INTERNATIONAL CONFERENCE ON APPLIED MATHEMATICS AND NUMERICAL METHODS

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Book of Abstracts and Program

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Contents

Welcome to the Fifth ICAMNM

We are very happy to welcome all participants to the fifth edition of ICAMNM and we would like to express our gratitude for their scientific contributions.

We are especially grateful to our main speakers, all of them strong mathematicians, who, by their expertise, add value to our conference.

Also, we are very proud to announce our mini-symposium "Nonlinear Differential Equations and Related Applications" organized by Beatrice Di Bella and Valeria Morabito. This symposium is dedicated to convening leading experts and promising young researchers to present recent advances in the field of nonlinear differential equations.

In fact, the quality of all our speakers makes us confident that we are going to achieve our goals: to present the latest scientific results, to exchange interesting new ideas, and to identify possible future cooperation.

In addition to the invited talks given in the plenary sessions and in the mini-symposium, the program of the conference consists of presentations scheduled in the following two parallel sections of the conference:

A. Applied Mathematics, Numerical Methods, Algebra, and Geometry;

B. Differential Equations, Dynamical Systems, and Their Applications.

This book contains the abstracts of the presenters' contributions.

Special thanks to the members of the Scientific Committee who agreed to endorse all papers that will be presented.

Acknowledgements are also addressed to the Boards of the University of Craiova and the Faculty of Sciences for their involvement in the organization of the conference and the financial support.

We wish to all the participants a successful joint work !

The Organizing Committee

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Abstracts of Plenary Lectures

Homogenization of Maxwell's equations and related scalar problems with sign-changing coefficients

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Abstract. In this work, we are interested in the homogenization of Maxwell's equations posed in a composite medium with small, periodically distributed inclusions consisting of a negative material, namely a material modeled by a negative permittivity and permeability. By using T-coercivity techniques on the one hand and periodic homogenization on the other hand, we give sufficient conditions on the physical parameters which ensure the well-posed nature of the initial problem and the corresponding homogenized problem.

Based on joint work with L. Chesnel, K. Ramdani, M. Rihani.

About number theory and nuclear fusion

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Abstract. A class of Hamiltonian systems is studied in order to describe, from a mathematical point of view, the configuration of the magnetic field in tokamaks (toroidal devices used in controlled thermonuclear fusion). These models are important because the formation of internal transport barriers for charged particles has been experimentally associated with the region of low magnetic shear and the presence of main rational magnetic surfaces.

General explanations for some experimental observations (concerning the magnetic transport barriers, magnetic reconnection etc) are issued from the analytical properties of the models using the KAM (Kolmogorov-Arnold-Moser) theory. It is shown that the most resistant internal transport barriers have Diophantine rotation numbers. Their location is described using the Diophantine approximations.

In this way, a contribution of number theory to the understanding of complex phenomena related to nuclear fusion is highlighted.

Categories of modules

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Abstract. Two distinct categories of modules are considered. We prove there is an equivalence of the two categories, when they are restricted to almost finitely generated projective modules and their allowed morphisms, newly defined. In particular, we obtain the well-known equivalence of the two categories of finitely generated projective modules, thus our main result is an extension of this.

2020 Mathematics Subject Classification: 13C60, 13C10.
Key words and phrases: almost finitely generated, projective module, equivalence of categories.

Weak KAM solutions to the Hamilton-Jacobi equation for non-mechanical Lagrangians

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Abstract. In this talk I will discuss the Hamilton-Jacobi equation in the Wasserstein space of probability measures. This equation, in the case of mechanical systems, was considered by W. Gangbo and A. Tudorascu [2014], who provided the appropriate framework to ensure the existence of weak KAM solutions in the torus. In this talk, we revisit the setting of the problem and discuss the generalization for non-mechanical systems. This is a joint work with D. Cabanas as part of his MSc thesis.

Diffusion over ramified domains: solvability and global regularity

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Abstract. We consider a domains $\Omega_a \subseteq \mathbb{R}^2$ with ramified boundary Γ_a^∞, for a a parameter with $1/2 \leq a \leq a^* \simeq 0.593465$. This domain represents an idealization of bronchial trees in the lungs system. Since the exchanges between the lungs and the circulatory system take place only in the last generation of the bronchial trees, an accurate model for diffusion of oxygen may involve inhomogeneous Robin boundary conditions over Γ_a^∞. Therefore, we investigate the realization of the diffusion equation

$$\frac{\partial u}{\partial t} - \mathscr{A}u + \alpha u = f(x,t) \qquad \text{in } \Omega_a \times (0,\infty)$$

with mixed boundary conditions

$$\frac{\partial u}{\partial \nu_{\mathscr{A}}} + \beta u = g(x,t) \text{ on } \Gamma_a^\infty \times (0,\infty); \qquad u = 0 \text{ in } (\partial\Omega_a \setminus \Gamma_a^\infty) \times (0,\infty),$$

and $u(x,0) = u_0 \in C(\overline{\Omega}_a)$, where $\mathscr{A}$ stand as a linear (possibly non-symmetric) divergence-type differential operator, $\frac{\partial u}{\partial nu_{\mathscr{A}}}$ represents a generalized notion of a normal derivative over irregular surfaces, $\alpha \in L^r(\Omega_a)$, $\beta \in L^s_\mu(\Gamma_a^\infty)^+$ with $\operatorname{ess\,inf}_{x\in\Gamma_a^\infty} |\beta(x)| \geq \beta_0$ for some constant $\beta_0 > 0$ large enough, where $\min\{r,s\} > 1$. We show unique solvability of this diffusion equation, and moreover we establish that weak solution of this model equation are globally continuous in space and in time.

Key words and phrases: Ramified domains, Robin boundary conditions, Heat equation, Weak solutions, Schauder estimates.

References

[1] Y. Achdou and N. Tchou, Trace results on domains with self-similar fractal boundaries. *J. Math. Pures Appl.* **89** (2008), 596–623.
[2] P.W. Jones, Quasiconformal mappings and extendability of functions in Sobolev spaces. *Acta Math.* **147** (1981), 71–88.
[3] M.R. Lancia and A.Vélez - Santiago, A priori estimates for general elliptic and parabolic boundary value problems over irregular domains. *Submitted* (2023).

[4] K. Silva - Pérez and A. Vélez - Santiago, Diffusion over ramified domains: solvability and fine regularity. *Submitted* (2024).
[5] A. Vélez - Santiago, Global regularity for a class of quasi-linear local and nonlocal elliptic equations on extension domains. *J. Functional Analysis* **269** (2015), 1–46.

