Scientific Report 2006

Control Theory Group (cotg)
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February 2007

Members of the Control Theory Group

- **Senior Researchers**

  1. Delfim F. M. Torres (cotg Coordinator, Public Key J001957OH25)
  2. Eugénio Rocha
  3. Manuel Guerra (Public Key J02465926JU)
  4. Moulay Rchid Sidi Ammi (Post-Doc, Public Key J021763HKS7)
  5. Olena V. Mul (Post-Doc, Public Key J045337A9HD)

- **PhD Students**

  1. Cristiana J. Silva (Public Key J003420E03G)
  2. Gastão S. F. Frederico (Public Key J091910K19A)
  3. Paulo D. F. Gouveia (Public Key J010525EG62)

- **MSc Students**

  1. Célia Teresa Ligeiro Mendes Pereira

Activities done during 2006

Manuel Guerra has considered the problem of minimizing a quadratic noncoercive functional along the trajectories of a control-affine system. Due to lack of coercivity, existence of "classical"minimizers cannot, in general, be guaranteed. Under appropriate commutativity assumptions the problem can be extended into the space of generalized controls of class $W_{-1,\infty}$ and reduced into a new problem which is generically coercive but nonconvex. It was shown how to extend further the problem in order to include generalized controls which are "generalized derivatives of one-parameter families of regular probability measures", thus achieving convexification. Generalized trajectories for this type of controls exist only in a weak sense. A geometric formulation of Pontryagin maximum principle for the extended problem was given. This gives a geometric

characterization of the limit trajectories approximated by minimizing sequences of the original problem.

An open problem has been suggested by Yu. Orlov for a recently published volume "Unsolved Problems in Mathematical Systems and Control Theory", V.D. Blondel & A. Megretski (eds), Princeton Univ. Press, 2004. The problem regards possible approaches to regularization of control-affine optimal control problems which may admit 'cheap (generalized) controls' as minimizers. It was shown by M. Guerra and A. Sarychev that Orlov's conjecture admits, in general, a positive answer, independently of commutativity assumptions for the controlled fields and other issues typically involved in the study of generalized controls. An index to measure the "singular behavior"of minimizing sequences for control-affine optimal control problems was proposed. It is shown that, in the particular case of singular linear-quadratic problems, this index is tightly related to the "order of singularity"of the problem. A partial result for the commutative nonlinear case was obtained. Some new open problems were posed.

In cooperation with Maria de Lourdes Centeno (Universidade Técnica de Lisboa/ISEG), M. Guerra studied the optimal form of reinsurance from the ceding company point of view, when the cedent seeks to maximize the adjustment coefficient of the retained risk. The problem was studied by exploring the relationship between maximizing the adjustment coefficient and maximizing the expected utility of wealth for the exponential utility function, both with respect to the retained risk of the insurer. Assuming that the premium calculation principle is a convex functional and that some other quite general conditions are fulfilled, existence and uniqueness of solutions was proved, together with a necessary optimality condition. These results are used to find the optimal reinsurance policy when the reinsurance premium calculation principle is the expected value principle or the reinsurance loading is an increasing function of the variance. In the expected value case the optimal form of reinsurance is a stop loss contract. In the other cases, it is described by a nonlinear function.

Eugénio A. M. Rocha was Chairman of the Organizing Committee of the International Conference "Communicating Mathematics in the Digital Era"that took place in Aveiro, 15-18 August 2006, and which was a satellite conference of the International Congress of Mathematicians 2006. In this conference Eugénio presented a mathematical model that describes the publication process in Mathematics, defining an appropriate topology in the space of authors and publications.

In cooperation with Delfim F. M. Torres, a method to compute effective first integrals by combining Noether's principle with the Kozlov-Kolesnikov integrability theorem was obtained. A sufficient condition for the integrability by quadratures of optimal control problems with controls taking values on open sets was proved. We illustrated our approach on some problems taken from the literature. An alternative proof of the integrability of the sub-Riemannian nilpotent Lie group of type (2,3,5) was also given.

