the advantages of creating and using simulation models in the MODELICA language, developed by the no-profit Modelica Association (www.modelica.org).

The basic advantages of the use of this language over commonly used commercial and free tools will be discussed in depth.

Below some examples of what Modelica models allow are listed:

- Object-oriented simulation The physical systems, such as resistors, electrical machines or mechanical rotors, are not represented by means of input-output blocks, but in a way that mimics their physical realisation.
- Equation-based models. Models are not made of C-like or Fortran-like procedures, but basically of equations that are written in a way that is near, indeed quasi-identical, to their written representations in books and papers
- Hybrid simulation This allows to combine in a single model continuous time simulations with *events*, in which the system's equations switch from one set to another with continuity of the state variables automatically imposed
- Integration of system from several domains (electrical, translational mechanic, rotational mechanic, control, fluidic, etc.) that can operate simultaneously and interact in an arbitrary way
- Model Reusability Models created in Modelica can be used in principle within all the Modelica-capable tools, either commercial or open-source
- Library availability. Modelica comes with a very large and comprehensive library of well validated models, called Modelica Standard Library. All this library's models are public domain and non-encrypted. The user can use them as they are or modify them freely.
- The course is composed of two parts: a Seminar and a Workshop, that are intrinsically related to each-other.

Students that want to have only a general idea about what Modelica can do and which libraries are available, can attend only the first session.

Students that want to gain practical on how to use tools based on this language are warmly recommended to attend also the workshop.

At the end of the course students are expected to have gained a clear idea on what Modelica and Modelica tools can do, will bring with themselves the OpenModelica program and all the examples, and are expected to be able to approach rather autonomously new, simple, simulation problems and to create for them Modelica models that they will be able to run. Naturally whey will be able to use Modelica and Modelica tools only within a very limited subset of the available features.

**Lecture title: The circuital approach in R&D**

**Lecturer: Pier Paolo Civalleri**

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Short CV

Pier Paolo Civalleri was born in Turin, Italy, on 17 June 1934. He received the degree in Electrical Engineering from the Polytechnic of Turin in 1959 and the degree of Professor in Network Theory (Libera Docenza) from the Department of Public Education in 1966.

From 1960 to 1970 he was a researcher and from 1971 to 1975 a Research Director at Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin, Italy. From 1967 to 1986 he was a Professor of Applied Mathematics and since 1975 he has been the Professor of Electrical Engineering for the Electrical Engineering Course in the Polytechnic of Turin.

From 1975 to 1981 he was the Director of the Institute of Mathematics of the Polytechnic of Turin. From 1960 to 2006 he has been the Professor of Electrical Engineering in the Scuola di Applicazione of the Army. Since 1989 he has been a corresponding member and since 2005 a national member of the Accademia delle Scienze di Torino. He has been a member of the New York Academy of Sciences from 1993 to 2002.

He is a Life Fellow of the Institute of Electrical and Electronic Engineers.

He was the President of the North-Italy Section of IEEE (1979-1980) and the President of the Turin Section of the Associazione Elettrotecnica ed Elettronica Italiana (AEI) (1981-1983).He is currently a life member of the Board of Directors of the same Section.

He was a co-founder and a member of the Scientific Committee of the Center for System Studies, Turin, Italy. He was a visiting Professor in Cornell University, Ithaca, NY, in 1977, 1979, 1982, 1983, 1986. He has been a member of the Editorial Board of the International Journal of Circuit Theory and Applications, Wiley-Interscience since 1974. He has been an Associate Editor of the Journal of Circuits, Systems and Computers, World-Scientific Publishing Co., Singapore and Teaneck (USA). He has been the TCAS-I Associate Editor for Distributed Networks 1995-1997 and the TCAS-I Editor 1997-1999.

His research interests have covered network topology, analysis and synthesis of single-element-kind networks, multilayer n-port analysis, modeling of active and passive distributed circuits, controllability and

observability of linear systems, modeling of dielectric guides, cellular neural networks and nonlinear dynamics. His present interests are mainly in the field of nanocircuits. He is the author of over 120 scientific publications and of the book "Elettrotecnica" in Italian.
He was awarded the IEEE Centennial Medal in 1984.