Convergence and well-posedness concepts in the study of nonlinear problems

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Abstract. The classical Tykhonov and Levitin-Polyak well-posedness concepts for a nonlinear problem are based on two main ingredients: the existence of a unique solution and the convergence to it of a special class of sequences, the so-called approximating sequences. Inspired by these properties, we define a new mathematical object, the so-called Tykhonov triple, denoted by $\mathscr{T}$. Then, we introduce a new concept of well-posedness for abstract problems in metric spaces, the $\mathscr{T}$-well-posedness concept, which extends both the Tykhonov and Levitin-Polyak well-posedness concepts, among others. The theory of $\mathscr{T}$-well-posedness problems we construct gives necessary and sufficient conditions which guarantee the convergence to the solution of a nonlinear problem, unifies different convergence results and provides a framework in which the link between different problems can been established. It can be used in the study of fixed point problems, minimization problems, inequality problems and various inclusions, for instance. We illustrate the theory in the study of elliptic and history-dependent variational inequalities for which we present examples, counter-examples and applications in Contact Mechanics.

Minimization problems interpolating between the p-Torsion problem and the principal frequency of the p-Laplacian

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Abstract. We analyse the family of minimization problems

$$M_\alpha(p;\Omega) := \inf_{u\in W_0^{1,p}(\Omega)\setminus\{0\}} \frac{\dfrac{1}{|\Omega|}\displaystyle\int_\Omega |\nabla u|_D^p \, dx}{\left(\dfrac{1}{|\Omega|}\displaystyle\int_\Omega |u|^p \, dx\right)^\alpha \left(\dfrac{1}{|\Omega|}\displaystyle\int_\Omega |u| \, dx\right)^{(1-\alpha)p}},$$

where $\Omega \subset \mathbb{R}^D$ ($D \geq 1$) is an open, bounded and convex set with smooth boundary and $\alpha \in (0,1)$ and $p \in (1,\infty)$ are two real numbers. We study the existence of minimizers, their asymptotic behavior as $p \to \infty$ when $\alpha \in (0,1)$ is fixed, and as $\alpha \to 0^+$ and $\alpha \to 1^-$ when $p \in (1,\infty)$ is fixed. Further, we investigate the monotonicity of the map $(1,\infty) \ni p \mapsto M_\alpha(p;\Omega)$ when $D \geq 1$, $\alpha \in (0,1)$ and $\Omega \in \mathbb{R}^D$ are given. In particular, we recover the results available in the literature for the limiting cases where $\alpha = 0$ (related to the p-torsion problem) and $\alpha = 1$ (the principal frequency of the p-Laplacian). This is a joint work with Marian Bocea and Mihai Mihăilescu.

2020 Mathematics Subject Classification: 47J10; 49J40; 49J35; 35Q74; 35D40.
Key words and phrases: minimization problem; p-Laplacian; principal frequency; p-torsion problem; asymptotic behavior.

Geometry in its historical course and its role in modeling phenomena in physical space. Differential operators and associated invariants

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Abstract. In the first part we will present the open dynamic system of the transition from mathematics to modeling and the role of geometry in this system. In this way, a connection is made between communication and the specifics of the math department. In the second part, we will present, as a novelty, the notion of second-order differential operator and the associated invariants. Their geometrization is presented in the multitude of linear connections and not only. Classical parallel and generalized parallel transport associated with these operators is studied. There are also classes of operators that allow the modeling of systems of physical phenomena in the gravigraphic physical space, both for regular and chaotic phenomena. Technique needs such modeling.Einstein's theory is generalized with the help of these operators. The presentation uses invariant modern language.

Abstracts of the Mini-symposium

Existence results for nonlinear elliptic equations, via the sub and supersolutions method

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Abstract. In this talk I present existence and regularity results for nonlinear elliptic equations, via the sub and supersolutions method. The problem is driven by a general differential operator, depending on $(x, u, \nabla u)$, and has a convective term f

$$\begin{cases} -\mathrm{div}(A(x,u,\nabla u)) = f(x,u,\nabla u) & \text{in } \Omega\,, \\ u = 0 & \text{on } \partial\Omega\,. \end{cases} \tag{1}$$

The assumptions on the members of the equation are formulated in terms of Young's functions and of generalized Young's functions.

The results presented are a part of the research carried out within the Research project of the Italian Ministry of Education, University and Research (MIUR), Prin 2022 "Nonlinear differential problems with applications to real phenomena", grant number 2022ZXZTN2, CUP C53D23002600006.

2020 Mathematics Subject Classification: 35J25, 35J60, 46E30, 47J05.
Key words and phrases: Nonlinear elliptic equations, Orlicz-Sobolev spaces, subsolution and supersolution.

A survey about the existence of two positive solutions for parametric singular p-Laplacian type problems

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Abstract. The aim of this survey is to provide a review of some results about the existence of at least two positive solutions for parametric singular p-Laplacian type problems, with particular attention to those contained in [1, 2, 3].

2020 Mathematics Subject Classification: 35J92; 35A01, 35J20, 35J75.
Key words and phrases: Variational methods, quasilinear elliptic equations, p-Laplacian problem, singular reaction term, sub-super solutions, truncation techniques.

References

[1] P. Candito, U. Guarnotta, K. Perera, *Two solutions for a parametric singular p-Laplacian problem*, J. Nonlinear Var. Anal. 4 (2020), No. 3, pp. 455–468.
[2] P. Candito, U. Guarnotta, R. Livrea, *Existence of two solutions for singular Φ-Laplacian problems*, Adv. Nonlinear Stud. 22 (2022), no. 1, 659–683.
[3] P. Candito, F. Failla, R. Livrea, *Positive solutions for a p-Laplacian equation with sub-critical singular parametric reaction term*, Z. Anal. Anwend., to appear.

On a class of problems involving the $p(\cdot)$-biharmonic operator

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Abstract. We present some results concerning the existence of non-trivial weak solutions for the following type of problems with Navier boundary conditions

$$(P_\lambda) \qquad \begin{cases} \Delta^2_{p(x)} u = \lambda f(x,u) \text{ in } \Omega \\ u = \Delta u = 0 \text{ on } \partial\Omega. \end{cases}$$

In this problem $\Omega \subset \mathbb{R}^N$ is an open bounded domain with Lipschitz boundary $\partial\Omega$, $N \geq 1$, p is a convenient element in $C(\bar{\Omega})$, $\Delta^2_{p(x)} u := \Delta(|\Delta u|^{p(x)-2}\Delta u)$ denotes the $p(\cdot)$-biharmonic operator, the nonlinear term f is in $C^0(\Omega \times \mathbb{R})$ and λ is a positive, real parameter.

By applying variational techniques that involve the application of recent results on the existence of critical points, we will establish some conditions on the nonlinear term f and on the parameter λ in order to guarantee the existence and multiplicity of solutions for problem (P_λ).
The results presented are contained in the following paper

> G.BONANNO, A.CHINNÌ, V.D.RĂDULESCU *Existence of two non-zero weak solutions for a $p(\cdot)$-biharmonic problem with Navier boundary conditions* , "Rend. Lincei Mat. Appl." **34**, 727-743,**2023**

and are part of the research carried out within the projects:

- PRIN 2022-Progetti di Ricerca di rilevante Interesse Nazionale, "Nonlinear differential problems with applications to real phenomena", (2022ZXZTN2),
- "INdAM-GNAMPA Project", codice CUP E53C23001670001.