Paulo D. F. Gouveia, Delfim F. M. Torres and Eugénio A. M. Rocha used a computer algebra system to compute, in an efficient way, optimal control varia-

tional symmetries up to a gauge term. The symmetries were then used to obtain families of Noether's first integrals, possibly in the presence of nonconservative external forces. As an application, we obtained eight independent first integrals for the sub-Riemannian nilpotent problem (2,3,5,8).

Gastão S. F. Frederico and Delfim F. M. Torres extended Noether's theorem to dynamical optimal control systems being under the action of nonconservative forces. A systematic way of calculating conservation laws for nonconservative optimal control problems was given. As a corollary, the conserved quantities previously obtained in the literature for nonconservative problems of mechanics and the calculus of variations were derived.

Fractional (or non-integer) differentiation is an important concept both from theoretical and applicational points of view. The study of problems of the calculus of variations with fractional derivatives is a rather recent subject, the main result being the fractional necessary optimality condition of Euler-Lagrange obtained in 2002. The notion of Euler-Lagrange fractional extremal was used to prove a Noether-type theorem. For that a generalization of the classical concept of conservation law was proposed, by introducing an appropriate fractional operator. It was then obtained, following the Lagrange multiplier technique, a new version of Noether's theorem to fractional optimal control systems.

A Noether symmetry theorem to fractional action-like Riemann-Liouville variational functionals was also proved.

Moulay Rchid Sidi Ammi and Delfim F. M. Torres used a dual mesh numerical method to study a non-local parabolic problem arising from the thermistor problem. The thermistor problem and its variants have applications in several fields of physics and in industry.

A system of nonlinear partial differential equations resulting from the traditional modelling of oil engineering within the framework of the mechanics of a continuous medium was studied. Existence and regularity of the optimal solutions for this system were established, together with appropriate necessary optimality conditions.

Delfim F. M. Torres addressed with Agnieszka B. Malinowska, from the Institute of Mathematics & Physics of Bialystok Technology University, the problem of obtaining well-defined criteria for multiobjective optimal control systems. Necessary and sufficient conditions for an optimal control functional to be nonessential were proved. The results provide effective tools for determining nonessential objectives in vector-valued optimal control problems.

Optimal control problems are usually addressed with the help of the famous Pontryagin Maximum Principle (PMP) which gives a generalization of the classical Euler-Lagrange and Weierstrass necessary optimality conditions of the calculus of variations. Success in applying the PMP permits to obtain candidates for a local minimum. In 1967 a direct method, which permits to obtain global minimizers directly, without using necessary conditions, was introduced by Leitmann. Leitmann's approach is connected, as showed by Carlson in 2002, with "Caratheodory's royal road of the Calculus of variations". Cristiana J. Silva

and Delfim F. M. Torres proposed a related but different direct approach to problems of the calculus of variations and optimal control, which permit to obtain global minima directly, without recourse to needle variations and necessary conditions. The new method was inspired by the classical Noether's theorem and its recent extensions to optimal control. We have used the variational symmetries of the problem, considering parameter-invariance transformations and substituting the original problem by a parameter-family of optimal control problems. Parameters are then fixed in order to make the problem trivial, in some sense. Finally, by applying the inverse of the chosen invariance-transformation, we get the global minimizer for the original problem. The proposed method was illustrated, by solving concrete problems, and compared with Leitmann's approach.

Olena V. Mul has studied possible vibrations in a nonlinear dynamical system of controlled machine units with discrete parameters described by a system of ordinary differential equations of the fifth order with nonlinear boundary conditions. Ways to decrease the harmful effect of vibrations on normal functioning of the considered control system were obtained. For the investigations the averaging method was applied, which allowed to determine conditions of stability of both one-frequency stationary modes and biharmonic ones. Amplitudes of the vibrations, as well as the character of transient to the stationary modes, were obtained. Dependence of stationary modes on the different parameters of the system were analyzed.

