IEEE Circuits and Systems Society Activity:

"*Developing Inter-disciplinary Education in Circuits and Systems Community*"

24th January 2014, 10.00-13.00

Dipartimento di Elettronica, Informazione e Bioingegneria

Aula Beta, Edificio 24, Via Golgi 40, Milano

- **10.00-11.00: Luca Daniel,** Massachusetts Institute of Technology**:** "***Stochastic Simulation, Modeling & Optimization of Complex Systems via Parameterized Model Reduction***"

- **11.00-11.45: Fernando Corinto,** Politecnico di Torino: ***" Introduction to Memristor Technology for Bio-inspired Nanocomputing"***

- **11.45-12.30: Federico Bizzarri,** Politecnico di Milano: ***"Advanced simulation of Analog Mixed Signal circuits modeled as hybrid systems: the PAN simulation environment".***

Stochastic Simulation, Modeling & Optimization of Complex Systems via Parameterized Model Reduction

Prof. Luca Daniel, Massachusetts Institute of Technology

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Many complex systems developed by engineers (e.g. iPads, sensor body networks, power delivery networks, magnetic resonance imaging machines) or found in nature (e.g. the human cardiovascular system, or the geophysical oil/water/gas reservoir networks) can be viewed as large collections of interconnected dynamical system components. The performance or characteristics of each individual component critically depend on what engineers or scientist refer to as “second order effects”, and can be captured only by resorting to accurate partial differential equation descriptions (e.g. Poisson, Maxwell, Navier-Stokes equations etc…). In addition, such components are often affected by random uncertainties in parameters and in geometries. In the first part of this talk I will illustrate how recent advances in computational techniques have made it possible to quantify efficiently and accurately the effect of second order effects and random uncertainties in individual system components. In the second part of this talk I will show how parameterized model order reduction techniques are beginning to enable the efficient simulation, design and optimization of “entire” complex networks of interconnected dynamical systems. Examples of complex systems analysis and optimization will be presented from the electrical engineering world including network of integrated circuit interconnect, RF inductors, micro-electro-mechanical sensors, low noise RF amplifiers, and power amplifiers, as well as city/state wide power distribution grids. At the end of the talk I will outline how the same stochastic field solver and parameterized compact dynamical modeling techniques used for designing complex electronic systems can be used to handle complex systems in other fields (e.g. to control undesired local heat deposition in human tissues by the RF power used in high resolution MRI machines, or to diagnose diseases of the human cardiovascular system, or to enable water/oil/gas reservoir exploration.)

Luca Daniel is an Associate Professor in the Electrical Engineering and Computer Science Department of the Massachusetts Institute of Technology (MIT). Prof. Daniel received the Ph.D. degree in Electrical Engineering from the University of California, Berkeley, in 2003. In 1997, he collaborated with STMicroelectronics Berkeley Labs. In 1998, he was with HP Research Labs, Palo Alto, and in 2001 with Cadence Berkeley Labs. Dr. Daniel research interests include development of integral equation solvers for very large complex systems, stochastic field solvers for large number of uncertainties, and automatic generation of parameterized stable compact models for linear and nonlinear dynamical systems. Applications of interest include simulation, modeling and optimization for mixed-signal/RF/mm-wave circuits, power electronics, MEMs, nanotechnologies, materials, MRI machines, and the human cardiovascular system. Prof. Daniel has received the 1999 IEEE Trans. on Power Electronics best paper award; the 2003 best PhD thesis awards from both the Electrical Engineering and the Applied Math departments at UC Berkeley; the 2003 ACM Outstanding Ph.D. Dissertation Award in Electronic Design Automation; 5 best paper awards in international conferences, 8 additional nominations for best paper award; the 2009 IBM Corporation Faculty Award; and the 2010 IEEE Early Career Award in Electronic Design Automation.

An introduction to Memristor Technology for Bio-inspired Nanocomputing

Dr. Fernando Corinto, Politecnico di Torino

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Memristors were first conjectured by Leon Chua as published in his seminal paper in 1971, which was further extended by L. O. Chua and S. M. Kang in their 1976 paper on memristive devices and systems. Recently physical realization of memristors was reported in Nature by HP's Stan Williams team in 2008. To date, memristor represents the latest technology breakthrough to build electronics devices with characteristics that show an intriguing resemblance to the brain synapses. The seminar aims to address a novel area of research that makes use of a disruptive technology as the fundamental bio-inspired computation element, the memristor.

