CURRICULUM VITAE

Personal Information

Name	Rachid Touzani
	Married, 2 children
Birth	February 1st 1955, Kénitra (Morocco)
Office Address	Université Clermont Auvergne
	Laboratoire de Mathématiques Blaise Pascal
	63000 Clermont-Ferrand, France
	e-mail: `rachid.touzani@gmail.com`
Current Situation	Professor Emeritus at the Université Clermont Auvergne.

Professional degrees

1976 – 1978	Master in Mathematics at the University of Besançon (France).
1979 – 1981	PhD Thesis (French) at the University of Besançon, France.
1985 – 1988	PhD Thesis (Swiss) at the Swiss Federal Institute of Technology, Lausanne, Switzerland.

Positions

1982 – 1985	Research Assistant at the Department of Civil Engineering.
	Swiss Federal School of Engineering, Lausanne, Switzerland.
1985 – 1988	Research Assistant at the Department of Mathematics
	Swiss Federal School of Engineering, Lausanne, Switzerland.
1988 – 1992	Senior Researcher at the Department of Mathematics
	Swiss Federal School of Engineering, Lausanne, Switzerland.
1992 – 2022	Professor of Applied Mathematics at the Blaise Pascal University, now Université Clermont Auvergne, France.
Since September 2022	Professor Emeritus of Applied Mathematics at the Université Clermont Auvergne, France.

Teaching

1981 – 1982	Undergraduate courses in Numerical Analysis at the University of Besançon (France).
1984 – 1992	Undergraduate courses in Vector Analysis and Numerical Analysis at the Swiss Federal School of Technology (Lausanne, Switzerland).
1992 – 1994	Graduate courses in Numerical Analysis of Partial Differential Equations at the Blaise Pascal University, (Clermont–Ferrand, France)
	Graduate courses in Numerical methods in optimization at the Mechanics Engineering School (IFMA) of Clermont–Ferrand, France.
1994 – Present	Undergraduate courses in Lebesgue Integration at the Engineering School of Clermont–Ferrand, Department of Mathematical Engineering.
	Graduate courses in Mathematical and Numerical Analysis of Partial Differential Equations at the Engineering School of Clermont–Ferrand, Department of Mathematical Engineering.
	Postgraduate courses in Numerical methods and scientific computing at the Blaise Pascal University.
	Postgraduate courses in Optimization in engineering at the Swiss Federal Institute of Technology (Lausanne, Switzerland).
	Postgraduate courses in Object oriented programming of the finite element method (École des Mines, Sophia Antipolis, France).

Research

○ Mathematical analysis and implementation of a numerical method to solve heat conduction problems involving a free boundary: Doctorat Thesis (Old french thesis), Advisor: Prof. Pierre Lesaint, University of Besançon, France. This work has been accomplished from 1979 to 1982.

○ Implementation of a finite element code simulating two and three dimensional incompressible fluid flow taking into account thermal diffusion and convection effects (Boussinesq equation).
This research was realized at the Civil Engineering Department at the Swiss Federal School of Engineering, Lausanne, Switzerland from 1982 to 1985, and has consisted in simulating heat island phenomena involved in environment modelling.

○ Derivation of a new Discontinuous Galerkin method to solve three-dimensional boundary layer equations for incompressible fluid flow. Mathematical analysis of the method and computer implementation. Derivation of an element numbering algorithm to follow inflow for the Discontinuous Galerkin method.
This research was realized in the Department of Mathematics of the EPFL and was my PhD thesis work between 1985 and 1988. Advisor: Dr. Philippe Caussignac.

○ I have worked on mathematical modelling and numerical solution of a large scale industrial problem consisting in simulating electromagnetic casting of Aluminium. This problem

involves multiphenomena (electromagnetism, hydrodynamics, two-phase heat transfer, free boundary).

This work was realized, from 1988 to 1990, in the framework of research project granted by the company *Alusuisse*, Currently *Rio Tinto*. In this project, I have managed computer implementation of the chosen numerical method. In addition, I have worked on theoretical aspects of mathematical and numerical analysis of the mathematical model, in collaboration with Jacques Rappaz.

○ I have managed, from 1990 to 1993, with the Swiss Army, a research project on numerical simulation of absorption processes of chemical species by activated Carbon beds. For this, I have developed a numerical scheme to solve the problem (A hyperbolic system of semilinear equations).