In cooperation with Delfim F. M. Torres, Olena V. Mul studied the possibilities of using the method of normal fundamental systems for solving some problems of oscillation theory. Large elastic dynamical systems with continuous and discrete parameters were considered, which have many different engineering applications. Intensive oscillations in such systems are possible, but not desirable. Therefore, it is very important to obtain conditions for which oscillations take or not-take place. Mathematically, one needs to search for the solutions of partial differential equations satisfying both boundary and conjugation conditions. The obtained results permit to analyze the influence of different system parameters on oscillations as well as to compute the optimal feedback parameters for the active vibration control of the systems. Dynamics of the hybrid systems of aerial cable-ways were investigated. The eigenvalue problems were considered for such hybrid systems with different assumptions.

Several informal working meetings took place during 2006. The following researchers, with joint research interests with members of the cotg, visited the Department of Mathematics of the University of Aveiro during 2006: Inta Volodko, Department of Engineering Mathematics, Riga Technical University, Latvia, February 15-24, 2006; Agnieszka B. Malinowska, Institute of Mathematics & Physics, Bialystok Technology University, Bialystok, Poland, June 5-12, 2006; Andrey V. Sarychev, Università degli Studi di Firenze, Italy, October 25 to November 1, 2006; Ilona Dzenite, Department of Engineering Mathematics, Riga Technical University, Latvia, November 26 to December 06.

Output indicators

Number of Publications	**2006**
Books	0
Papers in international journals	11
Papers in national journals	0
Number of Communications	
in International Meetings	23
in National Meetings	6
Reports (including proceedings)	19
Organization of seminar and conferences	9
Advanced training	
number of PhD theses	0
number of Master theses	2
Computational Applications	1

List of publications

- **Articles in International Journals (including book chapters)**

1. Gela Chikadze, Nino Mchedlishvili, Valida Sesadze and Delfim F. M. Torres, Structural Stability of Nonlinear Dynamic Control Systems, Scientific Proceedings of Riga Technical University, 48th international thematic issue: Boundary Field Problems and Computer Simulation, series Computer Science, 2006 (in press).
2. Ilona A. Dzenite, Delfim F. M. Torres, A Remark on Noether's Theorem of Optimal Control, Int. J. Appl. Math. Stat., Vol. 4, No. J06, 2006, pp. 88-93.
3. Abderrahmane El Hachimi, Moulay Rchid Sidi Ammi, Delfim F. M. Torres, A dual mesh method for a non-local thermistor problem, SIGMA Symmetry Integrability Geom. Methods Appl. 2 (2006), Paper 058, 10 pp. (electronic); [Zbl: 1092.35512] [MR: 2240731]
4. R. A. El-Nabulsi, I. A. Dzenite, and Delfim F. M. Torres. Fractional action functional in classical and quantum field theory, Scientific Proceedings of Riga Technical University, 48th international thematic issue: Boundary Field Problems and Computer Simulation, series Computer Science, 2006 (in press).
5. Gastão S. F. Frederico, Delfim F. M. Torres. Constants of motion for fractional action-like variational problems, Int. J. of Applied Mathematics, Vol. 19, No. 1 2006, pp. 97–104. [MR: 2256417]
6. Paulo D. F. Gouveia, Delfim F. M. Torres and Eugénio A. M. Rocha, Symbolic Computation of Variational Symmetries in Optimal Control, Control & Cybernetics, Vol. 35 (2006) No. 4 (in press).

7. Olena V. Mul, Analysis of Vibrations in Discrete Parameter Machine Units, International Journal of Applied Mathematics & Statistics, Vol. 6, No. D06, December 2006, pp. 56-69.
8. Eugénio A. M. Rocha and Delfim F. M. Torres, Quadratures of Pontryagin Extremals for Optimal Control Problems, Control & Cybernetics, Vol. 35 (2006) No. 4 (in press).
9. Rui C. Rodrigues and Delfim F. M. Torres, Generalized splines in $\mathbb{R}^n$ and optimal control. Rend. Sem. Mat. Univ. Pol. Torino, Vol. 64 (2006) No.1, pp. 63–78. [MR: 2201074]
10. Cristiana J. Silva, Delfim F. M. Torres. Absolute Extrema of Invariant Optimal Control Problems, Commun. Appl. Anal. Vol. 10, No. 4, 2006 (in press).
11. Delfim F. M. Torres, A Noether Theorem on Unimprovable Conservation Laws for Vector-Valued Optimization Problems in Control Theory. Georgian Mathematical Journal, Vol. 13 (2006), No 1, pp. 173–182. [Zbl: 05056603] [MR: 2242336]

