Curriculum Vitae of **Marco Spadini** *

Personal data

Born in Siena (Italy) on March 28, 1967.
Resident in Florence (Italy).
Italian Nationality.
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Research interests

Topological methods in mathematical analysis: theories of topological degree and of fixed point index. Nonlinear ordinary differential equations and dynamical systems. In particular, ordinary and functional differential equations on differentiable manifolds, forced oscillations of constrained mechanical systems, and control theory. Applications to Differential-Algebraic equations.

Affiliation

Dipartimento Matematica e Informatica 'U. Dini', Università di Firenze. Via S. Marta 3, 50139 Firenze (Italy). (Formerly member of "Dipartimento di Matematica Applicata 'G. Sansone'.")

Appointments and visiting position

1997 – 1998 CNR senior domestic scholarship (Borsa CNR senior per l'Italia), at "Dipartimento di Matematica U. Dini, Università di Firenze", research director: Prof. M. Furi.

1998 – 1999 Nonlinear Control Network (TMR program) post-doctoral scholarship, at "Institut für Mathematik, Universität Augsburg", under the direction of Prof. F. Colonius.

1999 – 2000 Research grant at Dipartimento di Matematica Applicata G. Sansone", Università di Firenze, and CNR foreign scholarship (Borsa di studio per l'estero) at "Université Catholique de Louvain". Director Prof. Jean Mawhin.

2000 – present Assistant Professor of Mathematical Analysis (Ricercatore per il settore MAT05 – Analisi Matematica) at "Facoltà di Ingegneria dell'Università di Firenze" since February 1, 2000. Confirmed since 2003.

Education

1992 M.Sc. Mathematics (Italian Laurea)
University of Florence, Italy
Thesis: La teoria dell'indice di punto fisso dal punto di vista della Topologia differenziale [*Fixed point index theory from the differential topology viewpoint*] (Advisor Prof. M. Furi)

1997 Ph.D. In Mathematics (Dottorato di Ricerca in Matematica)
University of Florence, Italy

*last update: June 30, 2015

Thesis: Perturbazioni periodiche di equazioni differenziali ordinarie su varietà differenziabili [*Periodic perturbations of ordinary differential equations on differentiable manifolds*] (Advisor Prof. M. Furi).

Grants

2015 G.N.A.M.P.A. grant "Dinamiche non autonome, sistemi hamiltoniani e teoria del controllo" [*Nonautonomous dynamics, Hamiltonian systems and Control Theory*]. (Principal investigator.)

2015 G.N.A.M.P.A. grant "Professori visitatori" [A small grant to *invite* a professor].

2008 – 2014 University of Florence research grants :

- (2013–14) Metodi topologici per l'analisi qualitativa di Equazioni e Inclusioni Differenziali e Algebro-Differenziali [*Topological methods for qualitative analysis of Differential and Differential-Algebraic Equations and Inclusions*]. (Principal investigator.)
- "Analisi Funzionale ed applicazioni alle Equazioni Differenziali Ordinarie" [*Functional analysis and applications to ordinary differential equations*]. (Principal investigator: Prof. M. Furi.)
- "Calcolo delle Variazioni e Teoria del Controllo" [*Calculus of variations and control theory*]. (Principal investigator: Prof. G. Stefani.)

2012 G.N.A.M.P.A. grant "Equazioni differenziali ordinarie nonlineari e inclusioni differenziali:analisi qualitativa e applicazioni" [*Nonlinear ordinary differential equations and differential inclusions: Qualitative analysis and applications*]. (Principal investigator: Dr. V. Taddei).

2011 G.N.A.M.P.A. grant "Equazioni differenziali nonlineari e inclusioni differenziali: Analisi qualitativa e applicazioni" [*Nonlinear differential equations and differential inclusions: Qualitative analysis and applications*]. (Principal investigator: Dr. S. Matucci).

2009 P.R.I.N. grant "Comportamento qualitativo delle soluzioni delle Equazioni Differenziali Ordinarie (con eventuale ritardo)" [*Qualitative behaviour of solutions of ordinary differential equations (with possible delay)*]. (Principal investigator: Prof. F. Zanolin).