○ I have managed, from May 1991 to September 1992, a research project, supported by Swiss Energy Foundation (NEFF) and the *Amysa* Yverdon company. This project consisted in numerical simulation of induction heating processes taking account for ferromagnetic effects.

○ I have worked on the mathematical justification of electromagnetic models in the presence of thin conductors. This work consists in obtaining, by asymptotical techniques simplified mathematical models having better approximability properties than Maxwell's equations. In particular, they enable coupling Maxwell equations with Kirchhoff circuit differential equations. This work was achieved in collaboration with Y. Amirat at the Blaise Pascal University (Currently *Université Clermont Auvergne*).

○ I have developed and implemented a C++ library for solving Partial Differential Equations by the Finite Element Method. This library (called *OFELI* as Object Finite Element LIbrary) is under the GNU Lesser General Public License and is available in the *Github* server.

○ I have managed, from 1998 to 2003, a research project with the *Michelin* company on adaptive finite element methods for elasticity problems with unilateral contact.

○ In collaboration with Thierry Dubois (Assistant Professor), I am currently working on the development of stabilized finite element methods for the space discretization of incompressible Navier-Stokes equations, coupled with projection schemes for time discretization. In this domain, we also work on numerical simulation of transition to turbulence in a thermal flow governed by the Boussinesq equations. An article is being written for the presentation of the obtained results.

○ I have worked from 2002 to 2017 on numerical approximation of free boundary problems using level set formulations. These formulations enable calculating front evolution with topology change. In particular, numerical simulation of free boundaries involve transmission problems for which classical finite element approximation give poor accuracy. We are working on the remedy to this difficulty by developing some particular finite element methods (or *immersed* interface methods) where enrichment of the finite element space enable taking into account the singularity due to the interface.

This work is realized in collaboration with F. Bouchon, S. Clain, (Blaise Pascal University), G. Peichl and K. Kunisch (University of Graz, Austria) and P. Gremaud, C. Kuster, *PhD student* (North Carolina State University, USA).

○ I have developed, since 1998, a library of classes in C++, that implements the finite element method for the numerical solution of various partial differential equations. This library is available under the LGPL license (Gnu Lesser General Public License) on the website `ofeli.org`. Since its installation, this library have had several thousands of downloads.

○ I have started, since 2009, started working on the mathematical modelling and numerical simulation of inductively coupled plasma torches. The modelling involves coupling of compressible Navier-Stokes and eddy current equations. With S. Clain and D. Rochette we have developed a numerical code for this purpose.

○ I have worked, between 2011 and 2015, as a consultant for the company LEAP Energy in Malaysia on the development of software, using the library OFELI, for the numerical simulation of fluid flow in reservoir engineering.

PhD students

○ Stéphane Clain: *Mathematical and numerical analysis of an induction heating model*, May 1994.
S. Clain was Assistant Professor in Clermont–Ferrand from 1998 to 2005 and is Professor at the University of Toulouse since 2005.

○ Pierre Béal: *Modelling of contact between elastic rods with large displacements*. January 1998.
P. Béal is the manager, since 2000, of the company *Numtech* that develops software for numerical simulation in atmospheric processes (`www.numtech.fr`).

○ Jean-Roch Julien: *Alternating Direction schemes for compressible fluid flow using structured meshes.*
J.-R. Julien is currently Software engineer in the Bosch company, Lyon, France.

○ Séverine Gauthier: *Numerical solution of three-dimensional eddy current problems*. September 1998.
S. Gauthier is a software engineer in the Michelin company.

○ Sébastien Zimmermann: *A finite volume scheme with projection for time dependent Stokes equations*. February 2006.
S. Zimmermann is currently teacher of Mathematics in a High School in France.

○ Malcom Djenno: *New numerical methods for the Stokes and Level Set Equations*. December 2007.
M. Djenno is Assistant Professor in the Masuku University, Franceville, Gabon.

Administration Activity

Local:

- Head of the Department of Mathematical Engineering and Modelling at the Engineering School of the Blaise Pascal University (1999 – 2009).

- Member of the board of the Blaise Pascal University (1994–2007 and 2008–2012).

- Member of the Editorial Board of the journal *Annales Mathématiques Blaise Pascal* (Since 1998).