Fernando Corinto received the Masters' Degree in Electronic Engineering and the Ph.D. degree in Electronics and Communications Engineering from the Politecnico di Torino, in 2001 and 2005 respectively. He also received the European Doctorate from the Politecnico di Torino, in 2005. Dr. Corinto was awarded a Marie Curie Fellowship (within the 'Marie Curie Actions' under the Sixth Framework Programme) in 2004. He is currently an Assistant Professor of Circuit Theory with the Department of Electronics and Telecommunications, Politecnico di Torino. His research activities are mainly in the areas of nonlinear circuits and systems, locally coupled nonlinear/nanoscale networks and memristor technology. Dr. Corinto is co-author of 3 book chapters and more than 90 international journal and conference papers. He has been reviewer of several papers for international journals and conferences. Since 2010, he is Senior Member of the IEEE. He is also Member of the IEEE CAS Technical Committees on "Cellular Nanoscale Networks and Array Computing" and "Nonlinear Circuits and Systems". Dr. Corinto is Visiting Professor at Peter Pazmany Catholic University of Budapest, since 2007. Dr. Corinto was the Technical Program Chair for the 13th International Workshop on Cellular Nanoscale Networks and their Applications and the co-organizer of the 3rd Memristor Symposium. He presented the Tutorial on "Memristor Technology in Neuromorphic Circuits" - ICECS 2012 (Sevilla, 09-12/12/2012).

Advanced simulation of Analog Mixed Signal circuits modeled as hybrid systems: the PAN simulation environment

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No push-button steady state and noise analysis methods are yet available off the shelf for circuits described by a combination of analog, digital and behavioural parts. The main reason for this, is that most algorithms used to perform steady state and noise simulations require continuity of the system being analysed, and this is intrinsically in contradiction with the Analog Mixed Signal (AMS) model. Recently a systematic extension of these algorithms to non continuous systems was proposed and successfully implemented in an academic circuit simulator. This extension was made possible by importing in the circuit simulation realm some mathematical tools that are well known among the researchers focused on hybrid dynamical systems. Such tools represent the interface between the conventional analog world and the more contemporary digital/behavioural one. This talk is focused on the main steps of this extension resulting in the first circuit simulator including all the classical “spice-like” features combined with a set of powerful, AMS specific augmentations. It was accomplished not simply by borrowing pre-existing mathematical tools but, mainly, by developing a novel circuit oriented modelling environment. The simulation framework is appealing not only for people interested in circuit analysis and design but, more in general, for all researches and engineers working in the more wide field of system simulation were the AMS concept is pervasive and present.

Federico Bizzarri was born in Genoa, Italy, in 1974. He received the Laurea (M.Sc.) five-year degree (summa cum laude) in electronic engineering and the Ph.D. degree in electrical engineering from the University of Genoa, in 1998 and 2001, respectively. Since June 2010 he has been a temporary research contract Assistant professor at the Electronic and Information Department of the Politecnico di Milano. In 2000 he was a visitor to EPFL, Lausanne, Switzerland. From 2002 to 2008 he had been a post-doctoral research assistant in the Biophysical and Electronic Engineering Department of the University of Genova, Italy. In 2009 he was a post-doctoral research assistant in Advanced Research Center on Electronic Systems for Information and Communication Technologies ``E. De Castro'' (ARCES) at the University of Bologna. His main research interests are in the area of nonlinear circuits, with emphasis on chaotic dynamics and bifurcation theory, circuit models of nonlinear systems, image processing, circuit theory and simulation. He is the author or coauthor of about 65 scientific papers, more than half of which have been published in international journals. Since 2012 he is a research fellow of the Advanced Research Center on Electronic Systems for Information and Communication Technologies ``E. De Castro'' (ARCES) at the University of Bologna. He is currently serving as an Associate Editor of the IEEE Transactions on CAS-I and he received the 2012-13 Best Associate Editor Award of that journal.