2008 G.N.A.M.P.A. grant "Tecniche di Analisi Non Lineare per problemi ai limiti associati a equazioni differenziali" [*Nonlinear analysis techniques for boundary value problems associated to ordinary differential equations*]. (Principal investigator: Prof. A. Capietto).

2007 P.R.I.N. grant "Comportamento qualitativo delle soluzioni delle equazioni differenziali ordinarie con eventuale ritardo" [*Qualitative behaviour of solutions of ordinary differential equations with possible delay*]. (Principal investigator: Prof. F. Zanolin).

2000 – 2007 University of Florence research grant "Analisi Funzionale ed applicazioni" [*Functional analysis and applications*]. (Principal investigator: Prof. M. Furi)

2006 G.N.A.M.P.A. grant "Analisi qualitativa di sistemi dinamici in dimensione finita" [*Qualitative analysis of finite dimensional dynamical systems*]. (Principal investigator: Prof. M. Sabatini).

2005 G.N.A.M.P.A. grant "Analisi qualitativa e comportamento asintotico di equazioni differenziali" [*Qualitative analysis and asymptotic behavior of differential equations*]. (Principal investigator: Prof. F. Battelli).

2005 P.R.I.N. grant "Comportamento Qualitativo delle Traiettorie delle Equazioni Differenziali Ordinarie" [*Qualitative behaviour of the trajectories of ordinary differential equations*] (Principal investigator: Prof. F. Zanolin).

2004 P.R.I.N. grant "Controllo nonlineare e controllo ottimo" [*Nonlinear and optimal control*] (Principal investigator Prof. A. Agrachev).

2003 Progetto Vigoni (Italo-German grant), (principal investigators: Prof. F. Colonius and Prof. R. Johnson).

2002 Progetto Giovani Ricercatori 2002 (grant for young researchers by the University of

Florence) "Problemi di controllabilità e di controllo ottimo di modelli concreti" [*Controllability and optimal control of concrete systems*]. (Principal investigator).

Visits to research centers and universities

- ✓ Institute of mathematics, University of Gdansk October 1995
- ✓ Mathematics Institute, Augsburg University, Germany. Nov. 2, 2000 – Dec. 8, 2000, Oct. 13, 2002 – Nov. 23, 2002, Jan. 25, 2003 – Feb. 13, 2003, Apr. 22, 2003 – Apr. 30, 2003, Jun. 27, 2005 – Jul. 7, 2005, Jan. 7, 2009 – Feb. 7, 2009.
- ✓ Mathematics Institute, University of Minnesota (Minneapolis, USA), Apr. 2005.
- ✓ Instituto de Matemática e Estatística, Universidade de São Paulo, SP Brazil. October 12, 2011 – November 30, 2011.

Organization of conferences and seminars

Mar. 16 - 17, 2006 Mini-workshop: *Dynamical Systems and Nonautonomous Differential Equations* Firenze, organized with R. Fabbri.

Jun. 13 - 16, 2007 International conference on *Topological Methods, Differential Equations, Dynamical Systems*, Firenze (organizing committee member).

May 25 - 28, 2010 Special Session *Topological Methods for the Qualitative Analysis of Differential Equations* (SS61), with P. Benevieri, in the framework of *The 8th AIMS Conference on Dynamical Systems, Differential Equations and Applications,* Dresden, Germany.

June 3-4, 2014 International workshop on "Topological and Variational Methods for ODEs", Florence Italy.