2020 Mathematics Subject Classification: 35J60, 35J20.
Key words and phrases: Variable exponent Sobolev spaces, $p(\cdot)$-biharmonic, Critical point.

Variational approach to some boundary value problems involving the p-biharmonic operator

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Abstract. In this talk we present some results on the existence of multiple solutions for differential inclusions involving p-biharmonic operator, subject to a general potential multivalued boundary condition. Our method is based on non-smooth critical point theory. The results presented are part of the research carried out within the project: PRIN 2022-Progetti di Ricerca di rilevante Interesse Nazionale, "Nonlinear differential problems with applications to real phenomena", (2022ZXZTN2). We are concerned with multiplicity of solutions which, among others, covers many particular boundary conditions that are frequently invoked in the literature.

2020 Mathematics Subject Classification: 34B15, 58E05.
Key words and phrases: Critical point theory, fourth-order equation, locally Lipschitz functions, variational-hemivariational inequalities.

Multiple solutions for nonlocal problems involving the $p(x)$-Laplacian operator

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Abstract. The aim of this talk is to present the recent joint work [1], devoted to the study of the following nonlocal elliptic problem,

$$\begin{cases} -a\left(\int_\Omega u^q dx\right)\Delta_{p(x)}u = \beta(x)f(u) & \text{in } \Omega\,, \\ u>0 & \text{in } \Omega\,, \\ u=0 & \text{on } \partial\Omega\,. \end{cases} \tag{2}$$

where $\Omega \subset \mathbb{R}^N$ is a bounded domain with smooth boundary, $a \in C([0,\infty))$ is a continuous changing sign function, $\beta \in L^\infty(\Omega)$, $f:\mathbb{R}\to\mathbb{R}$ is a suitable continuous function in a right neighborhood of zero and $\Delta_{p(x)} = \operatorname{div}(|\nabla u|^{p(x)} - 2\nabla u)$ is the $p(x)$-Laplacian operator. The constant exponent case has been studied in [4] for $p=2$ and in [2] for $p\in(1,+\infty)$. Here, we combine variational, super-sub solution and fixed-point techniques to obtain the existence of K pairs of positive solutions, one for each "positive bumps" of the a function, ordered in L^q-norm. Moreover, as pointed out in [3] and the references therein, these Carrier-type problems are of interest in physics, biology and engineering, in particular, in biological diffusion models.

2020 Mathematics Subject Classification: 35J35, 35J40, 35J60, 35J62.
Key words and phrases: $p(x)$-Laplacian, variable exponent, multiple solutions, variational, sub-super solution, fixed-point methods, truncation.

References

[1] P. Candito, G. Failla, R. Livrea, *Pairs of positive solutions for a Carrier $p(x)$-Laplacian type equation*, (submitted).
[2] P. Candito, L. Gasiński, R. Livrea, J. R. Santos Júnior, *Multiplicity of positive solutions for a degenerate nonlocal problem with p-Laplacian*, Adv. Nonlinear Anal. 11 (2022), no. 1, 357–368.
[3] M. Chipot, J. F. Rodrigues, *On a class of nonlocal nonlinear elliptic problems*, RAIRO Modél. Math. Anal. Numer. 26 (1992), no. 3, 447–467.
[4] L. Gasiński, J. R. Santos Júnior, *Multiplicity of positive solutions for an equation with degenerate nonlocal diffusion*, Comput. Math. Appl. 78 (2019), no. 1, 136–143.

Convergence estimates for solutions to the singularly perturbed semilinear problems of hyperbolic-parabolic type

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Abstract. In the real Hilbert space H we consider the following Cauchy problem:

$$\begin{cases} \varepsilon u''_{\varepsilon\delta}(t) + \delta\, u'_{\varepsilon\delta}(t) + Au_{\varepsilon\delta}(t) + B\big(u_{\varepsilon\delta}(t)\big) = f_\varepsilon(t), \quad \tau\in(0,T), \\ u_{\varepsilon\delta}(0) = u_{0\varepsilon}, \quad u'_{\varepsilon\delta}(0) = u_{1\varepsilon}, \end{cases} \tag{$P_{\varepsilon\delta}$}$$

where $A: V\subset H\to H$, be a linear self-adjoint operator and B is nonlinear $A^{1/2}$ lipschitzian or monotone operator, $u_{0\varepsilon}, u_{1\varepsilon}\in H$, $f_\varepsilon:[0,T]\to H$ and ε,δ are two small parameters. We investigate the behavior of solutions $u_{\varepsilon\delta}$ to the problem $(P_{\varepsilon\delta})$ in two different cases: (i) $\varepsilon\to 0$ and $\delta\ge\delta_0>0$, relative to the solutions to the following unperturbed system:

$$\begin{cases} \delta l'_\delta(t) + Al_\delta(t) + B\big(l_\delta(t)\big) = f(t), \quad \tau\in(0,T), \\ l_\delta(0) = u_0; \end{cases} \tag{P_δ}$$

(ii) $\varepsilon\to 0$ and $\delta\to 0$, relative to the solutions to the following system:

$$Av(t) + B\big(v(t)\big) = f(t), \quad \tau\in[0,T), \tag{P_0}$$

The mathematical model $(P_{\varepsilon\delta})$ governs various physical processes, which are described by the Klein-Gordon equation, the Sine-Gordon equation, the Plate equation and others equations.

Degenerate Dirichlet problems with unbounded coefficient and convection term

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Abstract. We prove the existence of a bounded solution for a Dirichlet problem with a convection term and driven by a nonhomogeneous differential operator with unbounded coefficient.

The unbounded coefficients prevent the direct application of classical methods to resolve these class of problems moreover for the convection term we can't use the variational methods. To overcame these difficulties we use a truncation methods to drop the unboundedness of coefficient, a priori estimates of solutions and the theory of pseudomonotone operators.

2020 Mathematics Subject Classification: 35J70, 35J92, 47H30.
Key words and phrases: Elliptic equation, unbounded coefficient, convection, bounded solution, truncation, pseudomonotone operator.

Multiple solutions to a Sturm-Liouville problem with highly discontinuous reaction term and periodic boundary conditions

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Abstract. The following problem with the Sturm-Liouville equation and periodic boundary conditions is investigated

$$(P_\lambda) \qquad \begin{cases} -(pu')' + qu = \lambda f(x, u(x)) & \text{in }]0,T[, \\ u(0) = u(T),\ u'(0) = u'(T), \end{cases}$$

where $p, q \in L^\infty([0,T])$ satisfying $p(0) = p(T)$, $q_0 := \operatorname{essinf}_{[0,T]} q > 0$, $p_0 := \operatorname{essinf}_{[0,T]} p > 0$ and the reaction term $f : [0,T] \times \mathbb{R} \to \mathbb{R}$ belongs to a suitable set of almost everywhere continuous functions called highly discontinuous. In particular, the set of the points of discontinuity of f may also be uncountable. We exploit the variational method. Under suitable growth conditions on f, we establish the existence of three weak solutions to problem (P_λ), for an appropriate range of the parameter λ, using the critical point theory for non-differentiable functions.

