



**UNIVERSITÀ DEGLI STUDI DI GENOVA**  
**SCUOLA POLITECNICA - DITEN**  
**Corso di LAUREA MAGISTRALE MULTIMEDIA SIGNAL PROCESSING AND**  
**TELECOMMUNICATION NETWORKS**

**(IN ITALIANO)**

**Marco Storce**

**Qualifica: Professore di I fascia**

**SSD: ING-IND/31**

**Indirizzo: Via Opera Pia 11A, c.o. DITEN**

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**Ambiti di insegnamento e ricerca**

Analisi e sintesi di modelli lineari e non lineari (per esempio isteresi, neuroni, sistemi di controllo, oscillatori elettronici)

**Orario di ricevimento**

Su appuntamento

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**Curriculum**

Nato a Genova il 25/04/1969. Laureato in Ingegneria Elettronica presso l'Università di Genova, dottore di ricerca in Ingegneria Elettrica. Ricamatore dal 1999, Professore Associato dal 2004, dal 2011 è Prof. Ordinario (settore scientifico-disciplinare ING-IND/31) presso l'Università di Genova. Ha svolto periodi di ricerca presso l'EPFL, a Losanna (CH), nel 1998 e nel 2002, sotto la guida del Prof. Martin Hasler, e ha insegnato presso il Politecnico di Milano dal 2000 al 2003.

Per l'anno accademico 2013/14, è titolare degli insegnamenti di:

Teoria dei Circuiti

Nonlinear Dynamics

Advanced Antenna Engineering & Signal Processing [modulo su filtraggio di segnali]

L'attività didattica e scientifica del Prof. Storce è attualmente rivolta ai seguenti settori:

- Sistemi dinamici lineari e non lineari;
- Sintesi di sistemi di controllo embedded;
- Reti di sistemi dinamici (neuroni, sensori wireless)

È membro del "Technical Committee on Nonlinear Circuits and Systems" della IEEE Circuits and Systems Society dal 2006 (<http://www.eecs.berkeley.edu/~ljilja/tcnas/members.html>).

È componente della Giunta del Gruppo nazionale di coordinamento di Elettrotecnica (<http://www.gruppoeletrotecnica.it/index.php?who=organizzazione>).

Sintesi dei principali progetti di ricerca:

- Coordinatore scientifico del progetto europeo MOBY-DIC (<http://www.mobydic-project.eu/>) "Model-based synthesis of digital electronic circuits for embedded control" (FP7-INFSo-ICT-248858) (unità coinvolte: Università degli Studi di Genova, Technische Universiteit Eindhoven, Universidad de Sevilla, Università degli Studi di Trento, FORD Forschungszentrum Aachen GMBH, ON Semiconductor Belgium BVBA) - triennio 2009-2011, circa 2.140.000€ (totale, 505.264€ per l'unità di Genova), European Commission (<http://www.mobydic-project.eu/>).
- Coordinatore scientifico del Progetto Nazionale di Ricerca (PRIN2006) "Approssimazione di reti di sistemi dinamici non lineari (modelli di neuroni biologicamente plausibili) e realizzazione di circuiti a struttura parallela per la loro emulazione" - biennio 2007-2008, circa 113.000€ (totale), MIUR + Ateneo di Genova.
- Responsabile Scientifico dell'Unità Operativa dell'Università di Genova nell'ambito del Progetto Nazionale di Ricerca (PRIN2004) "Circuiti neurali cellulari per l'elaborazione in tempo reale di immagini oftalmiche in ausilio alla diagnostica medica" (Coordinatore: Prof. Fausto Sargeni – Roma Tor Vergata) - biennio 2005-2006, 43.000€ (unità di Genova), MIUR + Ateneo di Genova.
- Co-responsabile della ricerca del progetto regionale POR "SMUPIS: Sistema distribuito ed integrato per il monitoraggio dell'umidità delle piante e del suolo finalizzato alla prevenzione di rischi naturali" (unità coinvolte: Acrotec Srl, DIBE/DITEN, Fondazione CIMA) – 2011-2013, circa 200.890€.
- "Realizzazione di circuiti e sistemi tramite funzioni lineari a tratti", scambi di ricercatori, nell'ambito dell'Accordo di Cooperazione Scientifica e Tecnologica fra Italia e Argentina (Responsabile argentino: Prof. Pedro Julián, Universidad Nacional del Sur) - biennio 2004-2005, Ministero degli Affari Esteri.
- Co-responsabile della ricerca del Progetto Nazionale di Ricerca (FIRB2001): "Metodi innovativi per l'analisi e il progetto di circuiti caotici" - 2003-2006, circa 250.000€ (quota del gruppo di ricerca), MIUR.
- "Analisi, realizzazione e studio di possibili applicazioni di un circuito elettronico basato su isteresi in grado di produrre dinamica caotica", finanziato dal CNR Agenzia 2000, nell'ambito dei "progetti giovani" (riservati a ricercatori operanti presso strutture di ricerca pubbliche o private di età inferiore ai 35 anni) - biennio 2001-2002, circa 13.000€, CNR.
- Responsabile di vari progetti di Ateneo.