July 07-11, 2014 Special Session "Topological methods for the qualitative analysis of differential equations and inclusions" (SS67) with P. Benevieri, in the framework of *The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications.* Madrid, Spain

Other professional activities

- ✓ Editor for: The Scientific World Journal, Journal of Applied Mathematics and Physics.
- ✓ Reviewer for Zentralblatt für Mathematik.
- ✓ Referee for: Communications in Applied Analysis, Differential and Integral Equations, Electronic Journal of Differential Equations, Fixed Point Theory and App., J. of Dynamical and Control Systems, J. of Mathematical Analysis and Applications, Math. Meth. App. Sci., Nonlinear Analysis Series A: Theory Methods Applications, Portugaliae Math., Rend. Ist. Mat. Univ. Trieste, Rivista di Matematica della Università di Parma SIAM J. Control Optim., Topological Methods in Nonlinear Analysis.
- ✓ Elected member in the Commitee for the competitive exam for one place of 'Ricercatore di Analisi Matematica' at the "Free University of Bolzano". [2008–2009]

Computer skills

Knowledge of operating systems: ***Linux*** (User and system administrator); ***Windows and Mac*** (User).

Technical expertise: ***Markup languages*** (TEX/ LATEX/ LATEX 2$_\varepsilon$, HTML, CSS); ***Scripting and Programming languages*** (Bash, Fortran, C, Python); ***Parallel programming*** (experiences with OpenMP, CUDA C).

Teaching experience

Graduate courses

2014-'15 Dipartimento di Matematica e Informatica, Università di Firenze, Tirocini Formativi Attivi [Trainig course for teachers]: *Modelli Matematici [Mathematical Models].*
2011-'12 Instituto de Matemática e Estatística, Universidade de São Paulo, SP Brazil: *Fixed point index theory and periodic solutions of ODEs on manifolds (with P. Benevieri)*;
2008-'09 Doctoral School of Mathematics, Florence: *Differential equations on manifolds.*

Undergraduate courses

2014 Engineering School, University of Florence: *Probability theory*;
2014 University of New Haven (Prato Campus): *Calculus II*
2000-'14 Engineering School, University of Florence: *Mathematical Analysis I/II*;
2009-'11 School of Medicine, University of Florence: *Mathematical Analysis.*
2001-'03 Engineering School, University of Florence: *Mathematical Methods.*

Practice sessions

1996-2004 Engineering School, University of Florence: *Practice sessions for Mathematical Analysis I/II.*

Further teaching activity

2014 "Commissione Ingresso Tirocini Formativi Attivi 2015 (Classe 048, matematica applicata)" [*Admission committee* to trainig course for prospective math teachers] (Class 048: Applied Mathematics).
2005-'07 and 2009-'11 "Commissione Accertamento Debiti Formativi" [*Admission committee*] of the School of Engineering of the University of Florence.

Scientific activity

Talks and seminars

✓ **The structure of the set of harmonic solutions to periodic perturbations of autonomous ODEs on manifolds**. Mathematical Institute, Gdansk University, Oct. 24, 1995 (invited by Prof. W. Marzantowicz).

✓ **La struttura dell'insieme delle soluzioni armoniche di perturbazioni periodiche di equazioni autonome su varietà**. "Incontro su EDO e applicazioni- Bressanone (TN)" May 29-31, 1995.

✓ **L'indice di punto fisso dell'operatore di Poincaré ed applicazioni alle soluzioni periodiche di equazioni differenziali su varietà**. "XV congresso U.M.I." Padova, Sept. 11-16, 1995.

✓ **The structure of the set of solutions of periodically perturbed autonomus equations on manifolds**. "Nonlinear analysis and boundary value problems for ordinary differential equations. Udine Oct. 2-6, 1995.

✓ **Multiplicity and bifurcation for Forced Second Order ODE's on Manifolds**. "Metodi Topologici e Sistemi Dinamici. Florence, May 3-4, 1996.

✓ **Forced motion equations on manifolds and multiplicity results for the spherical pendulum**. "The second world congress of Nonlinear Analists". Athens, July 10-17, 1996.

✓ **Branches of forced oscillations for periodically perturbed autonomous second order ODE's on manifolds**. "IX Colloquium on differential equations". Plovdiv, Bulgaria, Aug. 18-24, 1998.

✓ **Uniqueness of control sets for perturbations of linear systems**. "First NCN Workshop on Stability and Stabilization of Nonlinear Systems", Gent, Belgium, March 15-16, 1999.

✓ **Uniqueness of control set for small perturbations of linear systems**. "Asymptotic behaviour of solutions of differential equations", Bressanone May 31 - June 2, 1999.