2020 Mathematics Subject Classification: 49J52, 34C25, 34B24.
Key words and phrases: Sturm-Liouville equation, highly discontinuous nonlinearities, nonsmooth analysis.

Acknowledgement: The authors are members of the Gruppo Nazionale per l'Analisi Matematica, la Probabilità e le loro Applicazioni (GNAMPA) of the Istituto Nazionale di Alta Matematica (INdAM). The paper is partially supported by PRIN 2022–Progetti di Ricerca di rilevante Interesse Nazionale, "Nonlinear differential problems with applications to real phenomena" (2022ZXZTN2).

References

[1]. Bonanno G., Marano S.A. *On the structure of the critical set of non-differentiable functions with a weak compactness condition* Applicable Analysis 89 No. 1, 2010.
[2]. Livrea R., Vassallo B., *Three weak solutions to a periodic boundary Sturm-Liouville problem with discontinuous reaction*, preprint, 2024.

Abstracts of Short Presentations (alphabetical order by presenters' surname)

Some new constructions involving Minkowski combination

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Abstract. Our aim is to relate Minkowski combinations to the geometry of Lagrangians and Hamiltonians. A new construction of a lift of some non-linear (possible quadratic) functions is performed in the main result, using a Minkowski combination (in particular a Minkowski sum). Using this, we analyse some Lagrangians and Hamiltonians and their domains, providing some examples.

2020 Mathematics Subject Classification: 52A40, 52A99.
Key words and phrases: Minkowski combination, Minkowski lift.

Mathematical models. Applications in Economics and in Technology

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Abstract. In this paper, starting from recent data provided by the National Institute of Statistics, we analyze the tourism activity in Mehedinţi County.

We apply the regression method and analyze some models. We also compare the economic results with those of previous years.

Also, in this paper we study the stability of dynamic systems with applications in economics. The stability study is done using the Leapunov function method.

The originality of the paper consists in the way we choose the mathematical model in case of regression and in the way we choose the Leapunov function in case of dynamic systems in which we analyze stability.

Existence of solutions to rate independent systems with history variable of integral type

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Abstract. This talk focuses on rate independent systems (RIS) where the dissipation functional depends not only on the rate but also on the history of the state. The latter is expressed in terms of a Volterra integral operator. We establish an existence result for the original problem and for the control thereof. Under a smoothness condition, we prove the uniqueness of solutions to a certain class of history dependent RIS with unbounded dissipation potentials. In this context, we derive an essential estimate that opens the door to future research on the topic of optimization.

An energy-consistent discretization of hyper-viscoelastic contact models for soft tissues

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Abstract. We propose a mathematical model of hyper-viscoelastic problems applied to soft biological tissues, along with an energy-consistent numerical approximation. We first present the general problem in a dynamic regime, with certain types of dissipative constitutive assumptions. We then provide a numerical approximation of this problem, with the main objective of respecting energy consistency during contact in adequacy with the continuous framework. Given the presence of friction or viscosity, a dissipation of mechanical energy is expected. Moreover, we are interested in the numerical simulation of the non-smooth and non-linear problem considered, and more particularly in the optimization of Newton's semi-smooth method and Primal Dual Active Set (PDAS) approaches. Finally, we test such numerical schemes on academic and real-life scenarios, the latter representing the contact deployment of a stainless-steel stent in an arterial tissue.

2020 Mathematics Subject Classification: 74M15, 74M20, 74M10, 74B20, 74H15, 74S30, 49M15, 90C53, 70F40, 70-08, 70E55, 35Q70.
Key words and phrases: Hyperelasticity, Unilateral Contact, Viscosity, Coulomb Friction, Energy consistency, Semi-Smooth Newton method, Primal-Dual Active Set, Numerical simulations, Biological soft tissues.

Anisotropic Wentzell-type systems with variable exponents

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Abstract. We are concerned with a nonhomogeneous and anisotropic system of Wentzell-type, involving generalized Leray-Lions operators in the interior of the domain and on the boundary. Our study is conducted in the framework of the anisotropic spaces with variable exponents. We discuss the generality of this system, we provide an existence and uniqueness result, and we present global a priori estimates. This talk is mainly based on a joint work with Alejandro Vélez - Santiago, that is, "Generalized anisotropic Wentzell-type systems with nonstandard growth conditions over manifolds with boundary", which was submitted for publication.

2020 Mathematics Subject Classification: 35J57, 35D30, 35J50.
Key words and phrases: anisotropic elliptic system, variable exponents, Wentzell boundary conditions, Leray-Lions operators, a priori estimates.

The study of the behavior of a three-dimensional system with cubic perturbation

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Abstract. In this paper we will study the stability of equilibrium points of the three-dimensional system:

$$\begin{cases} \dot{x} &= y \\ \dot{y} &= z \\ \dot{z} &= k^2\alpha x^2 + kx - 2\alpha x^2 y - kz \end{cases}$$

which comes from a type jerk equation.

For this system we will study the stability of the equilibrium points and Hopf bifurcation.

Keywords: jerk equations; stability; bifurcations.

Tau method based on shifted Chebyshev operational matrix of differentiation applied to a two-phase Stefan melting problem with power-type temperature-dependent thermal coefficients

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Abstract. A one dimensional two-phase Stefan problem for the melting process of a semi-infinite material with temperature-dependent thermal coefficients imposing a Dirichlet boundary condition at the fixed face is considered. Through the similarity transformation, an equivalent ordinary differential problem is obtained from which existence and uniqueness of solution is proved. Moreover, numerical approximations are obtained through the Tau method based on shifted Chebyshev operational matrix of differentiation. Some comparisons between exact and approximate solutions are provided in order to test the accuracy of the method.

2020 Mathematics Subject Classification: 35R35, 35C06, 80A22, 35K05, 65N35.
Keywords: Stefan problem, variable thermal conductivity, variable heat capacity, temperature-dependent thermal coefficients, similarity solution, Tau method.

Characterization of solutions to Fredholm integral equations of the first kind

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Abstract. Fredholm integral equations of the first kind play a pivotal role in various fields of science and engineering due to their widespread applications. Despite their significance, determining the existence and uniqueness of solutions to these equations remains challenging. In this study, we introduce a developed criterion for the existence of a solution, shedding light on the conditions under which a solution can be guaranteed. We delve into the theoretical underpinnings of this criterion, providing rigorous mathematical analysis to support its validity. Furthermore, we explore the characterization of solutions to these integral equations utilizing harmonic tools. Overall, our findings contribute to advancing the theoretical foundations and practical applications of Fredholm integral equations of the first kind. Our work provides valuable insights for researchers and practitioners across diverse disciplines through the developed criterion for existence and the characterisation of solutions.

2020 Mathematics Subject Classification: 45B05, 45Q05.
Key words and phrases: Fredholm integral equations, ill-posed problems.