I suoi principali interessi di ricerca riguardano la modellistica (anche circuitale) e l'analisi di sistemi dinamici non lineari (p.es. isteresi, neuroni), metodi per la sintesi circuitale di sistemi non lineari (p.es. sistemi di controllo embedded, neuroni). È (co)autore di circa 100 articoli scientifici, più della metà dei quali pubblicati su riviste internazionali.



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È stato relatore invitato a vari workshop nazionali e internazionali e organizzatore e 'chairman' di sessioni in conferenze internazionali (ISCAS, ECCTD, ICECS, World Congress of IFAC).

Ha svolto il ruolo di Associate Editor per le IEEE Transactions on Circuits and Systems II (biennio 2008-2009) e di revisore per molte riviste internazionali (p.es., IEEE Transactions on Circuits and Systems [I and II], International Journal of Circuit Theory and Applications, IEEE Transactions on Neural Networks, International Journal of Bifurcation and Chaos, Physica D, Chaos), per conferenze internazionali e per enti di ricerca e case editrici nazionali e internazionali (p.es., MIUR, Research Grants Council di Hong Kong, Netherlands Organisation for Scientific Research, McGraw-Hill).

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**Pubblicazioni su rivista internazionale degli ultimi 3 anni (2010-2012)**

1. T. Poggi, F. Comaschi, M. Storace, "Digital circuit realization of piecewise affine functions with non-uniform resolution: theory and FPGA implementation," IEEE Transactions on Circuits and Systems-II: Transaction Briefs, vol. 57, n. 2, pp. 131-135, Feb. 2010, doi: 10.1109/TCSII.2010.2040316.
2. F. Bizzarri, A. Brambilla, D. Linaro, M. Storace, "Continuation analysis of a phase/quadrature electronic oscillator," Journal of Circuits, Systems and Computers, special issue on "Advances in oscillator analysis and design", vol. 19, N. 4, pp. 773-785, 2010, doi: 10.1142/S0218126610006438.
3. M. Parodi, M. Gaggero, M. Storace, "Piecewise linear approximations of multivariate functions: a multiresolution-based compression algorithm suitable for circuit implementation," Applied Numerical Mathematics, vol. 60, pp. 924-933, 2010, doi: 10.1016/j.apnum.2010.05.002.
4. D. Linaro, T. Poggi, M. Storace, "Experimental bifurcation diagram of a circuit-implemented neuron model," Physics Letters A, vol. 374, N. 45, pp. 4589-4593, 11 Oct. 2010, doi: 10.1016/j.physleta.2010.09.030.
5. F. Bizzarri, D. Linaro, B. Oldeman, M. Storace, "Harmonic analysis of oscillators through standard numerical continuation tools," International Journal of Bifurcation and Chaos, vol. 20, No. 12, pp. 4029-4037, December 2010, doi: 10.1142/S0218127410028161.