- Head of the group *Partial Differential Equations and Numerical Analysis* of the Laboratory of Mathematics of the Blaise Pascal University (6 professors, 9 assistant professors) (2010–2015).

National and international:

- Vice President of the GAMNI (Groupe pour l'Avancement des Méthodes Numériques de l'Ingénieur) (2000 – 2010).

- Member of the Council of the French *Société de Mathématiques Appliquées et Industrielles* (2004 – 2009).

- Member of the Council of the Moroccan *Société Marocaine de Mathématiques Appliquées*.

- Member of the French National Council of Universities (2007–2012).

- Expert at the French Agency of Evaluation for the evaluation of research institutions (2008–2009).

- Member of the jury of more than 40 PhD theses.

Invitations and Seminars

- Talks in seminars of universities of Besançon (France), Nancy (France), Clermont–Ferrand, Maryland (USA), École Polytechnique (France), Lisbon (Portugal), Laval University (Canada), Toulouse (France), Rennes (France), Rabat (Morocco), Kénitra (Morocco), Raleigh (NC, USA), Brighton (UK).

- Visiting Professor at the University of Rennes (April–May 1990).

- Invited speaker (plenary session) at the conference: "Metallurgical Fluid Flows", Lulea University, Sweden (June 1990).

- Visiting Professor at the University of Rabat, Morocco (March 1991 and December 1991).

- Invited speaker (plenary session) at the IFIP Conference, Rabat, Morocco (December 1993).

- Visiting Professor at the École Polytechnique Fédérale de Lausanne, Switzerland (July 1995).

- Visiting Professor at the University of Lisbon, Portugal (May 1996).

- Invited speaker (Minisymposium) at the 2nd World Conference of Nonlinear Analysts, (Athens, Greece (July 1996).

- Visiting Professor at the Laval University, Canada (June 1997).

- Invited speaker (Minisymposium) at SIAM Annual Meeting (Toronto, July 1998).

- Visiting Professor at the École Polytechnique Fédérale de Lausanne, Switzerland (November 1998).

- Invited speaker (Minisymposium) at the SIAM Annual Meeting (Toronto, July 1998).

- Invited speaker (Minisymposium) at the 4-th World Conference of Nonlinear Analysts, Catania, Italia (July 2000).

- Invited speaker (Minisymposium) at the 5-th World Congress of Computational Mechanics, (Vienna, Austria, July 2002).

- Visiting Professor at the École Polytechnique Fédérale de Lausanne, Switzerland (April and October 2002).

- Invited speaker (plenary session) at the International Conference on Applied Mathematics for Industry and Physics, El Jadida, Morocco (April 2004).

- Invited speaker (plenary session) at the Second Workshop on Numerical Methods Evolution Equations, Crete, September 2004.

- Visiting Professor at the University of Graz, Austria (July 2004 and July 2005).

- Visiting Professor at the North Carolina State University, Raleigh, NC, USA (October 2004).

- Invited speaker (plenary session) at the Eighth Workshop on Numerical Analysis and Optimization, Rabat, Morocco (December 2005).

- Visiting Professor at the North Carolina State University at Raleigh, NC, USA (March 2006).

- Invited speaker to Applied Mathematics Workshop, Metz, France (April 2006).

- Visiting Professor at the École Polytechnique Fédérale de Lausanne, Switzerland (May–July 2006).

- Visiting Professor at the University of Graz, Austria (April 2006 and June 2007).

- Invited speaker at the Conference on the honour of the 60-th birthday of J. Rappaz, Lausanne, Switzerland (September 2007).

- Invited professor at the *École Nationale d'Ingénieurs de Tunis* (March 2009).

- Invited speaker to the Workshop on Discretization methods for viscous flows: 22–26 june 2009, Porquerolles, France (June 2009).

- Invited speaker to the Fifth Workshop on Numerical Methods on Evolution Equations, Crete (September 2010).

○ Invited speaker to the FEMTEC: 3rd International Conference on Computational Methods in Engineering and Science (May 9–13, 2011), Reno, Nevada, USA.

○ Invited speaker to the MAAM Conference: Mathematical Analysis with Applications in Mechanics (September 6–3, 2017), Perpignan, France.

Publications

PhD Theses

[1] Rachid Touzani. *Éléments finis pour le problème de Stefan*. PhD thesis, Université de Franche Comté, Besançon, France, 1981.