**Lecture title: Modeling and simulation of mechatronic systems**

**Lecturer: Filippo Cianetti**

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**Short CV**

He received the Eng. degree from the University of Perugia (Italy) in 1990. He became Assistant Professor of Machine Design at the same University in 1992 and in 2002 became Associate Professor.
Now, He's Lecturer within the Department of Engineering of the University of Perugia. His research interests include dynamic simulation, multibody simulation, finite element analysis, fatigue mechanics, random loads fatigue, comfort evaluation, motion sickness analysis.
He is ASME and AIAS (Italian Association of Stress Analysis) member and member of the National Committee of Machine Design Researchers and Professors of Italian Universities.

**Description of the lecture:**

Dynamic characterization of mechatronic systems: definition of the modeling main parameters and identification of these quantities by using behavior simple models.
Synthesis of generic mechanical system and its characterization for implementing control logic: definition of state-space modeling (SS), modeling of systems with one and two degrees of freedom, usability of SS approach for the in frequency characterization and for the dynamics simulation of the system.
MultiBody Modeling (MBS): introduction to multibody modeling of rigid systems and its usability in the study of mechatronic systems. Flexibility of the components in the classic multi-body modeling.

**Lecture title: The Magic of Stochastic Geometry at a Low Complexity – Modeling and Experimental Validation for Application to 5G Cellular Networks**

**Lecturer: Marco Di Renzo**
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**Short CV**

Marco Di Renzo (S'05–AM'07–M'09–SM'14) was born in L'Aquila, Italy, in 1978. He received the Laurea (cum laude) and the Ph.D. degrees in Electrical and Information Engineering from the Department of Electrical and Information Engineering, University of L'Aquila, Italy, in April 2003 and in January 2007, respectively. In October 2013, he received the Habilitation à Diriger des Recherches (HDR) from the University Paris-Sud XI, Paris, France.

Since January 2010, he has been a Tenured Associate Research Professor ("Chargé de Recherche Titulaire CNRS") with Paris-Saclay University in the Laboratory of Signals and Systems (L2S), a joint academic and research laboratory of CNRS, CentraleSupelec and University Paris-Sud XI, Paris, France. His main research interests are in the field of wireless communication theory. He is a Principal Investigator of six European-funded research projects (Marie Curie ITN-GREENET, Marie Curie IAPP-WSN4QoL, Marie Curie ITN-CROSSFIRE, Marie Curie IAPP-SmartNRG, Marie Curie ITN-5Gwireless and Marie Curie RISE-CASPER). He is a co-founder and the Chief Scientific Officer for Wireless Communications Research of the university spinoff company WEST Aquila s.r.l..

From August 2002 to January 2008, he was with the Center of Excellence for Research DEWS, University of L'Aquila, Italy. In the fall of 2006, he was a Visiting Scholar in the Bradley Department of Electrical and Computer Engineering, Virginia Tech, USA. From February 2008 to April 2009, he was a tenured Research Associate with the Telecommunications Technological Center of Catalonia (CTTC), Spain. From May 2009 to December 2009, he was an EPSRC Research Fellow with the Institute for Digital Communications (IDCOM), The University of Edinburgh, United Kingdom.

Dr. Di Renzo is the recipient of a special mention for the outstanding five-year (1997-2003) academic career, University of L'Aquila, Italy; the THALES Communications doctoral fellowship (2003-2006),

University of L'Aquila, Italy; the 2004 Best Spin-Off Company Award, Abruzzo Province, Italy; the 2008 Torres Quevedo Award, Ministry of Science and Innovation, Spain; the "Dérogation pour l'Encadrement de Thèse" (2010), University of Paris-Sud XI, France; the 2012 IEEE CAMAD Best Paper Award; the 2012 IEEE WIRELESS COMMUNICATIONS LETTERS Exemplary Reviewer Certificate; the 2013 IEEE VTC-Fall Best Student Paper Award; the 2013 Network of Excellence NEWCOM# Best Paper Award; the 2013 IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY Top Reviewer Award; the 2013 IEEE-COMSOC Best Young Researcher Award for Europe, Middle East and Africa (EMEA Region); the 2014 Royal Academy of Engineering Distinguished Visiting Fellowship, United Kingdom; the 2014 IEEE ATC Best Paper Award; the 2014 IEEE CAMAD Best Demo Award; the 2014 IEEE CAMAD Best Paper Award; and the 2014 IEEE WIRELESS COMMUNICATIONS LETTERS Exemplary Reviewer Certificate.
Currently, he serves as an Editor of the IEEE COMMUNICATIONS LETTERS and of the IEEE TRANSACTIONS ON COMMUNICATIONS (Heterogeneous Networks Modeling and Analysis). He is a Senior Member of the IEEE and COMSOC, a Member of the European Association for Communications and Networking (EURACON), and an Member of Faculty Row - America's Top Professors.