6. M. Di Federico, T. Poggi, P. Julián, M. Storace, "Integrated circuit implementation of multi-dimensional piecewise-linear functions," Digital Signal Processing, vol. 20, pp. 1723-1732, December 2010, doi: 10.1016/j.dsp.2010.02.007.
7. M. Storace, T. Poggi, "Digital architectures for the circuit implementation of PWL multi-variate functions: two FPGA implementations," International Journal of Circuit Theory and Applications, vol. 39, pp. 1-15, 2011, doi: 10.1002/cta.610.
8. D. Linaro, M. Storace, M. Giugliano, "Accurate and fast simulation of channel noise in conductance-based model neurons by diffusion approximation," PLoS Computational Biology, vol. 7(3), pp. e1001102(1-17), March 2011, doi: 10.1371/journal.pcbi.1001102.
9. A. Oliveri, A. Stocchino, M. Storace, "Barriers to transport induced by periodic oscillations in a physical model of the human vitreous chamber," Physical Review E, vol. 83, pp. 036311(1-5), 2011, doi: 10.1103/PhysRevE.00.006300.
10. D. Linaro, M. Storace, M. Mattia, "Inferring network dynamics and neuron properties from population recordings," Frontiers in Computational Neuroscience, vol. 5, paper 43, pp. 1-17, September 2011, doi: 10.3389/fncom.2011.00043.
11. A. Bemporad, A. Oliveri, T. Poggi, M. Storace, "Ultra-Fast Stabilizing Model Predictive Control via Canonical Piecewise Affine Approximations," IEEE Transactions on Automatic Control, vol. 56, pp. 2883-2897, Dec. 2011, doi: 10.1109/TAC.2011.2141410.
12. T. Poggi, M. Rubagotti, A. Bemporad, M. Storace, "High-speed piecewise affine virtual sensors," IEEE Transactions on Industrial Electronics, vol. 59, N. 2, pp. 1228-1237, Feb. 2012, doi: 10.1109/TIE.2011.2161064.
13. D. Linaro, M. Righero, M. Biey, M. Storace, "Synchronization: a tool for validating a PWL circuit that approximates the Hindmarsh-Rose neuron model," Nonlinear Theory and Its Applications (NOLTA), IEICE, Special Section on "Synchronization in Nonlinear Science and Engineering", vol. 3, N. 2, pp. 165-179, 2012, doi: 10.1587/nolta.3.165.
14. D. Linaro, A. Champneys, M. Desroches, M. Storace, "Codimension-two homoclinic bifurcations underlying spike adding in the Hindmarsh-Rose burster," SIAM Journal on Applied Dynamical Systems, vol. 11, N. 3, pp. 939-962, 2012, doi: 10.1137/110848931.
15. F. Comaschi, B.A.G. Genuit, A. Oliveri, W.P.M.H. Heemels, M. Storace, "FPGA implementations of piecewise affine functions based on multi-resolution hyperrectangular partitions," IEEE Transactions on Circuits and Systems I: Regular Papers, vol. 59, N. 12, pp. 2920-2933, 2012, doi: 10.1109/TCSI.2012.2206490.