[2] Rachid Touzani. *Résolution numérique des équations de la couche limite tridimensionnelle par la méthode des éléments finis discontinus*. PhD thesis, École Polytechnique Fédérale de Lausanne, Switzeland, 1988.

Textbooks

[3] R. Touzani, editor. *Finite Elements and Symmetry*. MDPI, 2020.

[4] R. Touzani and J. Rappaz. *Mathematical Models for Eddy Currents and Magnetostatics. With Selected Applications*. Scientific Computation. Springer, Dodrecht, 2013.

Articles

[5] R. Touzani. Finite element computation of pollutant transport in thermally stratified flows. *Boundary-Layer Meteorology*, 41:279–285, 1987.

[6] R. Touzani. Numerical computation of three-dimensional turbulent boundary layers for the infinite swept wing. *ZAMP*, 38:741–757, 1987.

[7] P. Caussignac and R. Touzani. Linear conforming and nonconforming upwind finite elements for the convection-diffusion equation. *IMA J. Numer. Anal.*, 8:85–103, 1988.

[8] R. Touzani. Implementation of the discontinuous finite element method for hyperbolic equations. *Comp. Methods Appl. Mech. Eng.*, 68:115–123, 1988.

[9] P. Lesaint and R. Touzani. Approximation of the heat equation in a variable domain with application to the Stefan problem. *SIAM J. Numer. Anal.*, 26(2):366–379, 1989.

[10] O. Besson, M.R. Laydi, and R. Touzani. Un modèle asymptotique en océanographie. *C.R. Acad. Sci.*, Série I, t. 310 I:661–665, 1990.

[11] P. Caussignac and R. Touzani. Numerical solution of three-dimensional boundary layer equations by a discontinuous finite element method. Part I: Numerical analysis of linear model problem. *Comp. Methods Appl. Mech. Eng.*, 78:249–271, 1990.

[12] P. Caussignac and R. Touzani. Numerical solution of three-dimensional boundary layer equations by a discontinuous finite element method. Part II: Implementation and numerical results. *Comp. Methods Appl. Mech. Eng.*, 78:1–20, 1990.

[13] O. Besson, J. Bourgeois, P.-A. Chevalier, J. Rappaz, and R. Touzani. Numerical modelling of electromagnetic casting processes. *J. Comp. Phys.*, 92(2):482–507, 1991.

[14] J. Rappaz and R. Touzani. Modelling of a two-dimensional magnetohydrodynamic problem. *Eur. J. Mech. B/ Fluids*, 10(5):482–507, 1991.

[15] P. Laduguie, A. Lavanchy, and R. Touzani. Study of a simple model for chemical adsorption by active carbon beds. *Math. Eng. Ind.*, 3(4):247–264, 1992.

[16] J. Rappaz and R. Touzani. On a two-dimensional magnetohydrodynamic problem, I: Modelling and analysis. *M^2AN*, 26(2):347–364, 1992.

[17] S. Clain, J. Rappaz, M. Swierkosz, and R. Touzani. Numerical modelling of induction heating for 2-D geometries. *M^3AS*, 3(6):805–822, 1993.

[18] C. Chaboudez, S. Clain, R. Glardon, J. Rappaz, M. Swierkosz, and R. Touzani. Numerical modelling in induction heating of long workpieces. *IEEE Trans. Mag.*, 30(6):5028–5037, 1994.

[19] A. Nouailler, M. Sofonea, and R. Touzani. Sur l'existence et l'approximation numérique de la solution pour un problème de contact élastique. *Acta Technica Napocensis*, 1(37):37–46, 1994.

[20] R. Touzani. Un problème de courant de Foucault avec inducteur filiforme. *C.R. Acad. Sci.*, t. 319, Série I:771–776, 1994.

[21] J. Rappaz and R. Touzani. On a two-dimensional magnetohydrodynamic problem, II: Numerical analysis. *M^2AN*, 30(2):215–235, 1996.

[22] R. Touzani. Analysis of an eddy current problem involving a thin inductor. *Comp. Methods Appl. Mech. Eng.*, 131:233–240, 1996.

[23] S. Clain and R. Touzani. Solution of a two-dimensional stationary induction heating problem without boundedness of the coefficients. *M^2AN*, 31(7):845–870, 1997.