**Description of the Lecture**

The fifth-generation (5G) is coming. Quo vadis 5G? What architectures, network topologies and technologies will define 5G? Are methodologies to the analysis, design and optimization of current cellular networks still applicable to 5G? This lecture is aimed to offer a comprehensive and in depth crash course to graduate students, researchers and professors. It is aimed to critically illustrate and discuss essential and enabling transmission technologies, communication protocols and architectures that are expected to make 5G wireless communication networks a reality. More specifically, it is focused on illustrating the critical and essential importance of spatial models for an accurate system-level analysis and optimization of 5G networks, which are expected to use different frequency bands compared to state-of-the-art networks and to rely on a much denser deployment of access points and antenna-elements, to a scale that has never been observed in the past.
At present, no precise definition for 5G is available. Despite that, the vast majority of industrial and academic researchers believe that three concepts are expected to make 5G a revolution in the cellular industry:
- The densification of access points with heterogeneous characteristics (e.g., transmit-power, density, access technologies, etc.).
- The utilization of millimeter-wave frequencies for high-rate data transmission.
- The densification of antenna-elements per access point, in order to further enhance the link spectral efficiency.

More specifically, a fundamental and overarching issue is currently attracting the interest of the research community, because of its peculiarity compared to previous generations of cellular networks: Due to the densification of access points and antenna elements, as well as to the peculiar channel models for transmission in the millimeter-wave band, the approaches used in the past for system-level simulation, analysis and optimization as a function of the network deployments are not applicable anymore. New and scalable (with the density of access points and antennas, as well as will the complexity of the new channel models) approaches need to be developed and experimentally validated for the envisaged access technologies and frequency bands.

In this lecture, new methodologies for simulating, modeling, analyzing and optimizing hyper-dense 5G cellular networks that use a variety of emerging access technologies will be introduced and discussed. In

particular, the audience will be introduced to the concept of computational stochastic geometry and to how the mathematical potential of stochastic geometry can be leveraged to an affordable computational complexity, yet retaining its accuracy and capability of modeling practical 5G communication networks. The new methodological approaches for system-level simulation and modeling will be validated with the aid of experimental data related to the locations of cellular base stations and to channel propagation models at millimeter-wave frequencies.

The research outcomes described in this lecture have been developed within the activities of the European-funded Marie Curie Initial Training Network project FP7-CROSSFIRE and of the European-funded Marie Skłodowska-Curie Innovative Training Network project H2020-5Gwireless.

**Lecture title: Digital Image Processing: Some Basic Concepts and Applications**

**Lecturer: Antonio Fernández**

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**Short CV**

Antonio Fernàndez received the M.Eng. degree in electrical engineering in 1993 and the Ph.D. degree (with honors) in applied physics in 1998, both from the University of Vigo, Vigo, Spain.
He held a research fellowship in the Department of Applied Physics, University of Vigo, during the period 1994 through 1998. He was appointed to the Department of Engineering Design, University of Vigo, in 1999, where he is currently full-time Senior Lecturer in Engineering Graphics. He has worked as a visiting researcher at Centre for Research on Optics (Mexico), University of Perugia (Italy), Dublin City University (Ireland), Computer Vision Centre (Spain) and University of Almeria (Spain). His major research interests include image processing, pattern recognition, machine learning and computer vision, with a special focus on image texture analysis. He has authored or co-authored over 40 peer-reviewed publications in these areas.