First integrals of a cubic differential system having invariant straight lines and invariant cubics

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Abstract. We consider the real cubic differential system of the form

$$\dot{x} = y + p_2(x, y) + p_3(x, y),\ \dot{y} = -x + q_2(x, y) + q_3(x, y), \tag{1}$$

where $p_j(x, y)$, $q_j(x, y)$, $j \in \{2, 3\}$ are homogeneous polynomials of degree j and the origin $O(0, 0)$ is a singular point which is a center or a focus (a fine focus) for (1). The problem of distinguishing between a center and a focus (the center-focus problem) is open for general cubic systems (1).

A singular point $O(0, 0)$ is a center for (1) if and only if the system has a holomorphic first integral of the form $F(x, y) = C$ in some neighborhood of $O(0, 0)$. In this work we study the conditions for the existence of first integrals for cubic system (1) of the form $\Phi = C$, $l_1^{\alpha}\Phi^{\gamma} = C$, $l_1^{\alpha}l_2^{\beta}\Phi^{\gamma} = C$, composed of irreducible invariant algebraic curves, where $l_j = 0$, $j = 1, 2$ are invariant straight lines, $\Phi = 0$ is an invariant cubic and α, β, γ, $\gamma \neq 0$ are real parameters.

2020 Mathematics Subject Classification: 34C05, 34C14.
Key words and phrases: the center-focus problem, invariant algebraic curve, first integral.

Remarks on a sixth-order equation

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Abstract. The aim of this note is to complement the results presented in the paper *Existence Results for a Semilinear Sixth-Order Equation by T.Gyulov, G.Morosanu and S.Tersian, J.Math.Anal.Appl. 321, 86-98, 2006.* The authors proved some existence and multiplicity results for a sixth-order ODE when the potential F of the nonlinear term f is superquadratic, i.e., $F(x, s)/s^2 \to \infty$ as $s \to \infty$. Although sixth-order equations are used to describe some phenomena, it seems that very few results are available.

Under different restrictions on the coefficients, we discuss here existence results under weaker conditions on F (nonquadracity of F at infinity, etc.) or different conditions (subquadracity of F, i.e., $F(x, s)/s^2 \to \lambda < \infty$ as $s \to \infty$). Moreover, we add some uniqueness results and note that the results also hold for the corresponding sixth-order PDE.

2020 Mathematics Subject Classification: 34A12, 34B15, 35A05, 35B50, 35J35, 35J40.
Key words and phrases: Sixth-Order, Variational Method, Mountain-Pass Theorem, Ambrosetti-Rabinowitz, Maximum Principle.

On a non-compact hyperbolic 5-manifold of finite volume with fundamental group generated by parabolic translations

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Abstract. On a non-compact hyperbolic 5-manifold of finitie volume with fundamental group generated by parabolic translations. A method of construction of a complete non-compact hyperbolic manifold of dimension 5 of finite volume is given. Geometry of this manifold and its total geodesical submanifolds of different codimenions are investigated. Similar constructions, for different dimensions, of manifolds with fundamental groups generated by translations (parabolic or hyperbolic) are discussed.

Frames of almost finitely generated projective modules

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Abstract. In this work are presented some aspects about frames in projective modules that are finitely generated or, more general, almost finitely generated. An important role is played by the syzygies of the module and the matrix of the frame, not necessarily finite dimensional. Some examples are also considered.

2020 Mathematics Subject Classification: 13C13, 13C10.
Key words and phrases: Projective module, (almost) fintely generated module, syzygies, frame.

Graph theory approach to CML therapy

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Abstract. This work presents a mathematical model using graph theory to investigate immune system dynamics during Chronic Myeloid Leukemia (CML) therapy. The model represents interactions between key cell populations, such as healthy and leukemic cells, and immune cells, including T-helper cells (Th1, Th2) and regulatory T cells (Tregs). By employing a system of delay differential equations, we capture the temporal progression of these interactions and drug effects. Graph theory allows for a structured representation of the competitive and cooperative interactions between these cell types. This approach helps identify critical points in the immune response, potentially improving CML treatment strategies.
Simulations show the model's ability to indicate patient outcomes under various treatment conditions, providing a better understanding of immune dynamics and ways to improve therapy protocols.

Keywords: Chronic Myeloid Leukemia, Imatinib Therapy, Mathematical Modeling, Immune System Dynamics, T Cell Subset Modulation, Graph Theory, Pharmacokinetics, Cellular Interactions, Th1, Th2, Treg Cells, Stem-like, Mature Cell Populations, Time Delays, Differential Equations, Pharmacodynamics.

A Fejér-type inequality for co-ordinated convex functions on n-dimensional intervals

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Abstract. In this paper, we prove a Fejér-type inequality in for convex functions on the co-ordinates defined on multi-dimentional intervals. Key words: Hadamard' s inequality, Fejér's inequality, convexity on the co-ordinates.

Key words and phrases: Hadamard's inequality, Fejér's inequality, convexity on the co-ordinates.

Mixed Dirichlet–Robin problem for coupled anisotropic Darcy–Forchheimer–Brinkman equations

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Abstract. We study a mixed Dirichlet–Robin boundary value problem for a system of coupled anisotropic Darcy–Forchheimer–Brinkman equations as a general model of viscous flows in multidisperse porous media.

First, we consider the mixed Dirichlet–Robin problem for the anisotropic Brinkman system, which is a generalization of the Brinkman system for fluids with an anisotropic viscosity tensor. Regarding this problem, we present a well-posedness result obtained using a variational technique. Then, we obtain an existence and uniqueness result concerning the mixed problem for the nonlinear anisotropic Darcy–Forchheimer–Brinkman system with sufficiently small data using the Banach fixed-point theorem.

Second, we consider the mixed Dirichlet–Robin problem for multiple coupled anisotropic Darcy-Forchheimer-Brinkman equations. Such a system generalizes models proposed in the literature for describing fluid flows in

bidisperse and tridisperse porous media. Concerning this problem, we obtain an existence and uniqueness result by employing the Perov fixed-point theorem, a generalization of the Banach fixed-point theorem for operators defined on spaces endowed with vector-valued metrics.

Finally, as applications of the previously mentioned boundary value problems, we present numerical results related to viscous incompressible fluid flows in bidisperse and tridisperse porous media.

2020 Mathematics Subject Classification: 35Q30, 35Q35, 76S05, 76M10.
Key words and phrases: Anisotropic Navier-Stokes-type system, Existence and uniqueness result, Fixed-point technique, Bidisperse porous media.

The isolation of the principal eigenvalue of a Dirichlet problem involving the Finsler p-Laplacian and a nonlocal term

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Abstract. We analyse the isolation of the first eigenvalue for an eigenvalue problem involving the Finsler p-Laplace operator and a nonlocal term on a bounded domain subject to the homogeneous Dirichlet boundary condition.

A meshless method for solving the SBIE with vortex distribution of the compressible fluid flow around obstacles

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Abstract. The paper presents some numerical solutions for the singular boundary integral equation (SBIE) with vortex distribution of the 2D compressible fluid flow around obstacles. The SBIE is solved using a meshless method based on different radial basis functions. The numerical solutions are obtained by implementing the method into computer codes using Mathcad's programming capabilities. In some particular cases the problem has exact solutions and so, in order to validate the proposed approach, an analytical checking is made. The study shows that good agreement between the numerical solutions and the exact ones exist.