List of talks

- **Talks at International Conferences**

1. M. Lourdes Centeno and M. Guerra, The optimal reinsurance policy in terms of the adjustment coefficient criterion, 10th International Congress on Insurance: Mathematics and Economics, Lovaina, Bélgica, 18-20 de Julho, 2006.
2. Pedro A. F. Cruz and Delfim F. M. Torres, Evolution Strategies on Optimal Control – a numerical study, 5th Junior European Meeting on Control and Information Technology (JEM'06), Tallinn, Estonia, September 20-22, 2006 .
3. Paulo D. F. Gouveia, Delfim F. M. Torres, A Maple interface for computing variational symmetries in optimal control, poster presented by Paulo D. F. Gouveia at ICM 2006: International Congress of Mathematicians, Madrid, Spain, August 22-30, 2006.
4. M. Guerra, Generalized Synthesis for Singular Nonlinear Optimal Control Problems. International Symposium on Generalized Solutions in Control Problems. Ulan Ude, Russia, July 4-7, 2006.
5. M. Guerra and A. Sarychev, Approximation of generalized minimizers and regularization of optimal control problems. 3rd Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control (LHMNLC'06), Nagoya, Japan, July 19-21, 2006.
6. M. Guerra and A. Sarychev, Regularizations of optimal control problems for control-affine systems. 17th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2006), Kyoto, Japan, July 24-28, 2006.

7. Agnieszka B. Malinowska and Delfim F. M. Torres, Nonessential Functionals in Multiobjective Optimal Control Problems, 5th Junior European Meeting on Control and Information Technology (JEM'06), Tallinn, Estonia, September 20-22, 2006 .
8. Olena Mul, "Analysis of Some Hybrid Controlled Systems", INTAS Summer School on Nonlinear Analysis with Applications in Economics, Energy, and Transportation, Bergamo, Italy, June 5-9, 2006.
9. Olena Mul, "Some Applications of Partial Differential Equations For Analysis And Control of Hybrid Oscillation Systems"(poster), A Conference in Honor of Thomas I. Seidman "Advances in Control of Partial Differential Equations", Department of Mathematics and Statistics, University of Maryland, Baltimore County, USA, October 28 - 29, 2006.
10. Olena V. Mul and Delfim F. M. Torres, Dynamics of Controlled Hybrid Systems of Aerial Cable-Ways, The International Conference of Hybrid Systems and Applications, The University of Louisiana, Lafayette, LA, USA, May 22-26, 2006 .
11. Moulay Rchid Sidi Ammi, "Error estimates to a nonlocal parabolic problem"at ICM 2006: International Congress of Mathematicians, Madrid, Spain, August 22-30, 2006.
12. Moulay Rchid Sidi Ammi and Delfim. F. M. Torres, Regularity of Minimizers in the second-Order Calculus of Variations, 2nd Podlasie Conference of Mathematics (Druga Podlaska Konferencja Matematyczna), University of Mathematics and Applied Computer Science, Bialystok, Poland, April 2006.
13. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, Existence and uniqueness of solutions for a nonlocal parabolic thermistor-type problem, 13th IFAC Workshop on Control Applications of Optimisation, CAO'06, Paris - Cachan, France, 26-28 April 2006.
14. Moulay Rchid Sidi Ammi and Delfim. F. M. Torres, "Regularity of Minimizers in the second-Order Calculus of Variations", Conference "Views on ODEs"June 21-24, 2006 in honour of the Professors Arrigo Cellina and James A. Yorke on the occasion of their 65th birthday, Aveiro, Portugal.
15. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, A Dead oil isotherm optimal control problem (poster), A Conference in Honor of Thomas I. Seidman "Advances in Control of Partial Differential Equations", Department of Mathematics and Statistics, University of Maryland, Baltimore Country, USA, October 28 - 29, 2006.
16. Cristiana J. Silva and Delfim F. M. Torres, A new direct optimization method for problems of the calculus of variations and optimal control, Trends and Challenges in the Calculus of Variations and its Applications, Convento de Madre de Dios, Toledo, Spain, ICM Satellite Conference, August 16-19, 2006 .