**Description of the Lecture**

This short course is intended as a brief introduction to the vast field of digital image processing [1, 2, 3]. In the First part of the module we enumerate the major fields that use digital image processing and overview the fundamental methodologies that can be applied to images for different purposes. We then introduce a number of basic concepts in digital image processing that are used throughout the course. The second part of the module is devoted to describe the main pointwise intensity transformations as well as some of the most impor tant tools of traditional signal processing, namely linear filtering in the spatial and spatial-frequency domains. Lastly, the third part of the module deals with the mathematical morphology approach to image processing. In order to deliver a fruitful and engaging learning experience, lectures are interlaced with programming exercises using the Python language that give students the opportunity to implement and test some of the methods covered in the course.

SUMMARY OF CONTENTS

What is digital image processing? Purposes of image processing. Major fields of application. Basic concepts. Intensity transformation functions. Histogram processing. Fun-damentals of spatial filtering. 2D discrete Fourier transform.
Smoothing and sharpening through filltering in the spatial and spatial-frequency domains. Mathematical morphology.

Erosion and dilation. Opening and closing. Morphological algorithms. Python in a nutshell. Packages and libraries for image processing using Python.

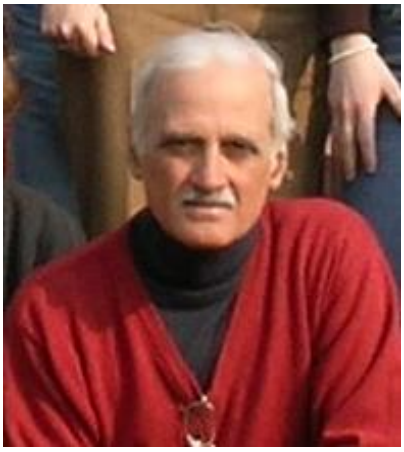
REFERENCES

[1] R. C. Gonzalez and R. E. Woods. Digital Image Processing, Third Edition. Pearson Prentice Hall, 2008.

[2] M. Petrou and C. Petrou. Image Processing: The Fundamentals, Second Edition. John Wiley & Sons, Ltd., 2010.

[3] M. Sonka, V. Hlavac, and R. Boyle. Image Processing, Analysis, and Machine Vision, Third Edition. Thomson, 2008.

**Lecture title: Magnetic materials and measurements**



**Lecturer: Fausto Fiorillo**

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**Short CV**

Dr. F. Fiorillo was Research Director at the Istituto Nazionale di Ricerca Metrologica (INRIM) in Torino (formerly Istituto Elettrotecnico Nazionale Galileo Ferraris) before his retirement in 2012. He is pursuing at present his research studies in magnetism at INRIM as an associate scientist. His scientific work and interests have been mainly devoted to the properties of magnetic materials and their measurement, with special focus on magnetization process and losses.

He authored/co-authored some 200 peer-reviewed publications in international scientific journals, review monographs, and chapters on international series on magnetic materials (ISI Thomson Reuter Hirsch-factor 21, Google-Scholar Hirsch-factor 24).

He is the author of the comprehensive treatise “Measurement and Characterization of Magnetic Materials” (10 Chapters, 647 pages), published by Academic Press-Elsevier, December 2004.

**Lecture title: Bioinformatics algorithms and predictive models**

**Lecturer: Pietro Liò**

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**Short CV**

Dr. Pietro Lió is a Reader in the Computer Laboratory which is the department of Computer Science of the University of Cambridge and a member of the Artificial Intelligence group of the Computer Laboratory. He is also a member of the Cambridge Neuroscience group.

He holds a PhD in Complex Systems and Non Linear Dynamics (School of Informatics, dept of Engineering of the University of Firenze, Italy), a PhD in (Theoretical) Genetics (University of Pavia, Italy) and a Honorary Degree from Cambridge.

He is author of about 300 papers in fields bridging computational and mathematical methods and life sciences application domains with particular interests in Predictive models in Personalised medicine and multi scale modelling of metabolic health.

He has delivered several keynote and plenary talks and in October 2013 has been awarded the Lagrange fellowship (Universita' Piemonte Orientale).

**Description of the Lecture**

1) Intra cellular and cell-cell communication; the communicome.
2) Role of diffusion and crowding
3) Designing metabolic networks
4) Computation and communication in cellular networks.