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(ENGLISH VERSION)

### Marco Storace

#### Full Professor

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phone/fax.: (+39) 0103532079/0103532290

e-mail: marco.storace@unige.it

#### Research topics

Analysis and circuit implementation of nonlinear models (e.g., hysteresis, biological neurons, control systems, electronic oscillators)

#### Office hours

By appointment

#### Curriculum

Brief Career History:

- 2011- Full Professor. Department of Electrical, Electronic and Telecommunications Engineering and Naval Architecture, University of Genoa.
- 2004-2011 Associate Professor. Biophysical and Electronic Engineering Department, University of Genoa.
- 2000-2003 Lecturer. Polytechnic of Milan.
- 1999-2004 Research Assistant and Lecturer. Biophysical and Electronic Engineering Department, University of Genoa.
- 1998 Visitor at the Laboratory of Nonlinear Systems of the École Polytechnique Fédérale de Lausanne, supervisor Prof. Martin Hasler. Research activity on: "Stochastic resonance and chaotic systems". Sponsored by the University of Genoa.
- 1998 Postdoctoral Research Assistant in the Biophysical and Electronic Engineering Department, University of Genoa.
- 1994-1997 Ph.D. in Electrical Engineering, University of Genoa. Thesis title Circuit modelling of nonlinear systems, supervisor Prof. Mauro Parodi.
- 1994 M.Sc. 5-year degree in Electronic Engineering, University of Genoa. Graduated with first class honours (Summa Cum Laude).

Current Teaching (academic year 2013/14):

Teoria dei Circuiti (Basic Circuit Theory)

Nonlinear Dynamics

Advanced Antenna Engineering & Signal Processing [teaching unit on signal filtering]

Current research interests:

- Modelling and circuit synthesis of devices and systems for engineering applications (e.g., circuit implementation of models of biological neurons)
- Piecewise-linear (PWL) approximation techniques and circuit implementation of PWL n-variate functions for engineering applications (e.g., emulation of nonlinear dynamical systems, nonlinear control systems)
- Nonlinear dynamics and bifurcation analysis of smooth and non-smooth dynamical systems (mainly, biological and electronic oscillators)
- Identification of nonlinear dynamical systems
- Analysis, synchronization and control of complex networks
- Wireless sensor networks

Professional Societies:

Member of the Technical Committee on Nonlinear Circuits and Systems of the IEEE CAS Society (from 2006) (<http://www.eecs.berkeley.edu/~ljilja/tcnas/members.html>).

Member of the Technical Committee of the national group of Electrical Engineering (<http://www.gruppoelettronica.it/index.php?who=organizzazione>).

Research Grants (with coordination roles):

- EU Grant "MOBY-DIC: Model-based synthesis of digital electronic circuits for embedded control" - 2009-2012 (FP7-INFOS-ICT-248858). Project coordinator of a research network with Università degli Studi di Genova, Technische Universiteit Eindhoven, Universidad de Sevilla, Università degli Studi di Trento, FORD Forschungszentrum Aachen GMBH, ON Semiconductor Belgium BVBA. Total value EUR 2.140.000. Genoa's share approx EUR 505.000, European Commission (<http://www.mobydic-project.eu/>).
- Italian Ministry of University and Research Grant (approx EUR 113.000) - 2006-2008 (PRIN2006). National coordinator of a research network with the Universities of Genoa, Turin, and Rome "Tor Vergata". Title: "Approximation of networks of nonlinear dynamical systems (models of biologically plausible neurons) and implementation of parallel circuits for their emulation"
- Italian Ministry of University and Research Grant - 2004-2006 (PRIN2004). Node coordinator (approx EUR 43.000) of a research network with the Universities of Genoa, Turin, Rome "Tor Vergata", and Bari. Title: "CNN application to real time processing of ophthalmic images as medical diagnosis support".



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- Italian and Argentine Ministry for Foreign Affairs, in the framework of the bilateral agreement for scientific and technologic cooperation between Italy and Argentina 2004-2005 (Argentine coordinator: Prof. Pedro Julián, Universidad Nacional del Sur). Title: "Circuit implementations of piecewise-linear systems "
- Italian Ministry of University and Research Grant - 2003-2006 (FIRB2001). Node co-coordinator (approx EUR 250.000) of a research network with the Universities of Ferrara, Genoa, Turin, and Milan. Title: "Innovative methods for analysis and design of chaotic circuits".
- Italian National Research Council (CNR) (approx EUR 13.000) - 2001-2002, in the framework of the "Young researchers projects" initiative. Title: "Analysis, implementation and possible applications of an electronic oscillator based on hysteresis able to produce chaotic dynamics".
- Many projects funded by the University of Genoa.