17. Delfim F. M. Torres and Gastão S. F. Frederico, The Noether's Principle and Fractional Differentiation, 2nd Podlasie Conference of Mathematics (Druga Podlaska Konferencja Matematyczna) (invited talk), University of Mathematics and Applied Computer Science, Bialystok, Poland, April 2006.
18. Delfim F. M. Torres and Gastão S. F. Frederico, Nonconservative Noether's Theorem in Optimal Control, 13th IFAC Workshop on Control Applications of Optimisation (CAO'06), Paris - Cachan, France, April, 2006.
19. Delfim F. M. Torres and Gastão S. F. Frederico, Noether's theorem for fractional optimal control problems, Fractional Differentiation and its Applications (FDA'06), 19 - 21 July, 2006, Porto, Portugal .
20. Delfim F. M. Torres and Olena V. Mul, Some Applications of the Method of Normal Fundamental Functions to Oscillation Problems, MTNS 2006 – the 17th International Symposium on Mathematical Theory of Networks and Systems, July 24-28, 2006, Kyoto, Japan.
21. Delfim F. M. Torres and Moulay Rchid Sidi Ammi, Lipschitzian Regularity of Minimizers in the Higher-Order Calculus of Variations, 5th Junior European Meeting on Control and Information Technology(JEM'06), September 20-22, 2006, Tallinn, Estonia .
22. Delfim F. M. Torres and Cristiana Silva, Absolute Extrema of Invariant Optimal Control Problems, Third International Conference of Applied Mathematics, August 12-18, 2006, Plovdiv, Bulgaria.
23. Delfim F. M. Torres and Cristiana Silva, Direct Optimization of Invariant Optimal Control Problems, 5th Junior European Meeting on Control and Information Technology (JEM'06), September 20-22, 2006, Tallinn, Estonia .

- **Talks at National Meetings**

1. M. Guerra, Geometrical synthesis for noncoercive nonconvex optimal control problems. Proceedings of CONTROLO'2006, 7th Portuguese Conference on Automatic Control, IST 11-13 September 2006.
2. M. Guerra and Maria de Lourdes Centeno, Contratos de resseguro óptimos para uma seguradora que procura minimizar o risco de ruína, Encontro CEOC-UA e CIMA-UE, 12 e 13 de Junho de 2006, Departamento de Matemática, Universidade de Aveiro.
3. Olena V. Mul, Delfim F. M. Torres and Volodymyr P. Kravchenko, Problemas de valores próprios para alguns sistemas híbridos de controlo de teleféricos, Encontro CEOC-UA e CIMA-UE, 12 e 13 de Junho de 2006, Departamento de Matemática, Universidade de Aveiro.
4. Moulay Rchid Sidi Ammi, "Error estimates to a nonlocal parabolic problem", "Control, Optimization and Computation", CONTROLO

2006 - 7th Portuguese Conference on Automatic Control, Lisbon, 11–13 September 2006.

5. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, Regularity of solutions to variational problems with higher order derivatives, Encontro CEOC-UA e CIMA-UE, 12 e 13 de Junho de 2006, Departamento de Matemática, Universidade de Aveiro.
6. Delfim F. M. Torres and Moulay Rchid Sidi Ammi, Regularity of solutions to second-order integral functionals in variational calculus, Invited Session "Control, Optimization and Computation", CONTROLO 2006 – 7th Portuguese Conference on Automatic Control, Lisbon, 11–13 September 2006.