**Lecture title: Computer vision for robotic and UAV applications**

**Lecturer Davide Scaramuzza**

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**Short CV**

Davide Scaramuzza (1980, Italian) is Assistant Professor of Robotics at the University of Zurich and associate faculty of the newly-founded Zurich Wyss Institute. He is founder and director of the Robotics and Perception Group (http://rpg.ifi.uzh.ch), where he develops cutting-edge research on low-latency vision and visually-guided micro aerial vehicles. He received his PhD (2008) in Robotics and Computer Vision at ETH Zurich (with Roland Siegwart). He was Postdoc at both ETH Zurich and the University of Pennsylvania (with Vijay Kumar and Kostas Daniilidis). From 2009 to 2012, he led the European project "sFly", which introduced the world's first autonomous navigation of micro quadrotors in GPS-denied environments using vision as the main sensor modality. For his research contributions, he was awarded an ERC Starting Grant (2014) through the SNSF, the IEEE Robotics and Automation Early Career Award (2014), a Google Research Award (2014), the European Young Researcher Award (2012), and the Robotdalen Scientific Award (2009). He coauthored the book "Introduction to Autonomous Mobile Robots" (MIT Press). He is author of the first open-source Omnidirectional Camera Calibration Toolbox for MATLAB, also used at NASA, Bosch, and Daimler. He is also author of the 1-point RANSAC algorithm, an effective and computationally efficient reduction of the standard 5-point RANSAC for visual odometry, when vehicle motion is non-holonomic. His research interests are field and service robotics, intelligent vehicles, and computer vision. Specifically, he investigates the use of cameras as the main sensors for robot navigation, mapping, exploration, reasoning, and interpretation. His interests encompass both ground and flying vehicles.

**Lecturer: Thomas Ciarfuglia**

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**Short CV**

Thomas A. Ciarfuglia (1980, Italian) received the M.Sc. magna cum laude degree in Electronics Engineering from the University of Perugia in 2004. He worked as HW/FW/SW designer engineer for various companies from 2004 to 2006. He then got an M.Sc. in Mechatronics and a Ph.D. degree in Robotics from the University of Perugia in 2008 and 2011 respectively. He joined the Service and Industrial Robotics and Automation Laboratory (SIRALab) in 2008 and he is currently working as a PostDoc there. His research interests are machine learning and computer vision applied to robotics.

**Lecturer: Gabriele Costante**

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**Short CV**

Gabriele Costante (1988, Italian) received the B.Sc. magna cum laude degree in Electronic and Information Engineering and the M.Sc. magna cum laude degree in Information and Automation Engineering from the University of Perugia respectively in 2010 and 2012. He then joined the Service and Industrial Robotics and Automation Laboratory (SIRALab) in 2012 and he is currently a Ph.D. student there. His research interests focus on Machine Learning and Computer Vision applied to Robotic applications. His works propose to enhance robotic platforms with visual understanding capabilities, to face exploration and recognition in dynamic and unknown environments. In particular, his researches involve exploration, recognition and planning for Unmanned Aerial Vehicles (UAVs).

**Description of the Lecture**

Autonomous microhelicopters will soon play a major role in tasks like search and rescue, environment monitoring, security surveillance, and inspection. If they are further realized in small scale, they can also be used in narrow outdoor and indoor environments and represent only a limited risk for people. However, for such operations, navigating based only on global positioning system (GPS) information is not sufficient. Fully autonomous operation in cities or other dense environments requires microhelicopters to fly at low altitudes, where GPS signals are often shadowed, or indoors and to actively explore unknown environments while avoiding collisions and creating maps. This involves a number of challenges on all levels of helicopter design, perception, actuation, control, and navigation, which still have to be solved.

Furthermore, the exploration and the interaction in complex environments and under unpredictable conditions require high level perception capabilities. This can be achieved by using state-of-the-art Machine Learning and Computer Vision strategies, that give robots and, in particular, Micro Aerial Vehicles (MAVs) , the ability to understand underlying models and structures of the scenarios where they operate. In this context, devising novel methods allowing the robots to adapt their internal knowledge and behavior over time is crucial. Therefore, it is clear how lifelong, online and transfer learning techniques are fundamental components for building mobile robot systems operating in highly dynamic environments.