[24] S. Clain and R. Touzani. A two-dimensional stationary induction heating problem. *Math. Meth. Appl. Sci.*, 20:759–766, 1997.

[25] Y. Amirat and R. Touzani. Self-inductance coefficient for toroidal thin conductors. *Nonlinear Analysis, TMA.*, 47:3295–3305, 2001.

[26] O. Bodart, A.-V. Boureau, and R. Touzani. Numerical investigation of optimal control of induction heating processes. *Applied Mathematical Modelling*, 25:697–712, 2001.

[27] M. Shillor, M. Sofonea, and R. Touzani. Quasistatic frictional contact and wear of a beam. *Discrete and Continuous Dynamic and Impulsive Systems*, 8(2):201–218, 2001.

[28] Y. Amirat and R. Touzani. Asymptotic behaviour of the inductance coefficient for thin conductors. *Math. Models Meth. Appl. Sci.*, 12(2):273–289, 2002.

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[30] P. Béal and R. Touzani. Analysis of contact of elastic rods subject to large displacements. *Applied Mathematics Letters*, 16:619–625, 2003.

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[32] A. Masserey, J. Rappaz, R. Rozsnyo, and R. Touzani. Power formulation for the optimal control of an industrial induction heating process for thixoforming. *International Journal of Applied Electromagnetics and Mechanics*, 19:51–56, 2004.

[33] F. Bouchon, S. Clain, and R. Touzani. Numerical solution of the free boundary Bernoulli problem using a level set formulation. *Comp. Methods Appl. Mech. Eng.*, 194(36–38):3934–3948, 2005.

[34] C.M. Kuster, P. Gremaud, and R. Touzani. Fast numerical methods for Bernoulli free boundary problems. *SIAM J. Sci. Comput.*, 29(2):622–634, 2007.

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[36] Y. Amirat and R. Touzani. A two-dimensional eddy current model using thin inductors. *Asymptotic Analysis*, 58(3):171–188, 2008.

[37] F. Bouchon, S. Clain, and R. Touzani. A perturbation method for the numerical solution of the Bernoulli problem. *Journal of Computational Mathematics*, 26(1):23–36, 2008.

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[39] T. Dubois and R. Touzani. A numerical study of heat island flows in an open domain: Stationary solutions. *Int. J. Numer. Meth. Fluids*, 56(6):631–655, 2009.

[40] P. André, J. Aubreton, S. Clain, M. Dudeck, E. Duffour, M.F. Elchinger, B. Izrar, D. Rochette, R. Touzani, and D. Vacher. Transport coefficients in thermal plasma. Applications to Mars and Titan atmospheres. *Eur. Phys. J. D*, 57:227–234, 2010.

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[50] N. Bachelard, J. Arlandis, C. Garay, R. Touzani, and P. Sebbah. Coalescence of Anderson-localized modes at exceptional points in 2D random media. *Optics Express*, 2022.

Conference Proceedings

[51] S. Clain, M. Swierkosz, and R. Touzani. Numerical simulation of induction heating processes. In O.C. Zienkiewicz F. Oñate Ch. Hirsh, editor, *Proceedings of the First European Conference on Numerical Methods in Engineering*. Brussels, 1992.

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International Conferences

[55] J. Bourgeois, P.-A. Chevalier, and R. Touzani. A numerical model for electromagnetic casters. In *Fourth ECMI Meeting on Industrial Mathematics*. St. Wolfgang, Austria, 1989.

[56] P. Caussignac and R. Touzani. A discontinuous finite element method for heat transfer in a three-dimensional boundary layer. In *International Symposium on Numerical Methods in Engineering*. Lausanne, Switzerland, 1989.

[57] P. Caussignac and R. Touzani. A finite element method for three-dimensional boundary layer equations. In *Seventh International Conference on Finite Element Methods in Flow Problems, Huntsville, Alabama, USA*, 1989.

[58] A. Lavanchy, R. Touzani, and M. Stöckli. Numerical simulation of dynamic physisorption on activated carbon beds. In *20th Biennal Conference on Carbon ACS*. Univ. of California at Santa Barbara, USA, 1991.

[59] J. Bourgeois, P.-A. Chevalier, M. Picasso, J. Rappaz, and R. Touzani. An MHD problem in the aluminium industry. In Hemisphere ed., editor, *Proc. 7-th International Conference on Finite Elements in Flow Problems*. Huntsville, Alabama, USA, 1992.