List of reports (including proceedings)

1. Pedro A. F. Cruz, Delfim F. M. Torres. Evolution Strategies on Optimal Control, Proc. 5th Junior European Meeting on Control & Information Technology (JEM'06), September 20-22, 2006, Tallinn, Estonia. Also available as Report no. CM06;I-44.
2. Abderrahmane El Hachimi, Moulay Rchid Sidi Ammi, Delfim F. M. Torres. Existence and uniqueness of solutions for a nonlocal parabolic thermistor-type problem, Proc. 13th IFAC Workshop on Control Applications of Optimisation (CAO'06), 26-28 April 2006, ENS de Cachan, Paris, pp. 407–411.
3. Gastão S. F. Frederico and Delfim F. M. Torres, Nonconservative Noether's Theorem in Optimal Control, Proc. 13th IFAC Workshop on Control Applications of Optimisation (CAO'06), 26-28 April 2006, ENS de Cachan, Paris, pp. 127-132.
4. Gastão S. F. Frederico, Delfim F. M. Torres. Noether's theorem for fractional optimal control problems, Proceedings of the 2nd IFAC Workshop on Fractional Differentiation and its Applications, 19-21 July 2006, Porto, pp. 142–147. Also available as Reports math.OC/0603598 and CM06/I-11.
5. Gastão S. F. Frederico, Delfim F. M. Torres, A Formulation of Noether's Theorem for Fractional Problems of the Calculus of Variations. Accepted to J. Math. Anal. Appl. (2007). Available as Reports math.OC/0701187 and CM06/I-04.
6. M. Guerra, Generalized Synthesis for Singular Nonlinear Optimal Control Problems. Proceedings of the International Symposium on Generalized Solutions in Control Problems. Ulan Ude, Russia, July 4-7, 2006.
7. M. Guerra, Geometrical synthesis for noncoercive nonconvex optimal control problems. Proceedings of CONTROLO'2006, 7th Portuguese Conference on Automatic Control, IST 11-13 September 2006.

8. M. Guerra and M.L. Centeno, Optimal reinsurance policy: the adjustment coefficient and the expected utility criteria. Submitted to the special issue of the journal "Insurance: Mathematics and Economics", devoted to the 10th IME Congress, 2006. Available as Report CEMAPRE N^o 1/2006.

9. M. Guerra and A. Sarychev, Approximation of generalized minimizers and regularization of optimal control problems. Proceedings of the 3rd Workshop on Lagrangian and Hamiltonian Methods for Nonlinear Control (LHMNLC'06), Nagoya, Japan, July 19-21, 2006.

10. M. Guerra and A. Sarychev, Regularizations of optimal control problems for control-affine systems. Proceedings of the 17th International Symposium on Mathematical Theory of Networks and Systems (MTNS 2006), Kyoto, Japan, July 24-28, 2006.

11. Agnieszka B. Malinowska, Delfim F. M. Torres. Nonessential Functionals in Multiobjective Optimal Control Problems, Proc. 5th Junior European Meeting on Control & Information Technology (JEM'06), September 20-22, 2006, Tallinn, Estonia. Also available as Reports math.OC/0609731 and CM06/I-33.

12. Olena V. Mul, Delfim F. M. Torres. Some Applications of the Method of Normal Fundamental Functions to Oscillation Problems, Proceedings of MTNS 2006 (the 17th International Symposium on Mathematical Theory of Networks and Systems), Kyoto, Japan, July 24-28, 2006, pp. 2078–2082. Also available as Reports math.NA/0607203 and CM06/I-17.

13. Olena V. Mul, Delfim F. M. Torres and Volodymyr P. Kravchenko, Dynamics of Controlled Hybrid Systems of Aerial Cable-Ways. Accepted to Nonlinear Analysis: Hybrid Systems, Vol. 1 (2007). Available as Reports CM06;I-16 and math.NA/0607200.

14. Frederico D. Regateiro and Delfim F. M. Torres, Extremais do Cálculo das Variações em Maple, Report CM06/D03.

15. Moulay Rchid Sidi Ammi, "Error estimates to a nonlocal parabolic problem", "Control, Optimization and Computation", Proceedings of the 7th Portuguese Conference on Automatic Control – CONTROLO 2006, Instituto Superior Técnico, Lisboa, Portugal, September 11-13, 2006 (electronic).