The first part of the lecture will focus on state-of-the-art algorithms for localization, mapping and navigation based on visual sensors. In particular, an introduction and a discussion about Visual Odometry, Dense Reconstruction, MAVs Navigation, Active Vision and multi-robot teams exploration will be given.

The second part of the lecture will cover an overview of Machine Learning and Computer Vision strategies applied to robotics, with a focus on place and gesture recognition. Lecture title: Non-linear system identification

**Lecture title: The Magic of Stochastic Geometry at a Low Complexity – Modeling and Experimental**

**Lecturer : Johan Schoukens**

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**Lecturer: Maarten Schoukens**

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**Short CV**

**Johan Schoukens** received both the degree of master in electrical engineering in 1980 and the degree of doctor in engineering (PhD) in 1985 from the Vrije Universiteit Brussel (VUB), Brussels, Belgium. In 1991 he received the degree of Geaggregeerde voor het Hoger Onderwijs from the VUB, and in 2014 the degree of Doctor of Science from The University of Warwick.

From 1981 to 2000, Johan Schoukens was a researcher of the Belgian National Fund for Scientific Research (FWO-Vlaanderen) at the Electrical Engineering (ELEC) Department of the Vrije Universiteit Brussel (VUB) where he is currently a full-time professor in electrical engineering. Since 2009 he is visiting professor at the department of Computer Sciences of the Katholieke Universiteit Leuven. His main research interests include system identification, signal processing, and measurement techniques. Johan Schoukens has been a Fellow of IEEE since 1997. He was the recipient of the 2002 Andrew R. Chi Best Paper Award of the IEEE Transactions on Instrumentation and Measurement, the 2002 Society Distinguished Service Award from the IEEE Instrumentation and Measurement Society, and the 2007 Belgian Francqui Chair at the Université Libre de Bruxelles (Belgium). Since 2010, he is a member of Royal Flemish Academy of Belgium for Sciences and the Arts. In 2011 he received a Doctor Honoris Causa degree from the Budapest University of Technology and Economics (Hungary). Since 2013, he is a honorary professor of the university of Warwick.

**Maarten Schoukens** was born in Jette, Belgium, on December 26, 1987. He received the degree of master in electrical engineering: electronics and information technology in July 2010 from the Vrije Universiteit Brussel (VUB), Brussels, Belgium. Since September 2010 he is a Ph.D. researcher at the VUB in the Department of Fundamental Electricity and Instrumentation (ELEC). His main interests are the measurement and identification of nonlinear systems using block structured models.

**Description of the Lecture**

The goal of these lessons is to give a practical introduction to system identification starting from a sound theoretical background.

Engineers use mathematical models intensively make high quality designs. These mathematical models can be obtained from first principles, making use of detailed knowledge about the physical laws that describe systems. The major advantage of such an approach is that it provides detailed physical models that give much insight into the problems studied, however, at the cost of a long and difficult modeling process. Frequently, these models are not well suited to be used in design applications. For that reason, data-driven black box approaches were developed to identify a model that describes the input-output behavior, and that can be retrieved from experimental data. It is usually less expensive and less time-consuming to get these models. System identification theory was developed to address the need for good methods to estimate mathematical models from noisy data. Nowadays, mature and inexpensive tools are available to derive good models for linear dynamic systems. However, many systems are nonlinear and/or time varying, so that more advanced tools are needed. In these lessons we focus on system identification in the presence of nonlinear distortions. Building nonlinear models is much more involved, more expensive, and more time consuming than identifying a linear model. For that reason it is an important decision at the beginning of a design procedure, whether a linear or a nonlinear model should be identified. In this course we will explain a systematic approach to tackle these problems.

List of topics

Lesson 1: System Identification: from data to model

Why do you need system identification? It will be shown that system identification is needed whenever mathematical models are extracted from experimental data. It will be shown, by a simple example, that

following intuitive approaches can lead to poor models without giving any warning to the user. For that reason a systematic approach is needed.

In this lesson, we give a basic introduction to least squares, weighted least squares, maximum likelihood, and Bayesian estimation. We will also explain how to deal with disturbances on both the input- and output measurements. The theory will be illustrated on many examples.