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[61] J. Rappaz and R. Touzani. Numerical simulation of solidification processes in EMC. In *International Symposium on MHD in Process Metallurgy*. San Diego, USA, 1992.

[62] S. Clain and R. Touzani. Solution for a two-dimensional stationary induction heating problem without bounding conditions on the physical properties. In *Proc. of the 2nd Conference on Elliptic and Parabolic Operators*. Pont-à-Mousson, France, 1994.

[63] J. Rappaz and R. Touzani. Modelling, analysis and numerical analysis of a two-dimensional MHD problem. In *SIAM Annual Meeting*. Charlotte, NC, USA, 1995.

[64] R. Touzani. Eddy current problems with thin inductors. In *SIAM Annual Meeting*. Charlotte, NC, USA, 1995.

[65] O. Bodart, A.-V. Boureau, and R. Touzani. Optimal control of induction heating. In *Journées Numériques de Besançon*. Besançon, France, 1996.

[66] J. Rappaz and R. Touzani. Mathematical and numerical problems in incompressible magneto-hydrodynamics. In *Second World Congress of Nonlinear Analysts*. Athens, Greece, 1996.

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[68] O. Bodart and R. Touzani. Optimal control problems in electromagnetic processess. In *SIAM Annual Meeting*. Toronto, Canada, 1998.

[69] P. Béal, J. Koko, and R. Touzani. A mesh optimization procedure for obstacle problems. In *CIMASI'2000 Conference*. Casablanca, Morocco, 2000.

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[71] F. Bouchon, G. Peichl, and R. Touzani. Numerical solution of the free boundary Bernoulli problem. In *ICIAM Conference*. Zürich, Switzerland, 2007.

[72] M. Hassine, A. Kooli, and R. Touzani. A level set method for the shape optimization problem in induction heating. In *ICIAM Conference*. Zürich, Switzerland, 2007.

[73] D. Rochette, W. Bussière, R. Touzani, S. Memiaghe, G. Velleaud, and P. André. Modelling of the pre-arcing period in hbc fuses including solid-liquid-vapor phase changes of the fuse element. In *8th International Conference on Electric Fuses and their Applications*. Clermont-Ferrand, France, 2007.

[74] P. André, S. Clain, M. Dudeck, B. Izrar, D. Rochette, R. Touzani, and D. Vacher. First step in theoretical approach in study of mars and titan atmospheres with an inductively coupled plasma torch. In *Radiation of High Temperature Gases in Atmospheric Entry*. Heraklion, Greece, 2008.

[75] S. Clain, R. Touzani, M. Lino Da Silva, D. Vacher, and P. André. A contribution on the numerical simulation of ICP torches. In *Fifth European Conference on Computational Fluid Dynamics, ECCOMAS CFD*. Lisbon, Portugal, 2010.

[76] R. Touzani. OFELI: An object-oriented finite element library. In *FEMTEC 2011: 3rd International Conference on Finite Element Methods in Engineering and Science*, South Lake Tahoe, Nevada, USA, May 2011.

[77] R. Touzani and L. Alessio. Finite element simulation of coal-bed methane reservoirs. In *6th International Conference on Approximation Methods and Numerical Modeling in Environment and Natural Resources*. Pau, France, June 2015.

[78] R. Touzani. A mathematical derivation of a circuit equation as a limit of eddy current equations. In *Numerical Analysis and Computational Methods in Mechanics*, Perpignan, France, September 2017.

[79] R. Touzani. Mathematical modelling and numerical simulation of two-phase fluid flow in porous media with adsorption. In *Emerging Trends in Applied Mathematics and Mechanics*, Krakow, Poland, 2018.

[80] R. Touzani and Y. Amirat. Derivation of mathematical models for eddy current systems with thin inductors. In *Emerging Trends in Applied Mathematics and Mechanics*, Krakow, Poland, 2018.

[81] Sebbah P., Bachelard N., Kumar B., and Touzani R. Coupling and coalescence of localized modes near an exceptional point in passive and active disordered media. In *META 2019, the 10th International Conference on Metamaterials, Photonic Crystals and Plasmonics*, July 2019.

R. Touzani

October 3, 2024