- ✓ **On the classification of control sets**. Mathematics Institute, Augsburg University, Germany, Dec. 6, 2000 (invited by Prof. F. Colonius).
- ✓ **Uniqueness of local control sets for nonlinear systems**. "Nonlinear Control in the year 2000". Paris, June 5 - 9, 2000.
- ✓ **A dynamic index for control sets**. "Dynamics, bifurcations and control", Kloster Irsee, Germany, April 1 - 3, 2001.
- ✓ **Sign jump detection for families of Fredholm operators of index zero and bifurcation**. Mathematics Institute, Augsburg University, Germany, Apr. 29, 2003 (invited by Prof. F. Colonius).
- ✓ **Fundamental semigroup for control sets**. "Feedback control and optimal control", Certosa di Pontignano, Italy, July 28 - 31, 2003.
- ✓ **On the uniqueness of the fixed point index on differentiable manifolds**. "Conference on fixed point theory and applications in honor of Andrej Granas", Montreal, Aug. 16 - 20, 2004.
- ✓ **Fundamental semigroups for dynamical systems**. "Dynamic Days", Ancona, Sept. 2 - 4, 2004.
- ✓ **Conley index of the skew product flow for small nonautonomous perturbations of dynamical systems**. Mathematics Institute, Augsburg University, Germany, June 27, 2005 (invited by Prof. F. Colonius).
- ✓ **Branches of harmonic solutions to periodically perturbed coupled differential equations on manifolds**. "Fixed Point Theory and Applications (in honor of J. Dugundji", Bęndlewo, Poland, Aug. 1 - 5, 2005. And "Trends in Differential Equations and Dynamical Systems", Reggio Emilia, Italy, Sept. 29 - 30, 2005.
- ✓ **Branches of harmonic solutions to periodically perturbed coupled equations on differentiable manifolds**. "Dynamical Systems and Nonautonomous Differential Equations". Florence, March 16 - 17, 2006.
- ✓ **On periodic solutions of forced coupled second order differential equations on manifolds**. "6$^{\text{ème}}$ Conférence Internationale AIMS: — Systèmes Dynamiques, Equations Différentielles et Applications—". Université de Poitiers, France. June 25–28, 2006.
- ✓ **Branches of forced oscillations in degenerate systems of second order coupled ODEs**. "ODE ART: Ordinary Differential Equations, their Applications and Related Topics". Levico Terme, Italy, Oct. 4 - 6, 2006.
- ✓ **Branches of harmonic solutions to delay periodic perturbations of autonomous ODEs on differentiable manifolds**. "Joint International Meeting UMI-DMV '07", Perugia, June 18-22, 2007. And "International Conference on Dynamical Methods and Mathematical Modeling', Valladolid, Spain, Sept. 18 – 22, 2007.
- ✓ **Conley index and connection matrices for small nonautonomous perturbations of a dynamical system**. "Bifurcation for Nonautonomous Dynamical Systems". Florence, Apr. 3, 2008.
- ✓ **Some Remarks on a Class of Strangeness Free Differential-Algebraic Equations**. "7$^{\text{th}}$ AIMS International Conference on Dyn. Systems, Diff. Equations and Applications", Arlington, Texas USA, May 18 - 21, 2008.
- ✓ **Three seminars on topological methods for ordinary differential on manifolds**, Mathematics Institute, Augsburg University, Germany, Jan. 2009 (invited by Prof. F. Colonius).
- ✓ **Degree of a tangent vector field on some zero sets in $\mathbb{R}^n$ with applications to forced oscillations of constrained systems**. "No^2DyS", Ancona, Italy, July 6 – 7, 2009.
- ✓ **Branches of forced oscillation for a class of constrained ordinary differential equations: a topological approach**. EQUADIFF 12, Brno (CZ), July 20-24, 2009.
- ✓ **Harmonic solutions of periodic retarded functional perturbations of autonomous ODEs on manifolds**. International Workshop on Variational, Topological and Set-valued Methods for Nonlinear Differential Problems, Messina, April 14-16, 2010.
- ✓ **A set of axioms for the degree of a tangent vector field on differentiable manifolds**. 8$^{\text{th}}$ AIMS International conference on Dynamical Systems Differential Equations and Applications, Dresden (DE) May 25–28, 2010.