Lesson 2: Identification of linear systems

In this lesson we explain how to identify a parametric model for linear dynamical systems from experimental data. We start from a frequency domain approach, and next we connect this framework to the classical time-domain prediction error framework. A live demonstration will be given how to use these methods in practice using the FDIDENT matlab toolbox that is freely available http://home.mit.bme.hu/~kollar/fdident/

Lesson 3: Impact of nonlinear distortions on the linear identification framework

Identification of nonlinear systems is much more involved than linear system identification. A typical linear identification problem can be solved in one week, while identifying a good nonlinear model can cost several months or even more. Hence, the choice between a linear- or nonlinear modelling approach is an important design decision with a large economical/financial impact. For that reason, we should have tools that provide reliable information at the beginning of the identification process to make this choice. We also need an estimate about the possible model improvements by turning towards more expensive nonlinear/time-varying models in order to decide if there will be a sufficient return on the additional investments that are needed to obtain a nonlinear model.

In this lesson we learn how to recognize the presence of nonlinear, to understand their behavior and their impact on the linear modeling framework. Next we present methods to quantify and to qualify the presence of the nonlinear distortions so that the designer has all information to choose between a linear or nonlinear modelling approach.

Lesson 4: Identification of nonlinear systems

When the preliminary analysis shows that a linear model is not able to give a sufficient description of the system, we have to consider nonlinear and/or time varying models. In this lesson we introduce the basic problems that should be addressed to come to good nonlinear models. Calibration issues, selection of the noise model, choice between different model structures, etc. will be discussed. In the second part of the lesson some recent nonlinear identification approaches will be explained in more detail.

Course material

The course is based on the books:

- Pintelon R. and J. Schoukens (April 2012). System Identification: A frequency domain approach. Wiley-IEEE Press, Piscataway (USA), 2nd edition, 30% renewed, 787 pages.

This book provides detailed and comprehensive information about the topics that are covered in this course.

- Schoukens J., R. Pintelon, and Y. Rolain (March 2012). Mastering System Identification in 100 Exercises. Wiley-IEEE Press, Piscataway (USA), 288 pages.

The book takes the readers step by step through a series of Matlab exercises that teach how to measure and model linear dynamic systems in the presence of nonlinear distortions from a practical point of view. It illustrates many of the topics that are covered in this course.

The Frequency Domain System Identification matlab toolbox FDiDent can be freely downloaded at http://home.mit.bme.hu/~kollar/fdident/ The toolbox can be used to get hand on experience on system identification, starting from the demo files that are available.

**Lecture title: Electromagnetic fields and their applications in the everyday's life**

**Lecturer: Roberto Sorrentino**

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**Short CV**

Roberto Sorrentino is a Professor at University of Perugia, Perugia, Italy, where he was the Chairman of the Electronic Department, Director of the Computer Center (1990-1995), and Dean of the Faculty of Engineering (1995-2001).

His research activities have been concerned mainly with numerical methods and CAD techniques for passive microwave structures and the analysis and design of microwave and millimetre-wave circuits including filters and antennas. In recent years he has been involved in the modelling and design of Radio Frequency Microelectromechanical Systems (RF-MEMS) and their applications on tuneable and reconfigurable circuits and antennas.

He is the author or co-author of more than 150 technical papers in international journals and 200 refereed conference papers and 4 books.

In 1990 he has become a Fellow of the IEEE "for contribution to the modelling of planar and quasi-planar microwave and millimetre-wave circuits". In 1993 he was the recipient of the IEEE MTT-S Meritorious Service Award and in 2000 he was one of the recipients of the IEEE Third Millennium Medal. In 2004 he received the Distinguished Educator Award from IEEE MTT-S. In 2010 he received the Distinguished Service Award from the European Microwave Association. In 2012 he received, with S.Bastioli and C. Tomassoni, the Microwave prize for the paper "A New Class of Waveguide Dual-Mode Filters Using TM and Nonresonating Modes", IEEE Trans. on Microwave Theory and Techniques, Vol. 58, Issue: 12, pp. 3909-3917, December 2010. In 2015 he was awarded the prestigious Microwave Career Award from the IEEE MTT-Society.