Workshops and Meetings (chair/organizer/invited speaker):

- Chairman and organizer of the invited session "Digital circuits for embedded control and security", ICECS2012 (Seville, Spain).
- Chairman and organizer of the workshop "Explicit MPC: from specifications to circuit implementations", August 23 2012, Noordwijkerhout, The Netherlands.
- Co-Chair and co-organizer of the invited sessions "MPC on Embedded Systems (I and II)" World Congress of the International Federation of Automatic Control (IFAC2011), 28 August – 2 September 2011 (Milan, Italy).
- Chairman and co-organizer of the invited session "Piecewise Linear Circuits and Systems: Bridging Electronics and Control Systems", ISCAS2010 (Paris, France).
- Invited speaker at "International Workshop on Multi-Rate Processes & Hysteresis", University College Cork, Ireland, March 31- April 5, 2008. Title: "Piecewise-linear Approximation of the Hindmarsh-Rose Neuron Model".
- Invited speaker at "International Workshop on Multi-Rate Processes & Hysteresis", University College Cork, Ireland, April 3-8, 2006. Title: "Codimension-2 Bifurcations in a Circuit Oscillator Based on Hysteresis".
- Invited speaker at "International Workshop on hysteresis & multi-scale asymptotics", University College Cork, Ireland, March 17-21, 2004. Title: "PWL approximation of nonlinear dynamical systems. Part-I: structural stability".
- Co-chairman of the invited session "Piecewise Linear Circuits and Systems", ISCAS2003 (Bangkok, Thailand).
- Invited speaker at the Int. Workshop "Bifurcations in Nonsmooth Dynamical Systems", Milan, 22-23 April 2002. Title: "Bifurcation analysis of a 3D piecewise-linear continuous flow through a 1D discontinuous map: a circuit example".

International Editorial and Organizing Activities

- 2008-2009 Associate Editor of the IEEE Transactions on Circuits and Systems II
- Review Committee Member for the International Symposium on Circuits and Systems (2008-2012) in the "Nonlinear Circuits and Systems" track.

Scientific activities

Marco Storace is the (co-)author of about 100 scientific papers, more than an half of which have been published in international journals (<http://ncas.dibe.unige.it/people/storace/journals.shtml>).

He serves as reviewer for many international journals (e.g., IEEE Transactions on Circuits and Systems [I and II], International Journal of Circuit Theory and Applications, IEEE Transactions on Neural Networks, International Journal of Bifurcation and Chaos, Physica D, Chaos), for international conferences, and for national and international research grants councils and editors (e.g., Italian Ministry of Research, Research Grants Council di Hong Kong, Netherlands Organisation for Scientific Research, McGraw-Hill).

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#### Recent publications on international journals (2010-2012)