- ✓ **The degree of a tangent vector field: some applications to periodic problems for ODEs**. Emerging problems in nonlinear analysis and differential equations, Glasgow (UK), June 1–4, 2010.
- ✓ **Oscillazioni forzate su una classe di varietà differenziabili definite implicitamente**. XIX Convegno Unione Matematica Italiana. Bologna, Italy, September 12-17, 2011.
- ✓ **Forced oscillations for a class of constrained ODEs: a topological approach**. Instituto de Matemática e Estatística, Universidade de São Paulo, SP Brazil. November 24, 2011. Invited by prof. P. Benevieri.
- ✓ **A topological approach to periodic solutions of constrained differential equations**. Dynamical methods for differential equations with applications. Valladolid (Spain) September 10-11, 2012.
- ✓ **On periodic problems for periodically perturbed equations on manifolds**. (Special Session 67: Topological Methods for the Qualitative Analysis of Differential Equations and Inclusions), within the framework of "The 10th AIMS Conference on Dynamical Systems, Differential Equations and Applications". Madrid, 7–11 July 2014.

Publications

Papers on refereed journals

1. L. Bisconti, M. Spadini, *Periodic perturbations with delay of coupled differential equations on manifolds with application to a sunflower-like equation.* To appear in NoDEA.
2. L. Bisconti, M. Spadini, *Harmonic perturbations with delay of separated variables differential equations.* To appear in Topol. Meth. Nonlin. Analysis
3. L. Bisconti, M. Spadini, *About the notion of non-T-resonance and applications to topological multiplicity results for ODEs on differentiable manifolds.* Math. Methods Appl. Sci. (2014). DOI: 10.1002/mma.3390
4. L. Bisconti, A. Calamai, M. Spadini, *Periodic solutions of semi-explicit differential-algebraic equations with time-dependent constraints.* Boundary Value Problems 09/2014; 2014(2014:179)
5. A. Calamai, M. Spadini, *Periodic perturbations of constrained motion problems on a class of implicitly defined manifolds.* Commun. in Contemp. Math. (2014) DOI: 10.1142/S0219199714500278
6. L. Poggiolini, M. Spadini, *Bang-bang trajectories with a double switching time in the minimum time problem.* ESAIM: Control, Optimisation and Calculus of Variations. In press. DOI: 10.1051/cocv/2015021
7. L. Poggiolini, M. Spadini, *Local inversion of planar maps with nice nondifferentiability structure.* Adv. Nonlin. Studies, 13 n. 2 (2013), pp. 411-430 .
8. A. Calamai, M. Spadini, *Branches of forced oscillations for a class of constrained ODEs: a topological approach.* NoDEA, 19, n. 4 (2012), pp. 383-399.
9. L. Bisconti, M. Spadini, *Corrigendum to On a class of differential-algebraic equations with infinite delay.* E. J. Qualitative Theory of Diff. Equ., No. 97 (2012), pp. 1-5.
10. L. Bisconti, M. Spadini, *On a class of differential-algebraic equations with infinite delay.* Electronic J. Qualitative Theory of Diff. Equ. , No. 81 (2011), pp. 1-21.
11. M. Furi, M. P. Pera, M. Spadini, *Periodic solutions of retarded functional perturbations of autonomous differential equations on manifolds.* Comm. Appl. Analysis **15**, 381–394 (2011).
12. L. Poggiolini, M. Spadini, *Strong local optimality for a bang-bang trajectory in a Mayer problem.* SIAM J. Control Optim., Vol. 49, No. 1, 140-161 (2011).
13. M. Furi, M. P. Pera, M. Spadini, *A set of axioms for the degree of a tangent vector field on differentiable manifolds.* Fixed Point Theory Appl. 1-11 (2010).
14. M. Spadini, *A note on topological methods for a class of Differential-Algebraic Equations.* Nonlinear Anal., Theory Methods Appl., Ser. A, Theory Methods **73**, No. 4,

1065-1076 (2010).