Control Lyapunov functions. Approaching LMI feasibility statements in 2D models

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Abstract. Construction of a Control Lyapunov Function (CLF) for a nonlinear dynamical system is generally a difficult problem, but once a CLF is found, stabilization of the system is straight-forward. The present paper focuses on the efficiency of using linear matrix inequalities (LMIs) and convex programming in process control applications. Models including mathematics in immune diseases and also models from mixing fluids are taken into account. Starting with the 2d case for such models is convenient in order to test the methods and calculus.

2020 Mathematics Subject Classification: 93D30, 93D25, 49J35, 49K35, 93C15, 65K05.
Key words and phrases: dynamical system, control Lyapunov function, optimization, control, convex programming.

Coupled flow and mechanics in a fractured porous medium

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Abstract. Numerous applications of subsurface engineering involve injection and extraction of fluids. Examples include geothermal energy extraction, nuclear waste storage, carbon sequestration, petroleum engineering applications, and energy storage. These anthropogenic activities involve a complex set of processes involving flow, thermal, chemical reactions, and mechanical effects all possibly coupled to each other. These complex sets of processes interact with the complex geology that involves ubiquitous fractures and faults. The network of fractures form the primary conduit of flow and transport and furthermore, act as the most vulnerable regions for mechanical instability. The interaction of processes and the complex geometry of fractures brings computational and mathematical challenges in the simulation of these processes. The fractured medium is generally anisotropic, heterogeneous, and has substantially discontinuous material properties spanning several orders of magnitude.

Our objective is to study coupling of flow and geomechanics in a fractured porous medium setting. We present a mixed dimensional model for a fractured poro-elasic medium. The fracture is a lower dimensional surface embedded in a bulk poro-elastic matrix. The flow equation on the fracture is a Darcy type model that follows the cubic law for permeability. The bulk poro-elasticity is governed by fully dynamic Biot equations. The resulting model is a mixed dimensional type where the fracture flow on a surface is coupled to a bulk flow and geomechanics model. The mathematical model is a variational inequality coupled to a set of PDEs and ODEs defined on a domain containing mixed dimensional geometry.

There are two directions in which our work contributes to. The first is in extending Biot equations to include fracture flow model and complex friction and contact mechanics. The second is in considering different time schemes for the multiphysics modelling. We consider finer time steps for the flow and coarser time steps for the mechanics. We provide a rigorous mathematical foundation in both directions.

This is a joint work with Mircea Sofonea (Perpignon), Mary F Wheeler (Austin), Vivette Girault (Sorbonne), Maarten de Hoop (Rice), and Tameem Almani (Aramco).

2020 Mathematics Subject Classification: 74A55, 74B05, 74F10, 65J10.
Key words and phrases: Porous media, Mechanics of deformable media, multiphysics problems, multirate methods, contact mechanics, variational inequalities.

Stochastic systems with multiple final sequences of states and independent transitions

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Abstract. The stochastic systems with multiple final sequences of states and independent transitions are represented by Markov processes defined as bellow. They are also called zero-order Markov processes with multiple final sequences of states and were introduced and deeply studied in [1].

In order to define a stochastic system with multiple final sequences of states, we consider a discrete stochastic system L with the set of states V, where $|V| = \omega < \infty$. At every discrete moment of time $t \in \mathbb{N}$ the state of the system is $v(t) \in V$. The system L starts its evolution from the state v with the probability $p^*(v)$, for all $v \in V$, where $\sum\limits_{v \in V} p^*(v) = 1$.

Also, the transition from one state u to another state v is performed according to the same probability $p^*(v)$ that depends only on the destination state v, for every $u \in V$ and $v \in V$. Additionally, we assume that r different sequences of states $X^{(\ell)} = (x_1^{(\ell)}, x_2^{(\ell)}, \ldots, x_m^{(\ell)}) \in V^m, \ell = \overline{1, r}$, are given and the stochastic system stops transitions as soon as the states $x_1^{(\ell)}, x_2^{(\ell)}, \ldots, x_m^{(\ell)}$ are consecutively reached in given order for an arbitrary $\ell \in \{1, 2, \ldots, r\}$.

The time T, when the system stops, is called evolution time of the stochastic system L with given final sequences of states $X = \{X^{(1)}, X^{(2)}, \ldots, X^{(r)}\}$.

The stochastic system L, described above, represents a stochastic system with final sequences of states $X = \{X^{(1)}, X^{(2)}, \ldots, X^{(r)}\}$ and independent transitions. The goal is to analyze the evolution time T of the stochastic system L. We prove that the distribution of the evolution time T is a homogeneous linear recurrent sequence, and a polynomial algorithm to determine the initial state and the generating vector of this recurrence is developed. Having the generating vector and the initial state of the recurrence, it is able to effectively use the numerical methods from [2] for determining the main probabilistic characteristics of the evolution time.

[1] Lazari A. *Zero-Order Markov Processes with Multiple Final Sequences of States.* Bul. Acad. Ştiinţe Repub. Mold. Mat., 2023, No. 2(102), 110–115.

[2] Lazari A., Lozovanu D., Capcelea M. *Dynamical deterministic and stochastic systems: Evolution, optimization and discrete optimal control* (in Romanian), Chişinău, CEP USM, 2015, 310p.

2020 Mathematics Subject Classification: 60J22, 65C40, 65Q30, 90C40.
Key words and phrases: stochastic system, final sequence of states, evolution time, homogeneous linear recurrence, initial state, generating function.

Two-field variational formulations for Winkler contact models in elastostatics

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Abstract. The present talk draws attention to a variational approach devoted to the weak solvability of Winkler contact problems in elastostatics. Herein, the material law is governed by a separable bipotential. We deliver a two-field weak formulation in a form of a variational system, the unknown being a pair consisting of the displacement field and the Cauchy stress tensor. Then, we discuss existence, uniqueness and data dependence results.

2020 Mathematics Subject Classification: 26B25, 49J40, 49J53, 74M15.
Key words and phrases: Winkler contact problems, bipotential, weak solution, variational inequalities, well-posedness.

A study of the Sprott BC system through Jacobi stability

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Abstract. In this paper, we examine a three-dimensional autonomous quadratic polynomial system of first order differential equations with two real parameters, known as the Sprott BC chaotic system. This system is symmetric with respect to the Oz-axis and represents an unique and special case within the class of chaotic Sprott systems. Our approach involves studying the nonlinear dynamics of this system using the Kosambi–Cartan–Chern (KCC) geometric theory. Specifically, we will analyze the corresponding system of second-order differential equations (SODE) from the view of Jacobi stability by determining the five invariants of the KCC theory. These invariants reveal the internal geometric characteristics of the system, with the deviation curvature tensor being particularly crucial for Jacobi stability. By calculating the components of the deviation curvature tensor at each equilibrium point, we concluded that no Jacobi stability exists around any of these points.