1. T. Poggi, F. Comaschi, M. Storace, "Digital circuit realization of piecewise affine functions with non-uniform resolution: theory and FPGA implementation," IEEE Transactions on Circuits and Systems-II: Transaction Briefs, vol. 57, n. 2, pp. 131-135, Feb. 2010, doi: 10.1109/TCSII.2010.2040316.
2. F. Bizzarri, A. Brambilla, D. Linaro, M. Storace, "Continuation analysis of a phase/quadrature electronic oscillator," Journal of Circuits, Systems and Computers, special issue on "Advances in oscillator analysis and design", vol. 19, N. 4, pp. 773-785, 2010, doi: 10.1142/S0218126610006438.
3. M. Parodi, M. Gaggero, M. Storace, "Piecewise linear approximations of multivariate functions: a multiresolution-based compression algorithm suitable for circuit implementation," Applied Numerical Mathematics, vol. 60, pp. 924-933, 2010, doi: 10.1016/j.apnum.2010.05.002.
4. D. Linaro, T. Poggi, M. Storace, "Experimental bifurcation diagram of a circuit-implemented neuron model," Physics Letters A, vol. 374, N. 45, pp. 4589-4593, 11 Oct. 2010, doi: 10.1016/j.physleta.2010.09.030.
5. F. Bizzarri, D. Linaro, B. Oldeman, M. Storace, "Harmonic analysis of oscillators through standard numerical continuation tools," International Journal of Bifurcation and Chaos, vol. 20, No. 12, pp. 4029-4037, December 2010, doi: 10.1142/S0218127410028161.
6. M. Di Federico, T. Poggi, P. Julián, M. Storace, "Integrated circuit implementation of multi-dimensional piecewise-linear functions," Digital Signal Processing, vol. 20, pp. 1723-1732, December 2010, doi: 10.1016/j.dsp.2010.02.007.
7. M. Storace, T. Poggi, "Digital architectures for the circuit implementation of PWL multi-variate functions: two FPGA implementations," International Journal of Circuit Theory and Applications, vol. 39, pp. 1-15, 2011, doi: 10.1002/cta.610.
8. D. Linaro, M. Storace, M. Giugliano, "Accurate and fast simulation of channel noise in conductance-based model neurons by diffusion approximation," PLoS Computational Biology, vol. 7(3), pp. e1001102(1-17), March 2011, doi: 10.1371/journal.pcbi.1001102.
9. A. Oliveri, A. Stocchino, M. Storace, "Barriers to transport induced by periodic oscillations in a physical model of the human vitreous chamber," Physical Review E, vol. 83, pp. 036311(1-5), 2011, doi: 10.1103/PhysRevE.00.006300.
10. D. Linaro, M. Storace, M. Mattia, "Inferring network dynamics and neuron properties from population recordings," Frontiers in Computational Neuroscience, vol. 5, paper 43, pp. 1-17, September 2011, doi: 10.3389/fncom.2011.00043.
11. A. Bemporad, A. Oliveri, T. Poggi, M. Storace, "Ultra-Fast Stabilizing Model Predictive Control via Canonical Piecewise Affine Approximations," IEEE Transactions on Automatic Control, vol. 56, pp. 2883-2897, Dec. 2011, doi: 10.1109/TAC.2011.2141410.



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12. T. Poggi, M. Rubagotti, A. Bemporad, M. Storace, "High-speed piecewise affine virtual sensors," *IEEE Transactions on Industrial Electronics*, vol. 59, N. 2, pp. 1228-1237, Feb. 2012, doi: 10.1109/TIE.2011.2161064.
13. D. Linaro, M. Righero, M. Biey, M. Storace, "Synchronization: a tool for validating a PWL circuit that approximates the Hindmarsh-Rose neuron model," *Nonlinear Theory and Its Applications (NOLTA)*, IEICE, Special Section on "Synchronization in Nonlinear Science and Engineering", vol. 3, N. 2, pp. 165-179, 2012, doi: 10.1587/nolta.3.165.
14. D. Linaro, A. Champneys, M. Desroches, M. Storace, "Codimension-two homoclinic bifurcations underlying spike adding in the Hindmarsh-Rose burster," *SIAM Journal on Applied Dynamical Systems*, vol. 11, N. 3, pp. 939-962, 2012, doi: 10.1137/110848931.
15. F. Comaschi, B.A.G. Genuit, A. Oliveri, W.P.M.H. Heemels, M. Storace, "FPGA implementations of piecewise affine functions based on multi-resolution hyperrectangular partitions," *IEEE Transactions on Circuits and Systems I: Regular Papers*, vol. 59, N. 12, pp. 2920-2933, 2012, doi: 10.1109/TCSI.2012.2206490.