15. M. Furi – M. Spadini, *Periodic perturbations with delay of autonomous differential equations on manifolds*. Advanced Nonlinear Studies, 9 (2009), no. 2, 263–276.
16. M. Lewicka – M. Spadini, *Branches of forced oscillations in degenerate systems of second order ODEs*. Nonlinear Analysis, 68 (2008) 2623-2628.
17. F. Colonius – R. Fabbri – R. Johnson – M. Spadini, *Bifurcation phenomena in control flows*; Topol. Methods Nonlin. Anal., 30, 2007, pp. 87-111.
18. F. Colonius – M. Spadini, *Fundamental semigroups for dynamical systems*. Discrete and Continuous Dynamical Systems **14** (2006), 447–463.
19. F. Colonius – L. San Martin – M. Spadini, *Fundamental semigroups for local control sets*. Annali di Matematica pura ed Applicata (4) 185 (2006), suppl., S69–S91.
20. M. Spadini, *Branches of harmonic solutions to periodically perturbed coupled differential equations on manifolds*. Discrete Contin. Dyn. Syst. **15** (2006), no. 3, 951–964.
21. M. Furi – M. P. Pera – M. Spadini, *On the uniqueness of the fixed point index on differentiable manifolds*. Fixed point theory and applications (2004) n.4 251–259.
22. P. Benevieri – M. Furi – M. P. Pera – M. Spadini, *About the sign of oriented Fredholm operators between Banach spaces*. Zeitschrift für Analysis und ihre Anwendungen **22** (2003) n.3, 619–654.
23. F. Colonius – M. Spadini, *Uniqueness of local Control Sets*. Journal of Dynamical and Control systems **9** (2003) n.4, 513–530.
24. M. Spadini, *Harmonic solutions to perturbations of periodic separated variables ODEs on manifolds*, Electronic Journal of Differential Equations **2003** (2003) n.88, 1–11.
25. M. Lewicka – M. Spadini, *A remark on the genericity of the multiplicity results for forced oscillations on manifolds*. Annali di Matematica Pura ed Applicata **181** (2002), 85–94.
26. M. Furi – M. P. Pera – M. Spadini, *Multiplicity of forced oscillations on manifolds and applications to motion problems with one-dimensional constraints*. Set-Valued Analysis **9** (2001), 67–73.
27. M. Furi – M. P. Pera – M. Spadini, *Multiplicity of forced oscillations for scalar differential equations*. Electron. Journal of Diff. Eqns., **2001** (2001), n.36, 1–9.
28. M. Furi – M. P. Pera – M. Spadini, *Forced oscillations on manifolds and multiplicity results for periodically perturbed autonomous systems*. Journal of computational and applied mathematics, **113** (2000), 241–254.
29. M. Spadini, *Harmonic solutions of periodic Carathéodory perturbations of autonomous ODEs on manifolds* - Nonlinear Analysis tma, **41a** (2000), 477–487.
30. M. Furi – M. Spadini, *Branches of forced oscillations for periodically perturbed autonomous second order ODEs on manifolds*. Journal of Differential Equations, **154** (1999), 96–106.
31. M. Lewicka – M. Spadini, *On the genericity of the multiplicity results for forced oscillations on compact manifolds*. NoDEA, **6** n.4 (1999), 357-369.
32. M. Furi – M. Spadini, *Multiplicity of forced oscillations for the spherical pendulum*. Topological methods in nonlinear analysis **11** n. 1 (1998), 147–157.
33. M. Furi – M. Spadini, *On the set of harmonic solutions of periodically perturbed autonomous differential equations on manifolds*. Nonlinear Analysis tma **29** (1997), 963–970.
34. M. Furi – M. Spadini, *On the Fixed Point Index of the Flow and Applications to Periodic Solutions of Differential Equations on Manifolds*. Bollettino U.M.I. vol. X-A N.2 (1996), 333–346.