2020 Mathematics Subject Classification: 34D20, 70K20, 70E50.
Key words and phrases: Sprott BC system, Chaos, KCC theory, Lyapunov stability, Jacobi stability.

References

[1] J. C. Sprott, Some simple chaotic flows, *Phys. Rev. E.*, 50, R647–R650, 1994.
[2] Marcos C. Mota and Regilene D. S. Oliveira, Dynamic aspects of Sprott BC chaotic system, *Discrete and Continuous Dynamical Systems-B*, 26(3), 1653–1673, 2021.
[3] C.G. Bohmer, T. Harko and S.V. Sabău, Jacobi stability analysis of dynamical systems–Applications in gravitation and cosmology, *Adv. Theor. Math. Phys.*, 16, 1145-1196, 2012.
[4] T. Harko, P. Pantaragphong and S.V. Sabau, Kosambi–Cartan–Chern (KCC) theory for higher order dynamical systems, *Int. J. Geom. Meth. Mod. Phys.*, 13, 1650014, 2016.
[5] F. Munteanu, F. Analyzing the Jacobi Stability of Lü's Circuit System, *Symmetry*, 14(5), 1248, 2022.
[6] F. Munteanu, Jacobi Stability for T-System, *Symmetry*, 16(1), 84, 2024.
[7] M. Gazor and N. Sadri, Symmetry-breaking controller design for Bogdanov-Takens bifurcations with an application to Chua system, preprint, 2024.

New perspectives on applications of fuzzy sets notions and certain hypergeometric functions in geometric function theory

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Abstract. The idea of differential inequality for real-valued functions was extended to complex-valued functions by Sanford S. Miller and Petru T. Mocanu in two articles published in 1978 and 1981. Their studies provided the basis for a new theory that was subsequently called the theory of differential subordination, or admissible functions theory. This research focuses on fuzzy differential subordination, which is a distinct variation on differential subordination. The idea of a fuzzy set was first introduced by Lotfi A. Zadeh in 1965, and since then, it has developed tremendously and is currently used in many scientific and technological disciplines. The fuzzy differential subordination theory was established in papers that appeared in 2011 and 2012. It is derived from the general theory of differential subordination, implementing most of the concepts from the classical theory to provide distinct findings by embedding certain aspects of the fuzzy sets theory. The research presented here also incorporates certain hypergeometric functions which became relevant for the studies in complex analysis after Louis de Branges applied hypergeometric functions to prove the renowned Bieberbach's Conjecture. One of the earliest studies to examine the implications of applying hypergeometric functions to the theory of univalent functions concerned Gaussian and confluent (Kummer) hypergeometric functions. This work considers those hypergeometric functions applying also fractional calculus aspects, a combination that currently yields interesting outcome regarding the general differential subordination theory and fuzzy differential subordination in particular.

2020 Mathematics Subject Classification: 30C45, 30C80, 33C15.
Key words and phrases: differential subordination, fuzzy differential subordination, univalent function, fuzzy set, Gaussian hypergeometric function, confluent (Kummer) hypergeometric function, fractional integral.

Rhaly operators and Sub Cesaro operators

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Abstract. Rhaly operators on separable Hilbert spaces are defined by inferior triangular terraced matrices, generated by a sequence of complex numbers $(a_n)_{n\geq 1}$. Cesaro operator is the Rhaly operator generated by $(1/n)_{n\geq 1}$. Consider a subsequence $(n_k)_{k\geq 1}$ of natural numbers $(n)_{n\geq 1}$, a Sub Cesaro operator is the Rhaly operator generated by the sequence $(a_n)_{n\geq 1}$ where $a_{n_k} = 1/n_k$ and all other $a_n = 0$.

We show there is strong connection between boundedness and compactness of a Rhaly operator and properties of Cesaro and Sub Cesaro operators, and hence coming down to properties of subseries $\sum 1/n_k$ of the harmonic series $\sum 1/n$, which are related to open problems of such subseries, actually hard to solve.

Godel filters in residuates lattices

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Abstract. In this paper, we study a new type of filters in residuated lattices: Godel filters. So, we characterize the filters for which the quotient algebra that is constructed via these filters is a Godel algebra and we establish the connections between these filters and other types of filters. Using Godel filters we characterize the residuated lattices which are Godel algebras. Also, we prove that a residuated latice is a Godel algebra (divisible residuated lattice, MTL algebra, BL algebra) if and only if every filter is a Godel filter (divisible filter, MTL filter, BL filter). Finally, we present some results about injective Godel algebras showing that complete Boolean algebras are injective objects in the category of Godel algebras.

Local dynamics in a closed ecosystem model

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Abstract. Starting from a general mathematical model for a closed three populations ecosystem with delay and using a specific distribution function a 5D model is derived. Subsequently, the model is reduced to a 4D continuous dynamical system. Local dynamics and bifurcations are found and investigated for the reduced model. Finally, the results are compared to the ones previously derived for the general model.

References

[1] M. Kloosterman, S.A. Campbell, F.J. Poulin, A closed NPZ model with delayed nutrient recycling, *J. Math. Biol.* **68** (2014), 815–850.
[2] L. Perko, Differential Equations and Dynamical Systems (Third Edition), Springer Verlag, New York, 2001.
[3] M. Sterpu, C. Rocşoreanu, R. Efrem, S.A. Campbell, Stability and bifurcations in a Nutrient–Phytoplankton–Zooplankton model with delayed nutrient recycling with Gamma distribution, *Mathematics* **11** (2023), no. 13, Art. 2911. https://doi.org/10.3390/math11132911

Application of interpolation in generating smoother roads

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Abstract. The purpose of my presentation is to use interpolation to generate a smoother path by selecting only a sparse subset of points in a path. We selected the main points that shape the road and we applied interpolation to get a smooth road. We repeated the process for road sections that had tight curves. This idea is part of a larger project where we were automatically designing a road.

A population model with pseudo exponential survival

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Abstract. The paper considers a model for population dynamics with age structure. Following Dufresne (2006) and Beghriche et all (2022), the probability of survival is assumed to be a linear combination of exponentials, and a product of a polynomial and an exponential. The number of births in unit time is characterized through a system of ordinary differential equations. This is solved explicitly in special cases, which leads to closed form expressions for the population size. The later allows an assymptotic analysis with three cases; the population goes extinct, explodes or converges to a finite number depending of the interplay between model parameters. From a practical standpoint our modelling approach leads to a better fit of population data when compared to the exponential survival, and it is also allows for more shapes of population as a function of time.

2020 Mathematics Subject Classification: 37N25, 39A06, 44A10, 92D25.
Key words and phrases: Dynamical systems, Population dynamics, Differential-difference equation, Laplace transform.

On multiplication groups of loops

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Abstract. We consider the total multiplication group of a quasigroup $(Q, \cdot)$, i.e. the group $TMlt(Q, \cdot) =< L_a, R_a, D_a | a \in Q >$, where L_a, R_a, D_a are left, right and, respectively, middle translations of $(Q, \cdot)$. It is known the role of the multiplication group (the group generated by all right and all left translations) in the general theory of quasigroups and loops [1], in particular in solving questions concerning the nilpotency, solvability of loops. The normality of the multiplication group in $TMlt(Q, \cdot)$ is studied. Characterizations of the stabilizer $(TMlt(Q, \cdot))_1$ and of the center of total multiplication groups in loops are given.