Roberto Sorrentino has been active within the IEEE MTT Society. From 1984 through 1987 he was the Chairman of the IEEE Section of Central and South Italy and was the founder of the local MTT/AP Chapter that he chaired from 1984 to 1987. From Jan. 1995 through April 1998 he was the Editor-in-Chief of the IEEE Microwave and Guided Wave Letters. From 1998 to 2005 he has served on the Administrative Committee of the IEEE Microwave Theory and Techniques Society. He was elected again in MTT AdCom for

the term 2011-2013. He is also a member of Technical Committees MTT-15 on Field Theory and MTT-1 on Computer-Aided Design, which he chaired in 2003-04.

Roberto Sorrentino served the International Union of Radio Science (URSI) as Vice Chair (1993-1996) then Chair (1996-1999) of the Commission D (Electronics and Photonics). Since 2007 he is the President of the Italian Commission of URSI.

In 2002 he was among the founders and first President of the Italian Electromagnetic Society (SIEm) that he chaired until 2008. From 1998 to 2005 he was a member of the High Technical Council of the Italian Ministry of Communications.

In 2007 he founded RF Microtech, a spin-off company of the University if Perugia dealing with RF MEMS, microwave systems and antennas.

In 1998 he was one of the founders of the European Microwave Association (EuMA) was its President till 2009.

**Description of the Lecture**

Electromagnetic fieds have the key ability to provide long-distance interaction. At the end of the 19th century Marconi was the first to realize the enormous potential and the practical impact of electromagnetic waves for communications and, a few years later, for the radar technology. Today, the range of applications of EM fields has exploded and pervaded our everyday's life. Apart from the mobile phone that everyone carries in his/her pocket, electromagnetic fields are employed in a number of both common and advanced applications, from cooking (microwave oven) to positioning systems (GPS), automotive (collision avoidance, autonomous driving), wireless sensing, RF identification (RFID), medicine (biomedical devices), Internet of Things, meteorology (remote sensing and diagnostic), industrial process control, wireless power transfer and many others. This lecture will introduce the audience to the world of Electromagnetism by describing some of its many applications that impact (or will soon impact) onto our everyday's life.

**Lecture title: The constitutive error approach in the computation of the electric and magnetic fields**

**Lecturer: Guglielmo Rubinacci**

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**Short CV:**

Guglielmo Rubinacci received the Laurea degree (summa cum laude) in electronic engineering from the University of Naples Federico II in 1975. Currently, he is a Full Professor of fundamentals in electrical engineering at the University of Naples Federico II and a research affiliate at the MIT. He was the Dean of the Faculty of Engineering at the University of Cassino from 1996 to 2003. As a Fulbright-Hays Fellow he was a Visiting Scientist at MIT in 1980/81. He was also engaged in researches, in particular, at the Max Planck Institut fur Plasmaphysik, Garching and the Istituto Gas Ionizzati, CNR, Padova. He was the Coordinator of the Ph.D. courses in electrical engineering at the University of Napoli Federico II from 2009 to 2013. He was a Research scientist at the Università di Napoli from1982 to 1985, Professor in Charge and Associate Professor of electrical engineering at the Universities of Calabria from 1979 to 1984, Salerno from 1984 to 1988, and Napoli from 1988 to 1990, and Full Professor at the University of Cassino from 1990 to 2004. He is the author/coauthor of more than 200 papers in refereed scientific journals and books and co-editor of three volumes. His research interests are mainly in computational electromagnetics with applications in several fields such as plasma engineering in tokamaks and electromagnetic nondestructive evaluation. He has been involved in many international projects in the field of fusion such as INTOR, NET, RFX, Ignitor, and ITER. He has acted as a principal investigator and coordinator of European and national research projects. He received the Applied Electromagnetics and Mechanics Award for excellence in Applied Electromagnetics and Mechanics in 2009. He was the Chairman of the International Steering Committee of the COMPUMAG International Conference on the Computation of Electromagnetic Fields from 1990 to 1991, Chairman of the International Standing Committee of the Electromagnetic Nondestructive Evaluation Workshops from 2002 to 2006, and a member of the International Steering Committee of several International Conferences. He is a member of the Editorial Advisory Board of The International Journal for Computation and Mathematics in Electrical and Electronic Engineering (COMPEL), Co-editor of the Studies in Applied Electromagnetics and Mechanics, a series of volumes published by IOS Press.