Refereed chapters of books and proceedings

35. L. Poggiolini – M. Spadini, *Sufficient optimality conditions for a bang-bang trajectory in a Bolza Problem.* In *Mathematical Control Theory and Finance*, A. Sarychev, A. Shiryaev, M. Guerra, M. R. Grossinho Editors, Springer 2008.
36. M. Furi – M. P. Pera – M. Spadini, *The fixed point index of the Poincaré translation operator on differentiable manifolds.* Handbook of topological fixed point theory, R.F. Brown, M. Furi, L. Górniewicz, and B. Jiang Editors, Springer-Verlag, The Netherlands, 2005.
37. F. Colonius – M. Spadini, *A dynamic Index for control sets.* Nonlinear Analysis and Applications: To V. Lakshmikantham on his 80th birthday, Vol. 1, R. P. Agarwal, D. O'Regan Eds., Kluwer Academic Publishers, Dordrecht; Boston (2003).
38. F. Colonius – M. Spadini, *On the classification of control sets.* "Dynamics, Bifurcation and Control", F. Colonius, L. Grüne eds., Lecture notes in Control and Information Sciences, n.273, Springer-Verlag 2002.
39. F. Colonius – M. Spadini, *Uniqueness of Control Sets for Perturbations of Linear Systems.* "Stability and Stabilization of Nonlinear System", D. Aeyels, F. Lamnabhi-Lagarrigue, A. J. van der Schaft, Eds.; Lectures Notes in Control and Information Sciences, n.246, Springer Verlag, 1999.

Further publications and contributions

40. L. Poggiolini – M. Spadini, *Bang–bang trajectories with a double switching time: sufficient strong local optimality conditions.* arXiv:1010.1149v1 [math.OC], 2011.
41. P. Benevieri, M. Furi, M. P. Pera, M. Spadini *An introduction to topological degree in Euclidean spaces*, Università di Firenze, Dipartimento di Matematica Applicata, memoria n. 42, Gennaio 2003.
42. M. Spadini, *Perturbazioni periodiche di equazioni differenziali ordinarie su varietà differenziabili* (summary of Doctoral Thesis) - Boll. U.M.I. Vol. 1-A Suppl., (aprile 1998).
43. M. Furi (Notes by M. Spadini) *Second order differential equations on manifolds and forced oscillations*, Course delivered by M. Furi at Université de Montreal (1994). Published in *Topological methods in differential equations and inclusions* A. Granas M. Frigon Eds., Kluwer Acad. Publ. series C., vol. 472, 1995.

Theses

44. Tesi di Dottorato: *Perturbazioni periodiche di equazioni differenziali ordinarie su varietà differenziabili.* Università di Firenze, 1997.
45. Tesi di Laurea: *La teoria dell'indice di punto fisso dal punto di vista della topologia differenziale.* Università di Firenze, 1992.

Teaching aids

46. L. Poggiolini – M. Spadini, *Esercizi di Analisi Matematica II.* Progetto Leonardo, ed. Esculapio, Bologna (2013). ISBN: 9788874886302
47. F. Mugelli – M. Spadini, *Metodi Matematici per l'Ingegneria.* Progetto Leonardo, ed. Esculapio, Bologna (2013). ISBN: 9788874885794.
48. M. Spadini *Raccolta di esercizi di Analisi Matematica II.* Collection of exercises of Analysis II. Università di Firenze, 2008. Available online:
`http://www.dma.unifi.it/~spadini/archivio/didattica/esercizi.pdf`
49. M. Spadini *Note del corso di Metodi Matematici.* Notes of the course of Mathematical Methods for the students of Environmental Engineering. Università di Firenze, Dipartimento di Matematica Applicata, memoria n. 41, Jan. 2003. Available online:
`http://www.dma.unifi.it/~spadini/archivio/didattica/appunti/appunti.pdf`

Software:

50. M. Spadini, *Degree Calculator v. 1.5.01*, Free Software, available online through: `http://www.dma.unifi.it/~spadini/Software`

Firenze, June 30, 2015 M. Spadini