References

[1] Drapal A., Syrbu P. Middle Bruck loops and the total multiplication group. Results Math **77**, 174 (2022).

The limiting behavior of constrained minimizers in variable exponent spaces

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Abstract. In this talk we discuss the asymptotic behavior of the sequences of nonnegative minimizers for two families of constrained minimization problems considered on a given open and bounded set from the Euclidean space $\mathbb{R}^N$ $(N \geq 1)$ and involving variable exponent growth conditions. In both cases we show that the limit is the distance function to the boundary of the domain normalized in a given Lebesgue-type space involved in the construction of the two problems. In particular, our results complement to the case of variable exponent analysis similar studies available in the literature. This is a joint work with Mihai Mihăilescu.

An application of moment method to uniform boundary controllability property of a semidiscrete 1-d wave equation with a lower rate vanishing viscosity

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Abstract. We study with the approximation of a boundary control of the linear one-dimensional wave equation, when a lower rate numerical vanishing viscosity term is added. The high frequency spurious oscillations introduced by the classical method of space discrete numerical schemes lead to nonuniform controllability properties which are

dumped out using an additional vanishing viscosity term. We are able to prove the convergence of the sequence of discrete controls to a control of the continuous wave equation, when the mesh size tends to zero. A numerical experiment which confirm our results is also presented.

2020 Mathematics Subject Classification: 93B05, 30E05, 58J45, 65N06.
Key words and phrases: wave equation, control approximation, moment problem, biorthogonal families, vanishing viscosity.

Eigenvalue problems for nonlinear elliptic equations involving $(p_1(x); p_2(x))$-Laplacian-like operators

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Abstract. We are concerned with the qualitative and quantitative study of solutions for nonlinear eigenvalue problems. More precisely, we consider elliptic problems with Dirichlet boundary conditions which involve double-phase differential operators driven by nonhomogeneous potentials. In order to obtain our results we use variational arguments based on energy estimates and s ome well known theorems such as Ekeland's variational principle, the mountain pass theorem, the fountain theorem.

2020 Mathematics Subject Classification: 35P30, 49R05.
Key words and phrases: double-phase differential operator, variable exponent, multiplicity of eigenvalues, multiple groups of solutions, continuous spectrum.

The excitation regions of the Boolean asynchronous systems

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Abstract. A Boolean asynchronous system (or circuit) is a function $\Phi : \{0,1\}^n \to \{0,1\}^n$ whose coordinates $\Phi_1, ..., \Phi_n$ are computed, during the iterations, independently on each other.

A path is a finite sequence of states $\mu, \mu', ..., \mu''$ in $\{0,1\}^n$ that result, in succession, by iterating Φ. We denote $\mu \to \mu''$. The allowed states of the system result by indicating an initial value μ and by considering afterwards all the possibilities of making iterations.

A coordinate μ_i of $\mu \in \{0,1\}^n$ is called excited if $\Phi_i(\mu) \neq \mu_i$. The excited coordinates are the coordinates which, by computation, change their values.

In literature [1] we find the notion of excitation region presented like this: 'A connected set A of states (the set in which any two states are connected by a path totally belonging to the given set) constituting a sub-set of a set of allowed (working) states of a circuit is called an excitation region of variable z_j if z_j is excited in all the states of A and has the same value (either 0 or 1), and the set A is maximal, i.e. for any α and β such that $\alpha \notin A, \beta \in A$, and $\alpha \to \beta$ or $\beta \to \alpha$, the condition $\alpha_j \neq \beta_j$ holds'.

Our purpose is to define the excitation regions and other related concepts in an effort of constructing the foundations of this theory.

References

[1] Victor I. Varshavsky (ed), Self-Timed Control of Concurrent Processes, Kluwer Academic Publishers, 1990.

2020 Mathematics Subject Classification: 94C11.
Key words and phrases: Boolean, system, asynchronous, excited coordinate, excitation region.

Stability for a nonlinear second order ODE with coefficient functions in $W^{1,1}_{\mathbf{loc}}(0,\infty)$

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Abstract. In this paper we investigate the stability of the null solution of a nonlinear second order ODE, describing the dynamics of a 1-D damped nonlinear oscillator, in the case when its coefficient functions are in $W^{1,1}_{\rm loc}(0,\infty)$. Under assumptions more general than those from [G. Moroşanu, C. Vladimirescu, Stability for a damped nonlinear oscillator, *Nonlinear Analysis* 60 (2005), no. 2, 303–310] we obtain new stability results, by using classical differential inequalities. In addition, we deduce a new result for the uniform stability of the null solution of that equation, relying on the Lyapunov's method. Our theoretical results are illustrated with numerical simulations.

2020 Mathematics Subject Classification: 34C15, 3D20.
Key words and phrases: oscillator, uniform stability, asymptotic stability, uniform asymptotic stability.

Schedule

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13:30–14:00 Opening Ceremony (Mihai I Hall)

14:00–16:40 Plenary Lectures (Mihai I Hall)

16:40–17:00 Coffee Break

17:00–19:00 Session A and Mini-symposium

19:00–20:30 Gala Dinner (University Restaurant)

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15:00–16:40 Short Lectures, Sessions A and B

16:40–17:00 Coffee Break

17:00–19:00 Short Lectures, Sessions A and B

19:00–20:30 Dinner (University Restaurant)

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13:30–14:00 Opening Ceremony (Mihai I Hall)

14:00–16:40 Plenary Lectures (Mihai I Hall)

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14:40–15:20 **Alejandro VÉLEZ-SANTIAGO**, *Diffusion over ramified domains: solvability and global regularity* (p. 5)

15:20–16:00 **Ana Margarida RIBEIRO**, *Weak KAM solutions to the Hamilton-Jacobi equation for non-mechanical Lagrangians* (p. 5)

16:00–16:40 **Petre STAVRE**, *Geometry in its historical course and its role in modeling phenomena in physical space. Differential operators and associated invariants* (p. 6)

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18:00–18:20 **Livia BETZ**, *Existence of solutions to rate independent systems with history variable of integral type* (p. 12)

18:20–18:40 **Laurenţiu-Emanuel TEMEREANCĂ**, *An application of moment method to uniform boundary controllability property of a semidiscrete 1-d wave equation with a lower rate vanishing viscosity* (p. 22)

18:40–19:00 **Tahir COSGUN**, *Characterization of solutions to Fredholm integral equations of the first kind* (p. 14)

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18:00–18:30 **Pasquale CANDITO**, *A survey about the existence of two positive solutions for parametric singular p-Laplacian type problems* (p. 8)

18:30–19:00 **Elisabetta TORNATORE**, *Degenerate Dirichlet problems with unbounded coefficient and convection term* (p. 11)

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