16. Moulay Rchid Sidi Ammi and Delfim F. M. Torres. Regularity of solutions to second-order integral functionals in variational calculus, Proceedings of the 7th Portuguese Conference on Automatic Control – CONTROLO 2006, Instituto Superior Técnico, Lisboa, Portugal, September 11-13, 2006 (6 pages, electronic). Also available as Report no. CM06/I-21.

17. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, Existence and Regularity of Optimal Solution for a Dead Oil Isotherm Problem. Accepted for publication in the journal "Differential Geometry – Dynamical Systems"(22-July-2006). To appear in 2007. Available as Reports math.OC/0608378 and CM06/I-27.

18. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, Necessary Optimality Conditions for a Dead Oil Isotherm Optimal Control Problem. Accepted to Journal of Optimization Theory and Applications (JOTA). To appear in Vol. 134, No. 2, 2007 (in press). Available as Reports CM06;I-42 and math.OC/0612376.

19. Moulay Rchid Sidi Ammi and Delfim F. M. Torres, Numerical analysis for a nonlocal parabolic problem resulting from thermistor problem, Report CM06/I-25.

List of organized seminars and conferences

Organized seminars

1. Inta Volodko, Unsteady flows of a viscous incompressible fluid, Department of Engineering Mathematics, Riga Technical University, Riga LV-1658, Latvia. Seminar of CEOC, February 10, 2006.

2. Ilona A. Dzenite, On the Formula for Impedance Change Used in Problems of Non-Destructive Testing by Eddy Current Method, Department of Engineering Mathematics, Riga Technical University, Latvia. Seminar of CEOC, February 17, 2006.

3. Gastão S. F. Frederico, Teorema de Noether no Cálculo das Variações Fraccionário, Bolseiro do IPAD. Seminar of CEOC, March 10, 2006

4. Moulay Rchid Sidi Ammi, A Chernoff scheme to approximate a nonlocal parabolic problem, Post-Doc, Universidade de Aveiro. Seminar of CEOC, March 24, 2006.

5. Olena Mul, Eigenvalue Problems For Some Hybrid Aerial Cable-Way Systems, Post-Doc Universidade de Aveiro. Seminar of CEOC, March 31, 2006.

6. Agnieszka B. Malinowska, Nonessential Objective Functions in Vector Optimization Problems, Technical University of Bialystok, Poland. Seminar of CEOC, May 30, 2006.

7. Andrey Sarychev, Controlabilidade para algumas equações não lineares de física matemática, Università degli Studi de Firenze, Dipartimento di Matemática per le Decisioni. Seminar of CEOC, October 20, 2006.

Organized conferences

8. Eugénio A. M. Rocha was member of the Organizing Committee of the International Conference "Views on ODEs", 21-24 June 2006, Aveiro, Portugal (in honour of Arrigo Cellina and James A. Yorke).

9. Eugénio A. M. Rocha was Chairman of the Organizing Committee of the International Conference "Communicating Mathematics in the Digital Era", 15-18 August 2006, Aveiro, Portugal.

List of MSc dissertations

1. Andreia M. F. Louro, Computação Simbólica em Maple no Cálculo das Variações, MSc dissertation, Mathematics, 2006 (supervisor: Delfim F. M. Torres).

2. Joana F. Costa, Teorema de Noether do Cálculo das Variações e do Controlo Óptimo na Economia, MSc dissertation, Mathematics, 2006 (supervisor: Delfim F. M. Torres) .

Computational Applications

Title: Automatic Computation of Conservation Laws in the Calculus of Variations and Optimal Control

Authors: Paulo D. F. Gouveia and Delfim F. M. Torres

Application Type: Maple Worksheet

Publish date: July, 2006

Language: English

Available from the Maple Application Centre:

`http://www.maplesoft.com/applications/app_center_view.aspx?AID=1983`